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 that low freq
    - picture sorting / matching intact

Non-linguistic assessment of semantics

?

EST: Speech output

EST, Cookie jar picture:

content word-finding difficulties with okay grammar, plus awareness of errors

Er. . . two children, one girl one male . . . the . . . the girl, they're in a. . . and their, their mother was behind them in in, they're in the kitchen. . . the boy is trying to get. . . a. . . er, a part of a cooking. . . jar. . . He's standing on. . . the lad, the boy is standing on a. . . standing on a. . . standing on a. . . I'm calling it a seat, I can't. . . I forget what it's, what the name of it is. . . . It is er a higher, it's a seat, standing on that, 'e's standing on that. . . this boy is standing on this, seat. . . getting some of this er stuff to. . . biscuit to eat. As he is doing that, the post, it's not a post, it's the, seat, is falling down, is falling over. . .

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

I have one or more of them. It's a... I like them. It must be over there in the... by the.... but it's not. My... also made one for some... that he had been with in the... as a... it was before he had his... most of them are like that. They can also be had from the.... a man has them, many of them, but a new one would be even more of a.... Did you have one when you were with them? You said that you had one from the time that you were at.... No, if that were so, you could not have made so much... at it all these years. Even then it's not the first new one that I must have been through.

Word naming

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

Word naming

Nonwords correctly inflected

A *bun, bun* (BULL)... a *buk* (BULL) is *cherchin* (CHASING) a boy or *skert* (SCOUT). A *sk*... boy *skut* (SCOUT) is by a *hone poe* (POST) of pine. A... post... *pone* (POST) with a, er, *tone ioe* (LINE?) with *washingt* (WASHING) hanging on including his *socks sqz* (?). A... a *nek* (TENT) is by the washing. A b-boy is *swr'ing* (SWINGING) on the bank with his hand (FEET) in the *strings* (STREAM). A table with *orstrum* (SAUCEPAN?) and... I don't know... and a three-legged *stroe* (STOOL) and a *strane* (PAIL)—table, table... near the water. A er *trowlvot* (TRIVET), three-legged er er means for hanging a *tong, tong* (PAN?) on the *fyest* (FIRE) which is blowed by a boy-boy. A boy *skrut* (SCOUT) is up a tree and looking at... through... *hone*(?) glasses. A man is knocking a paper... paper with a *notist* (NOTICE) by the er t-tent, tent er *tet* (TENT) er tent.

Subject RD: Ellis et al., (1983)

Word naming

- (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/

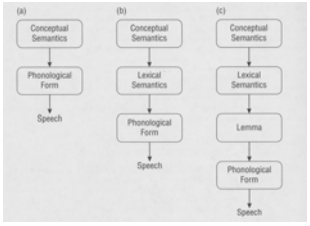
Declared => Dislap =>dislap/t/ not dislap/d/

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



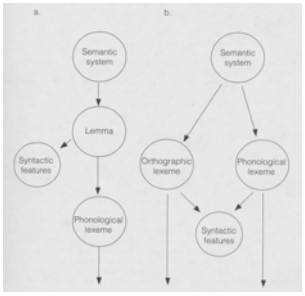
Word naming

- 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)

Word naming



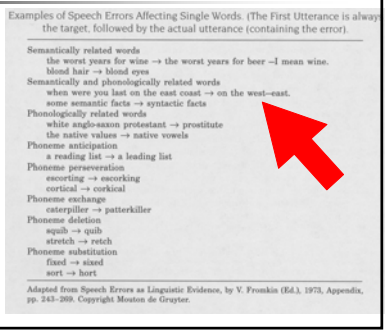
(Static localist models produce limited range of hypotheses?)

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)

Two approaches

- Word errors
  - Deduce functional structure from the way that naming can go wrong in normal individuals



Examples of Speech Errors Affecting Single Words. (The First Utterance is always the target, followed by the actual utterance (containing the error).

