Lexical semantics

What is meaning and how is it linked to word forms and to larger linguistic units?

- Word semantics
- – Prototype theory
- – Semantic distinctive features
- – Semantic fields
- – Semantic features and operations in aphasia
- Sources of data and theories
- – Deep dyslexia
- – Category-specific anomia
- – Right-hemisphere lesions and lexical-semantic problems
- – Semantic dementia
  - Methodological considerations
  - – Group studies versus case studies
- – Central or access disorder
- – Mapping of form and meaning
  - Types of process models
  - – Word comprehension
- – Word production
- Simulation
- Links to therapy

Nominalism

there are objects and phenomena in the world and words to denote them; nothing else (i.e., no intermediate representation) is needed.

Conceptualism (most often found in neurolinguistic studies):

there are concepts in our minds that link words to objects and phenomena in the world.

Conceptual realism

concepts exist in themselves, independently of human minds (e.g., so-called Platonic ideas).

Basic units of meaning

- What is or can be the basic units of meaning?
- words, parts of words, or even smaller features
- sentences, utterances, contributions, longer texts, monologues, or dialogues
- Or could they all be?
- And what is the relationship between the meanings of linguistic units and their context of use?

Anomia

Anomia (difficulties in finding "content words") is a symptom shared by almost all persons with aphasia.

(In the type of aphasia called "anomic aphasia," this is the only symptom; while in the other types of aphasia, it is one of several symptoms.)

Anomia creates problems in tasks such as naming objects (visually displayed, from verbal descriptions, or from memory).

Hypotheses about the ”mental lexicon”

Aphasic ways of searching for words and aphasic semantic word substitutions (semantic paraphasias) have been used to test different hypotheses about how a “mental lexicon” can be organized.

Central or access disorder?

A basic question is whether the “lexicon” can be disturbed in itself – that is, can its organization be affected? – or whether only the ways of accessing the lexicon can be disturbed.

Since we are dealing with **patterns of activation in the brain**, this is really a pseudo-question, or rather a question regarding the quality, degree, or variation in activation patterns

Example

Target word: LADDER

A: yes there we have it there… he had one of those yesterday the one who picked apples I know so well what it's called we have one over there by the shed no cannot

Target word: SHOEMAKER

A: carpen … no it isn't that shoebake … shoebaker, no carpen carpen

T: shoemake …

A: shoebaker

T: no shoemake …

P: shoemaker

Prototype theory

Rosch (1975)

- Categories are organized around the most prototypical exemplars, which are central and more “stable.”
- “prototypical” items, are named more easily and consistently than more “atypical” exemplars,
- exemplars that are borderline between categories are associated with the “fuzzy” fringes of the fields.

Prototype theory and aphasia

- Prototype theory
- Whitehouse, Caramazza, and Zurif (1978) (in an experiment designed by Labov, 1973).
- The task was to determine whether drawn objects were “cups,” “plates,” or “glasses.” Stimuli gradually became more similar and it was noted where each person drew the limits between the different types of objects.
- Broca’s aphasics used the same strategies as controls for classifying objects
- Anomic aphasics either showed a total inability to name objects systematically or used rules that were too simple. They were also unable to use the added context in a picture as a cue.

Superordinate-Basic-Subordinate level

Prototype theory has been combined with considerations of different levels of abstraction in a hierarchical organization of semantic categories into

- superordinate (animal)
- basic (dog)
- subordinate (poodle)

levels.

It has been claimed that base-level words are more likely to be prototypical, and remain more "robust" for many persons with aphasia

Therapy effects

Studies by Kiran and colleagues have shown that there is a **semantic complexity effect**, in that *training on atypical examples of animate and inanimate categories and their semantic features leads to improvement in the naming of more typical exemplars* as well, whereas the reverse does not hold

Semantic Distinctive Features

- The idea is that a category can be identified and described with reference to the **necessary and sufficient conditions for belonging to that category.**
- This process therefore involves **decomposition into more primitive or basic features**.
- Examples of semantic distinctive features are
- [+living], [+male], [– adult] for *boy*.

Semantic features and aphasia

- The words the participants had to classify were *mother, wife, cook, partner, knight, husband, shark, trout, dog, tiger, turtle,* and *crocodile*.

