We're Talking Stressed

A Domain-General Approach
to Language Disorders

Overview

- review of localizationist models of aphasia
- domain-general approaches
- implications
- evidence from normals under stress

The Modular Perspective

SOUND/VISUAL INPUT

↓

phonology

↓

lexicon

↓

grammar

↓

sentence meaning

The Past Tense Debate

The Dual Route Model
- irregulars ('go' → 'went')
    - → association (lexicon)
- regulars ('walk' → 'walked')
    - → rule (grammar)

*Pinker (1999); Pinker & Ullman (2002);
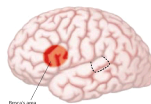Ullman et al. (2005)*

Aphasic Deficits
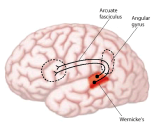
Broca's Aphasia
inferior frontal lesions
- nonfluent speech
- good comprehension
- grammatical deficit

Wernicke's Aphasia
posterior temporal lesions
- fluent speech
- poor comprehension
- lexical-semantic deficit

Grammar in Broca's Aphasia

production of morphology and complex sentences
omission/substitution of grammatical morphemes,
avoidance of passives
sentence-picture matching
*(Caramazza & Zurif, 1976; Caplan et al., 1985; cf.
Caplan, 1992)*
errors on passives and embedded clauses
morphological priming
*(Blumstein et al., 1991; cf. Marslen-Wilson & Tyler,
1997, 1998)*
absence of priming for morphological agreement
past tense generation/reading
(Ullman et al., 1997a,b)
errors on regular past tense forms

Lexical-Semantics in Wernicke's Aphasia

spoken word production and picture naming
semantic paraphasias, word-finding difficulties

word-picture matching *(Goodglass & Baker, 1976)*
selection of semantic foils

semantic clustering *(Zurif et al., 1974)*
failure to show normal category structure

relatedness judgments *(Milberg & Blumstein, 1981)*
unable to indicate whether two words are related

Grammaticality Judgments

- Broca's are better than chance
- Wernicke's aren't

Does this make sense?

'How many did you see birds in the park?' ✗
'Is the boy having a good time?' ✓
'John is very tall, doesn't he?' ✗
'He came my house ten o'clock.' ✗
'She went up the stairs in a hurry.' ✓

Linebarger, Schwartz, & Saffran (1983)

'Whodunit?' Task

'Cat.' 'Dog.'

'Who is doing the action?'

Active	'The dog is hitting the cat'
Subject Cleft	'It's the dog that is hitting the cat'
Passive	'The cat is hit by the dog'
Object Cleft	'It's the cat that is hit by the dog'

'Whodunit' Task

- Broca's *and* non-agrammatic aphasics show poor performance on complex sentence types

Dick, Bates, Wulfeck, Aydelott Utman, & Dronkers (2001)
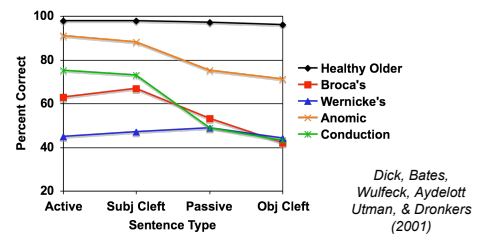
Semantic Priming

- Wernicke's show reliable priming
- Broca's don't

Paired
PRIME	war	cat	(ring)
TARGET	peace	peace	(glarf)

List
CAT ... STOVE ... BLICK ... **WAR** ... **PEACE** ... FENT ... JUDGE

(Milberg & Blumstein, 1981; Blumstein, 1997)

Semantic Priming

- CONTROLS: more related pairs = larger priming effect (*strategic processing*)
- WERNICKE'S: **no** relatedness proportion effect
- BROCA'S: **increased** relatedness proportion effect

Milberg, Blumstein, Katz, Gershberg, & Brown (1995)

Domain-General Performance Deficits

Broca's
- impaired facilitation
- spared judgments
- spared strategies
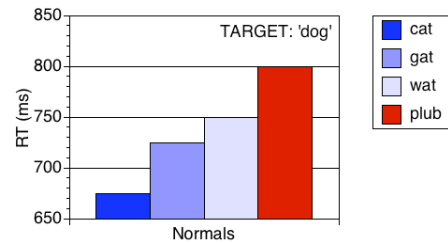
➔ **impaired automatic/implicit processing**

Wernicke's
- spared facilitation
- impaired judgments
- impaired strategies
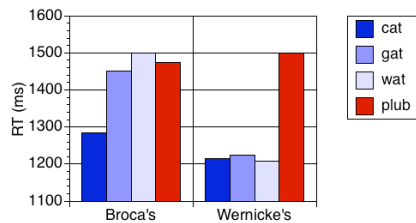
➔ **impaired controlled/strategic processing**