Semantically related words
the worst years for wine → the worst years for beer –I mean wine.
blond hair → blond eyes
Semantically and phonologically related words
when were you last on the east coast → on the west–east.
some semantic facts → syntactic facts
Phonologically related words
white anglo-saxon protestant → prostitute
the native values → native vowels
Phoneme anticipation
a reading list → a leading list
Phoneme perseveration
escorting → escorking
cortical → corkical
Phoneme exchange
caterpiller → patterkiller
Phoneme deletion
squib → quib
stretch → retch
Phoneme substitution
fixed → sixed
sort → hort

Adapted from Speech Errors as Linguistic Evidence, by V. Fromkin (Ed.), 1973, Appendix, pp. 243–269. Copyright Mouton de Gruyter.

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 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

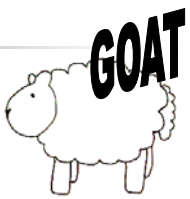


Table 1. The implicit priming method: priming the first syllable of bisyllabic words

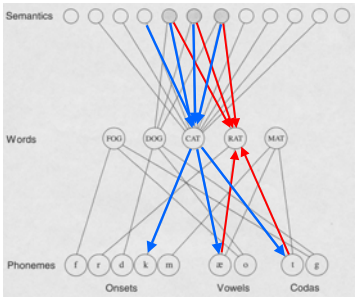
Homogeneous condition			Heterogeneous condition		
Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
single–loner	signal–beacon	captain–major	single–loner	place–local	fruit–lotus
place–local	priest–beadle	cards–maker	signal–beacon	priest–beadle	glass–beaker
fruit–lotus	glass–beaker	tree–maple	captain–major	cards–maker	tree–maple

Computational models (1)

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

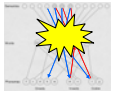
RAT instead of **CAT**

- Assumes INTERACTIVITY!



Computational model (1)

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



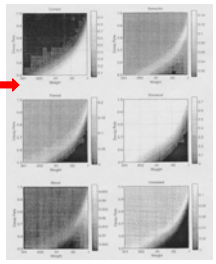
Or so they thought...

Computational models (1)

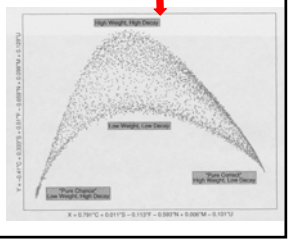
- Foygel and Dell (2000)

Correct + error types

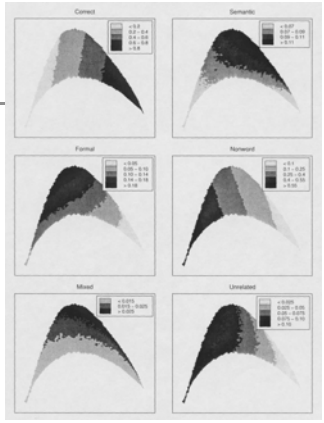
Correct
Semantic
Phonological
Nonword
Mixed
Unrelated



6 dimensions 'projected' onto 2...

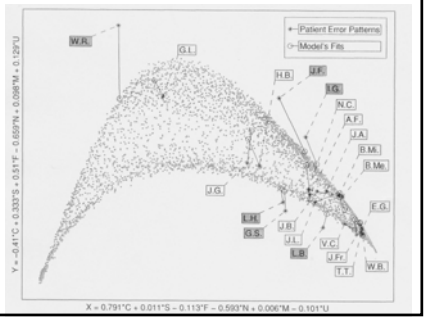


What sort of errors can the model not possibly make, varying just its 2 parameters?



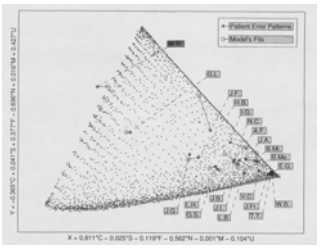
Computational models (1)

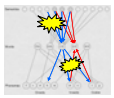
Because model is interactive, it struggles to account for patients showing semantic only or phonological only errors...



