Language production

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Outline
- Word naming
  - Structure from dissociations: “lexemes”?
  - Two approaches
  - Two models
  - Computational simulations
- Sentence production
  - Normal model
  - Sentence production in aphasia

Sources of evidence
- This is going to be a story based on:
  - Dissociations in aphasia
  - Psycholinguistic experiments in normals
  - Errors of production

Word naming
- Components of word naming system derived from aphasic dissociations
  1. Anomia due to semantic impairments
     - category-specific or category-general
     - correlation of comprehension and production deficits suggests single semantic system
  2. Anomia without semantic impairment
     (e.g., patient EST - Kay & Ellis, 1987)
     - difficulty retrieving content words
     - cueing with initial phoneme helps
     - high freq word forms easier than low freq
     - picture sorting / matching intact

Non-linguistic assessment of semantics

EST: Speech output
Cookie jar picture:

Role of frequency?
Marshall (1987): you can replicate anomic speech using just 100 most common English words.
(3) Neologistic jargonaphasia
- Output mostly nouns and function words, plus nonwords
- Frequency effect? (function words high freq)

Subject RD: Ellis et al., (1983)

(3) Neologistic jargonaphasia (cont.)
- Just more serious version of output lexicon damage than in (2)?
- But lack of awareness + poor comprehension = added comprehension deficit / pure word deafness?
- Inflections present but produced to be consistent with neologised word => separate inflection system acts on ROOT produced by Output lexicon
  Talk/t/ Declar/d/ Spout/ed/
  Declared --> Dislap -->dislap/t/ not dislap/d/

(4) Articulation disorders
- Problems of coordination and control of articulatory muscle groups
- Can occur if comprehension and productive knowledge of word forms (cf. rhyme judgement, # of syllables) both intact

Conclusion: (minimally) separate semantic system, output lexicon, and speech articulation

Why three models?
- Distinction between concepts (pre-linguistic) and semantics (meanings related to individual words)?
- Postulation of lemma? = (modality-neutral) identity of word including grammatical info prior to accessing phonological form
  - Evidence in favour of lemmas - grammatical info available to speaker without phonological form, e.g. TOT gender in French
  - Evidence against lemma - modality-specific output deficits inc. semantic errors (e.g. naming but not writing) - implies direct connection from semantics to modality of output (Chialant et al., 2002)
Word naming

(Static localist models produce limited range of hypotheses?)

Two approaches

- Two historical approaches to theories of word production
  - (1) Explain pattern of errors
  - (2) Explain time taken to produce word names (e.g., from pictures)

Relation of normal errors to aphasia

- It has been argued aphasic errors are exaggerated versions of normal speech errors
- Normal speech errors:
  - Semantic: “I really like to – hate to get up in the morning”
  - Phonological: “insect” for “index"
  - Neologisms: [given definition of platform for public speaking] “strow...strum...rostrum!”
  - Phoneme selection: “cuff of coffee” for “cup of coffee”

Semantic errors in normals

- An actual transcript of a call a woman made to a travel agent:
  
  WOMAN: I want to go from Chicago to Hippopotamus.
  TRAVEL AGENT: Err... are you sure that’s the name of the town?
  WOMAN: Yes, what flight do you have?
  TRAVEL AGENT: We don’t have anything flying to Hippopotamus.
  WOMAN: Oh, don’t be silly. Check your map.
  TRAVEL AGENT (after some time): You don’t mean Buffa... do you?
  WOMAN: That’s it. I knew it was a big animal.

Two approaches

- Chronometric
  - Deduce real time patterns from interference patterns or priming effects

Table 1. The implicit priming method: priming the first syllable of a homophone word

<table>
<thead>
<tr>
<th>Condition</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Set 5</th>
<th>Set 6</th>
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</tr>
</tbody>
</table>
Computational models (1)

- Dell et al. (1997)
- Explains mixed errors (+ others)
- Assumes INTERACTIVITY!

Computational model (1)

- Dell et al. model claimed to explain normal errors BUT ALSO aphasic errors if two parameters varied
  - Strength of connections
  - Rate at which unit activation decays
- Making two assumptions:
  - Assumption of global damage
  - Interactivity of processing

Or so they thought...

Computational models (1)

- Foygel and Dell (2000)
- Correct ± error types

Computational models (1)

- What sort of errors can the model not possibly make, varying just its 2 parameters?