(Aydelott Utman, Blumstein, & Burton, 2001; Blumstein, 1997; Milberg, Blumstein, Katz, Gershberg, & Brown, 1995)

Rhyme Priming

Milberg, Blumstein, & Dworetzky (1988)

Rhyme Priming

UNDERACTIVATION   UNDERINHIBITION

Milberg, Blumstein, & Dworetzky (1988)
cf. Aydelott Utman, Blumstein, & Sullivan (2001)

Behavioural Priming Effects

- **facilitation**
  - ➔ *activation* of congruent targets
  - rapid, 'automatic'
  - low attentional/processing demand
  - sensitive to acoustic variation
    (Andruski et al., 1994; Aydelott Utman et al., 2001; Marslen-Wilson, 1993; Neely, 1991; Simpson, 1994; Stanovich & West, 1983)

- **inhibition**
  - ➔ *suppression/inhibition* of incongruent targets
  - slow, 'controlled'
  - high attentional/processing demand
    (Gernsbacher, 1996, 1997; Stanovich & West, 1983; Simpson, 1994; Dagenbach & Carr, 1994)

Implications

- aspects of language processing that are disrupted in aphasia should be vulnerable to **domain-general cognitive stress**
- possible to induce aphasic profiles in **normal individuals**

Sentence Priming Paradigm

Biasing Context   **On a windy day, it's fun to go out and fly a**

Neutral Context   **Its name is**

Target

Congruent   *Incongruent*   *(Nonword)*

KITE   **TABLE**   (GLARF)

Acoustic Distortion

distortion affecting **intelligibility**
low-pass filtering, high-frequency noise
(Stuart & Phillips, 1996)
• reduced spectral information
• decreased perceptibility of phonetic contrasts

distortion affecting **processing**
increased speaking rate, competing speech
(Sommers, 1997; Gordon-Salant & Fitzgibbons, 1993, 1995)
• decreased processing time
• increased processing demand

Vulnerability of Lexical Processes

facilitation
• rapid, 'automatic'
• sensitive to quality of sensory input
• low attentional/processing demand
➔ *perceptual degradation*

inhibition
• slow, 'controlled'
• high attentional/processing demand
➔ *reduced time/increased demand*

Predictions

reduced **intelligibility**
(filtering/noise)
➔ reduced activation
➔ less facilitation
➔ less inhibition?

less **time**/more **demand**
(rapid/competing speech)
➔ reduced suppression
➔ less inhibition

Sentence Priming Paradigm with Acoustic Distortion

Biasing Context **On a windy day, it's fun to go out and fly a**

Neutral Context **Its name is**

➔ *intact or distorted*

Target

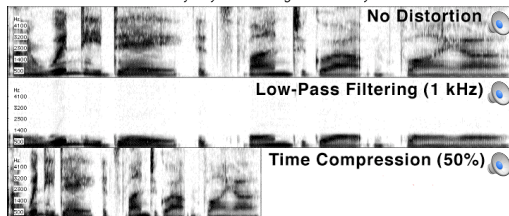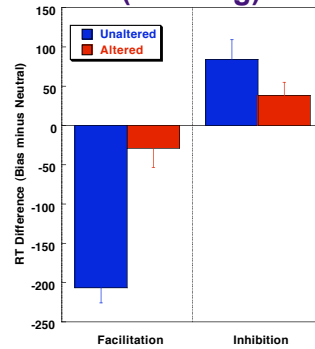| *Congruent*	*Incongruent*	*(Nonword)*
KITE	**TABLE**	(GLARF)

➔ *intact*

TASK:
'Is the target a real word?'
YES/NO

Spectrograms of Acoustic Distortions

'On a windy day it's fun to go out and fly a...'

No Distortion
Low-Pass Filtering (1 kHz)
Time Compression (50%)

Reduced Intelligibility (Filtering)

RT Difference (Bias minus Neutral)

Unaltered
Altered

Facilitation   Inhibition

Aydelott & Bates (2004)

Reduced Processing Time (Fast Rate)

