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
    - 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
EST, Cookie jar picture:

Role of frequency? Marshall (1987): you can replicate anomic-like speech using just 100 most common English words
Word naming

(3) Neologistic jargonaphasia
- Output mostly nouns and function words, plus nonwords
- Frequency effect? (function words are high frequency)

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/

Word naming

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

Word naming

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

Word naming

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
Word naming

- 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)

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] “straw... 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 Buffalo, 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 big/little words |
|--------------------------------------|------------------------|
| Homogeneous condition | Homogeneous transition |
| Set 1 | Set 2 | Set 1 | Set 2 | Set 1 | Set 2 |
| Single-tone | glass-steam | glass-beam | glass-beam | glass-beam | glass-beam |
| Single-tone | apple-beam | apple-beam | apple-beam | apple-beam | apple-beam |
| Single-tone | pond-steam | pond-steam | pond-steam | pond-steam | pond-steam |
| Single-tone | snow-steam | snow-steam | snow-steam | snow-steam | snow-steam |

Computational models (1)

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

- Foygel and Dell (2000)
  - Correct + error types
  - 6 dimensions ['projected' onto 2...]

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)

Note: 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 word 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

  - Stored 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

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

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

Verbs imply roles and syntactic structures
- **SOMEONE**
- **SOMETHING**
- **TO SOMEONE**

Interpreting breakdown
Sentence production in aphasia

- Problems with this analysis
  - overlap of symptoms between Broca’s and Wernicke’s
  - differentiation within 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 simplified: 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
  - [hint: use the passive!]
  - The horse ... The horse kicks the cow. The horse kicks the cow. The horse is kicking. 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.)
- But 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
  - Saffran et al. (1980) => problem selecting verb lemma 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”
- Separate syntactic, lexical-semantic, phonological working memories
- May have implications for matching functional structure to neural substrate and imaging data
Brain activations
Production vs. Comprehension

Emergence of language sub-networks
(Price, Thomas, Richardson & Donlan, in progress)

- 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 > Visual words (activates auditory cortex) Z scores = infinity!
- Visual words > Auditory words (activates visual cortex) Z scores = infinity!

The mini-experiments

- Auditory words > reversed
- Visual words > reversed
- Speech production > Mouth movements
- Action retrieval > Hand movements