- The controls tended to classify the words into the *human* and *animal* categories,
- Broca's aphasics divided them into *human + dog* versus *other animals*.

- Controls then sorted the animals according to species.
- Broca's aphasics sorted them into more or less dangerous groups.

Controls used semantic features in a systematic, “technical” way.

Broca’s aphasics used temporary and conspicuous features and were more dependent on emotional and situational influences.

Wernicke’s aphasics used indeterminate and deviant features and were generally “out of focus.”

Semantic fields or networks

- Semantic fields or networks are groupings of words according to semantic similarity, or contiguity (co-occurrence), relations.
- Hierarchical and similarity-based word association network used by Collins and Quillian (1969), based on “is a” relations between words; for example, a *poodle* is a *dog*, a *dog* is an *animal*.
- Especially for natural kinds, this is a good way of describing paradigmatic, similarity-based relations.

- Collins and Loftus (1975)
- model of word meanings based on semantic similarity.

- Words are activated by *spreading activation in the network when related words are aroused*.

- This is the basis for *semantic priming* of word recognition
- (i.e., that a word is recognized faster if it has been preceded by a semantically related word).

There are, however, also syntagmatic semantic field relations between words, based on contiguity or co-occurrence. Such relations exist between word pairs such as *cat* and *dog*, *eat* and *food*, or *red* and *light*.

Similarity - Contiguity

- Similarity and contiguity relations interact in determining association strength between words.
- For example, *cat* and *dog* both belong to the same category in a hierarchical, similarity-based field,
- but they also tend to co-occur in expressions such as *cats and dogs*.
- Semantic fields can be based on relations between words, which are in turn based on relations between objects, events, and properties in the world.

Semantic fields and aphasia

Wernicke's aphasics in particular have difficulties in recognizing and using the relations.

Luria (1976) claimed that words have graded semantic associative fields.

Goodglass and Baker (1976)

- parts of these fields could be damaged selectively
- object naming was affected by how much of the semantic field was accessible.

Task: to name objects and then judge whether other words were associated with the object names

The speed of recognizing associated words was measured.

All subjects had shorter response times for words associated with objects that they had been able to name.

Certain associated words were consistently easier, while others were harder to recognize.

Meaning potential and semantic operations

Words have meaning potentials and have their specific meaning determined by the current context (Allwood 1999, 2003).

Context determination of meaning is crucial and lexical semantics works by semantic operations on meaning potentials.

Semantics and pragmatics are, thus, unified.

This perspective is also important when looking at communicative contributions in context

Semantic features and operations in Aphasia

An intended target word is very often replaced by a word that is semantically and/or phonologically related to it.

The semantic relation can be based on similarity or contiguity (i.e., co-occurrence).

Some semantic relations that are often found in these situations are

same semantic category

superordinate

subordinate

part for whole

attribute

spatial relation

functional-causal relation.

Many semantic substitutions and paraphrases (circumlocutions) describe situational features, indicating a need to contextualize.

More substitutions seem to move in the direction from abstract to concrete than in the opposite direction, indicating difficulties with *abstraction*

(Allwood & Ahlsén, 1986, 1991).

- Same category: *cat* for *dog*
- Superordinate: *dog* for *poodle*
- Subordinate: *poodle* for *dog*
- Part for whole: *trunk* for *elephant*
- Attribute: *yellow* for *banana*
- Spatial relation: *head* for *cap*
- Functional causal relation: *kick* for *ball*
- Circumlocution: *he had one of those yesterday, the one who picked apples we have one over by the shed* for *ladder*

Category-specific Anomia

anomia that affects a certain category of words, but leaves other categories unaffected.

Nouns vs verbs

Nouns and verbs can be selectively disturbed in relation to each other.

Verbs - nonfluent, agrammatic aphasics with frontal lobe lesions.

Nouns - persons with anomia, who have temporal-parietal lesions.

The verb disorder can be considered in relation to a possible frontal encoding of verbs of movement and action

It may also be related to the role of verbs in grammatical structure.

The noun disorder would be more related to the association of sensory features.

Concrete vs abstract

Concreteness effect:

concrete nouns are more easily activated.

Why?

- concrete nouns have richer representational structures in memory, including, for example, a nonverbal image coding?
- more contextual information?
- a larger set of semantic features?