Because model is interactive, it struggles to account for patients showing semantic only or phonological only errors...

Computational models (1)

- Attempt to rescue model by rejecting globality assumption (allow selective connection damage S=>L or L=>P)
Computational models

- Implemented models produce progress because:
  - They force detailed specification of theory
  - The result is testable against quantitative data

Computational models (2)

- WEAVER (Roelofs, 1997; Levelt)
  - Attempts to explain priming / interference data
  - Assumes no interactivity between lemmas and form (phonology)
  - Has to explain mixed errors via a checking mechanism

Computational models (2)

- 2-step discrete model
- Aims to explain inflectional processes and stress patterns
- Also addresses syllabification, waits for word selection to be complete
- Stared syllable vocabulary drives articulation

Word naming: conclusions

- Consensus on separation of semantic system and phonological forms
- Debate concerning necessity of modality-neutral lemmas and how syntactic info is encoded
- Debate concerning need for interactivity
- Debate concerning relation of normal to aphasic errors
- Computational models from different traditions

Sentence production

- What's involved?

Bock and Levelt (1994) schematic model
Sentence production

- Distinguishes functional level representation and positional level representation
- Precise nature of roles to be filled at functional level not yet clear (probably depends on info carried by verb, what additional roles it requires)
- Model is sequential (top to bottom): same debate as in naming whether interactivity is required

Four levels

- (1) Message level: generating what is to be said [requires perspective taking]
- (2) Functional level: selecting major lexical concepts for conveying the intended message and assigning grammatical roles or syntactic functions
- (3) Positional level: assembling phonologically realised words and morphemes into sentence frame
- (4) Sound level: programming articulatory processes

Verbs imply roles and syntactic structures

Sentence production in aphasia

- Problems with this analysis
  - overlap of symptoms between Broca’s and Wernicke’s
  - differentiation with each syndrome

Interpreting agrammatism

- Saffran, Schwartz and Marin (1980)
  - Agrammatic speech generated without benefit of logical relations among lexical elements (functional level)
  - Speech produced is direct mapping from elements of message to skeletal structural form (e.g. noun-verb-noun)
  - Model not currently detailed enough to go much further
**Constructional deficits**

- Asked to describe a picture of a cow kicking a horse, but to start his sentence with "horse"

The horse ... The horse kicks the cow. The horse kicks the cow. The horse is going to kick. Jeez! The horse kicks. The horse is kicking. How is the horse. The horse.

**Interpreting agrammatism**

- Dissociation between morphological aspects and structural aspects of agrammatism needs to be explained
- One proposal: articulation impairment affects grammatical morphemes only when functional structures also disordered (Saffran et al.)
- Even bound vs. free grammatical morphemes dissociate

**Varieties of constructional deficit**

- Second form of simplification: absence of elaboration within phrases (adjectives, prepositional phrases)
  - Martin et al. (1998) => deficit in maintaining lexical/semantic information in memory when planning phrases
- Fragmented utterances, words produced outside of sentence structures, paucity of verbs
  - Saffran et al. (1980) => problem selecting verb lemmas which would specify argument structure linking noun lemmas to syntactic functions
- But few word-order problems in free speech of aphasics (they are found in elicitation) [English]
  - Lexical-semantic factors may affect word order more in aphasics => e.g. reliance on animacy to order nouns would not produce order violation

**Sentence Production: conclusions**

- Sentence production model requires more detailed specification to interpret aphasic data
- Discrete levels of planning for sentence production may have very specific cognitive support systems, rather than general “computational resource” (cf. syntactic, lexical-semantic, phonological working memories)
- May have implications for matching functional structure to neural substrate and imaging data

**Brain activations for production vs. comprehension**

**Emergence of language sub-networks**

- Silent speech > mouth movements
- Hand movement to object > unrelated hand movement to object
- Auditory sentences > reversed speech
- Visual sentences > meaningless symbols
**Single case study**

- **Auditory words**
  - LEFT hem
  - activates auditory cortex
  - Z scores = infinity!

- **Visual words**
  - RIGHT hem
  - activates visual cortex
  - Z scores = infinity!

**The mini-experiments**

- **Auditory words**
  - reversed

- **Visual words**
  - reversed

- **Speech production**
  - Mouth movements

- **Action retrieval**
  - Hand movements