Computational models (1)

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



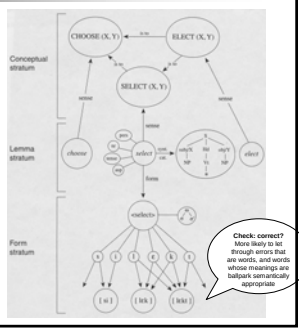


Computational models

- 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

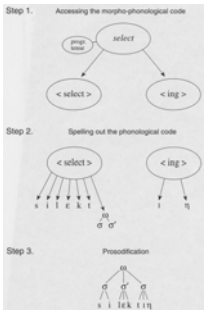


Computational models (2)

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

"Select me" => si-lekt-mi "Select us" => si-lekt-tus

- Stored syllable vocabulary drives articulation



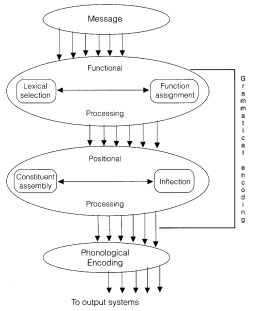
Word naming: conclusions

- 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



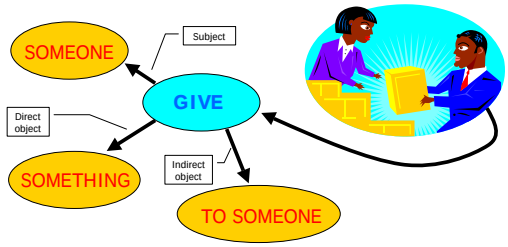
Four levels

- (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

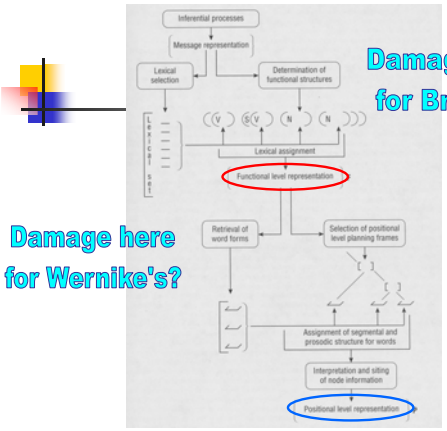
Sentence production

- Normal model: Garrett (1988), Bock & Levelt (1994)
- 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



Interpreting breakdown



Schematic of Garrett's (1988) model of sentence production

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

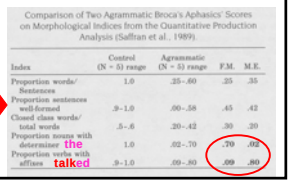
Constructional deficits

- E.g. Thompson & Faroqi-Shah (2002): CH
- 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. Jeese! 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


Comparison of Two Agrammatic Broca's Aphasics' Scores on Morphological Indices from the Quantitative Production Analysis (Saffran et al., 1989).

Index	Control (N = 5) range	Agrammatic (N = 5) range	F.M.	M.E.
Proportion words/ Sentences	1.0	.25-.60	.25	.35
Proportion sentences well-formed	.9-1.0	.00-.58	.45	.42
Closed class words/ total words	.5-.6	.20-.42	.30	.20
Proportion nouns with determiner the	1.0	.02-.70	.70	.02
Proportion verbs with affixes talked	.9-1.0	.09-.80	.09	.80

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 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

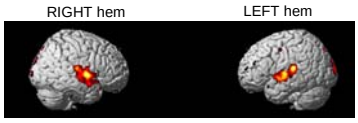
Brain activations
Production vs. Comprehension

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

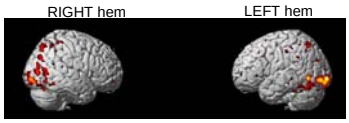
- Silent speech > mouth movements
- Hand movement to object > unrelated hand movement to object
- Auditory sentences > reversed speech
- Visual sentences > meaningless symbols

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