But some (albeit few) persons with aphasia activate abstract nouns more easily.

Another argument is that concrete nouns are specifically associated with sensorimotor (including perceptual) attributes

If these attributes are disturbed, abstract nouns would be easier to access than concrete ones.

Natural/living objects vs artifacts

Selective disturbances of

- words for either natural objects (animal, fruits, vegetables) or
- artifacts (tools, furniture, etc).

Such patients may have very vague semantic information about one of the category types, but very detailed semantic information about the other type.

Why?

- mainly perceptual/sensory versus mainly functional/motor basis (for natural objects and artifacts, respectively)

Support: naming of animals resulted in activation in the left medial occipital lobe, while naming of tools activated the left premotor area.

or

we really have more detailed category-specificity in the organization of our mental lexicon.

- Semantic word substitutions seem to keep "within category" and resemble "speech errors" made by normal speakers (e.g., *big* becomes *small*) (Buckingham, 1979). Others have studied conceptual organization. Zurif, Caramazza, Foldi, and Gardner (1979) found that both Broca's and Wernicke's aphasics had difficulties in structuring lexical knowledge by conceptual features. The subjects first had to sort words according to thematic relations and common conceptual features. Then they were given a word recognition test in order to see whether these relations were actually used. The words were related in the following ways:

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NECK  –  HEAD  – locative – CAP
  |         |      relation
+body     +body
  part      part
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SAW – instrumental –  WOOD – BRICK
        relation        |        |
                    building  +building
                    material   material
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Methodological Considerations

- Groups studies vs case studies
- Central or access disorder

Mapping of Form and Meaning

- How words are processed - how form and meaning are mapped onto each other in language production and comprehension.

  in relation to process models of different types and to the units studied,
- How much top-down versus bottom-up processing is assumed to take place?
- When we understand speech, do we start by mapping words or morphemes to meaning units and construct the meaning of larger units from this mapping,

  or do we start with expectations and hypotheses about the meaning of a specific word or utterance based on background knowledge, situation, and linguistic context?

  or do the two types of processing interact and, if so, how?

Models for word processing

- Many of the earlier studies, and present-day studies as well, are based on **serial models**, such as
- Garrett’s (1982) or
- Levelt’s (1989) model of speech production or
- the PALPA model (Kay, Lesser & Coltheart, 1992) of speech recognition/comprehension,
- as well as the search and cohort models for visual and auditory word recognition presented below.

Interactive activation models

- Interactive activation models, simulated in artificial neural networks (ANN) are, however, being used more and more,
- for example, the TRACE model for recognition/ comprehension and
- the IAM model for production used by Dell and coworkers

Word comprehension models

- Forster’s *active search model*
- Morton’s *logogen model,* which posit a passively responsive lexicon where different units are activated by incoming stimuli
- the *cohort model* proposed by
- the *TRACE model* of

Active direct search models

- In an *active, direct search* lexicon, it is assumed that one searches for matches of an incoming stimulus word in "bins" containing word representations (auditory or visual) which are ordered by some principle, for example, how frequently they have been encountered. The word representations in the "bins" are then linked to a "lexical master file," where phonological and semantic cross-references exist. Similarly, a word can be accessed from a semantic representation in production.

Passive indirect responsive models

- In a *passive, indirect, responsive* model, like the *logogen* model, auditory and visual incoming word stimuli can activate a specific "logogen" (recognition unit) if the stimulus is strong enough (i.e., contains enough activation and not too much inhibition in relation to the features of the logogen to get over its activation threshold). The logogens are also connected to a semantic cognitive lexicon, which can increase or decrease the activation and thus affect which logogen is activated.

Cohort model

A *cohort* model stresses the incremental build-up of activation as, for example, a written word is encountered letter by letter and a particular word is selected at a particular decision point. An early perceptual analysis determines that a set of words are possible candidates and recognition proceeds by eliminating the candidates from left to right

The TRACE model

- The *TRACE* model is a highly interactive model for spoken word recognition, emphasizing top-down processing, or dependence on the context, in word recognition. It claims that lexical knowledge helps acoustic perceptual processes.

Lexical Decision Experiment

	Words	Nonwords (made by changing letters in real words)
Frequent bisyllabic nouns	40	40
Infrequent bisyllabic nouns	40	40

Semantic priming

- A specific instance of the lexical decision task is **semantic priming**, where the relationship between two stimuli is investigated.
- The first stimulus is presented, followed by the second, which is the target word to decide on (as a real word or a nonword). Semantic priming tasks can establish patterns of association.
- Semantically related word as prime word facilitates the recognition (lexical decision) of the target word, when compared to a unrelated prime word.
- For example, the word *orange* is recognized faster as a real word if it has been preceded by the prime word *apple,* than if it has been preceded by, for example, the word *chair*.

Effects in word recognition that models have to explain

- The frequency effect: The more frequent a word is, the faster it is recognized.
- The length effect: The shorter a word is, the faster it is recognized.
- The concreteness effect: The more concrete a word is, the faster it is recognized.
- The word superiority effect: A letter is recognized faster in a word than if it occurs in isolation.
- The word/nonword effect: Words are identified as words faster than nonwords are identified as nonwords.
- The context effect: words are identified faster in context.
- The degradation or stimulus quality effect: A word that is presented clearly is recognized faster than a word that is blurred in some way (e.g., covered by a grid), if it is presented visually.

Word production models

Garrett's (1982a) production model and

Levelt's (1989) model for speaking are examples of influential **serial production models**

Interactive activation models have been presented by Dell and coworkers, Harley, and others

Levelt's model for speech production

Counter evidence to serial production

- **Blend**s, where two word forms are combined in the "word" that is finally produced - lexical semantics and phonology can mutually influence each other.
- *E.g. plower,* combining *plant* and *flower*.

- **Substitutions where the target and the substitute have both a semantic and a phonological relation** (e.g., *cat* for *rat, thumb* for *tongue*) are much more frequent than one would expect if the two levels did not interrelate in some way
- But the interaction is limited, so that processing is only semantic at first, while in the last stages phonology seems to dominate.

Simulation of aphasic word substitutions

Simulations of aphasic word substitutions have been done, using **artificial neural networks**

- modeling the interaction between phonology and semantics.

Interactive activation models are nonmodular (i.e., each process is not self-contained).

Activation spreads bidirectionally in a continuous flow. In this way, earlier and later “stages of processing” influence each other.

A compromise model which is interactive but contains a lexical and a phonological stage was developed by Dell et al. (1997) and can be used as an example.

Dell's ANN model

It is a *localist* model, that is, *nodes* correspond to psychological properties (one-to-one).

Three levels of nodes are included: *semantic features*

known words

phonemes

All connections between nodes are excitatory and bidirectional. All connections have the same (preset) *weight* and there is a preset *decay* factor (which determines how fast the activation of nodes decays) and normally distributed noise. External updating is used initially by activating the semantic features of the target word.

Simulation - semantic vs phonological errors

This model allows simulation of dissociations between patients with mostly semantic and mostly phonological errors.

Lesions affecting the **decay factor** produced **semantic, mixed, and formal errors**. If they were not severe, there was a semantic component in most errors.

Lesions affecting **connection weight**, on the other hand, produced mostly **phonological errors**.

Combinations of the two types of lesions resulted in intermediate, mixed patterns. The model could also simulate longitudinal data for the patients, with the same factors simulating the later stage, only closer to normal values.

Therapy

Lexical-semantic research at the single-word level has inspired a number of therapy methods, which are designed to train word association patterns, for example,

- Luria's restoration therapy (Luria, 1963),
- Deblocking therapy (Weigl & Bierwisch, 1970),
- BOX therapy (Visch-Brink, Bajema, & Van de Sandt-Koenderman, 1997)
- Semantic Association therapy (e.g., Martin & Laine, 2000).

Assignments

- Look at the following list of semantic word substitutions:
    1. football -> balloon
    2. hose -> house
    3. poodle -> lion
    4. zebra -> trunk
    5. donkey -> horse
    6. doll -> cap
    7. boy -> man
    8. spade -> garden thing
    9. orange -> apple
    10. green -> purple
- Try to explain each substitution:
    (a) in terms of semantic fields, prototype theory, or semantic distinctive features;

    (b) in terms of one or more diagnoses, indicating in which patients such a substitution might occur;

    (c) in terms of what type of model – a serial (Levelt-type) model or an interactive activation (Dell-type) model – you think would best explain the substitution.