Aydelott & Bates (2004)
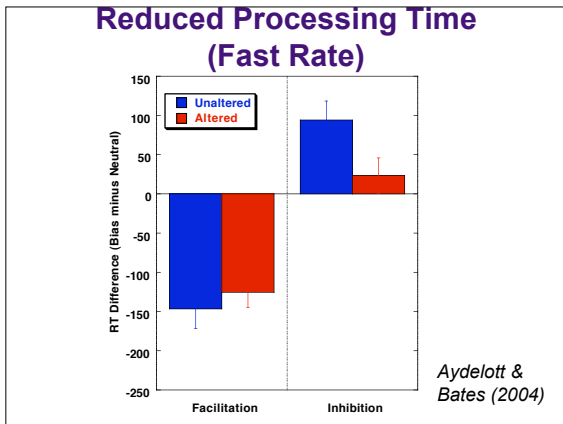
Summary

acoustic distortion reduces contextual priming effect

- distortions that reduce **intelligibility** reduce **facilitation** (& **inhibition**)
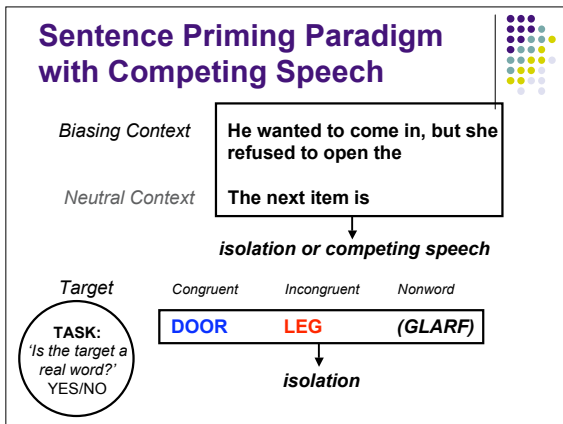- distortions that reduce **processing time** reduce **inhibition** only

➔ *lexical processes partially separable*

A Special Case: Competing Speech

- **perceptual** masking
- increased **attentional** demand
- conflicting **semantic** content

Implications

- reduced intelligibility
  - ➔ reduced **facilitation** & **inhibition**
- increased attentional demand
  - ➔ reduced **inhibition**

Sentence Priming Paradigm with Competing Speech

Biasing Context   **He wanted to come in, but she refused to open the**

Neutral Context   **The next item is**

↓

isolation or competing speech

Target

Congruent   *Incongruent*   *Nonword*

TASK: *'Is the target a real word?'* YES/NO

DOOR   **LEG**   *(GLARF)*
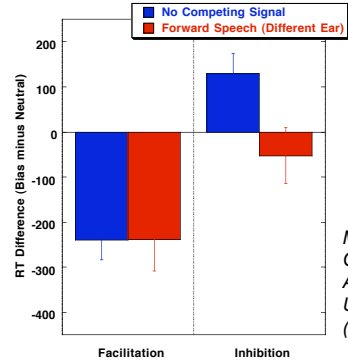
↓

isolation

Competing Signal Conditions

- **isolation** (no competing signal)
- **forward speech** (different ear)
- **backward speech** (different ear)
  - similar acoustic properties
  - no semantic content
- **forward speech** (same ear)
  - spectral masking
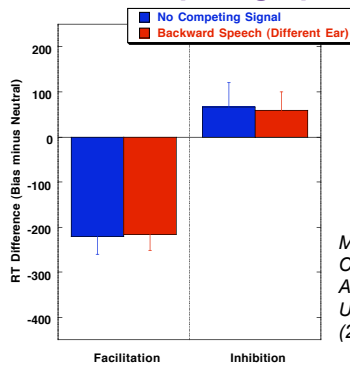 - reduced intelligibility

Predictions

- **same ear** speech
  - ➜ reduced **facilitation** & **inhibition**
- **different ear** speech
  - ➜ reduced **inhibition**
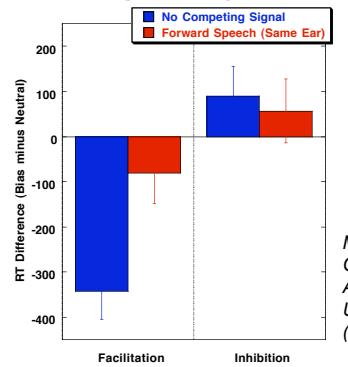 - ➜ semantic content?
    (**forward** vs **backward** speech)

Forward Competing Speech

Legend:
- No Competing Signal
- Forward Speech (Different Ear)

y-axis: RT Difference (Bias minus Neutral)
x-axis: Facilitation, Inhibition

Moll, Cardillo, & Aydelott Utman (2001)

Backward Competing Speech

Legend:
- No Competing Signal
- Backward Speech (Different Ear)

y-axis: RT Difference (Bias minus Neutral)
x-axis: Facilitation, Inhibition

Moll, Cardillo, & Aydelott Utman (2001)

Forward Speech (Same Ear)

Legend:
- No Competing Signal
- Forward Speech (Same Ear)

y-axis: RT Difference (Bias minus Neutral)
x-axis: Facilitation, Inhibition

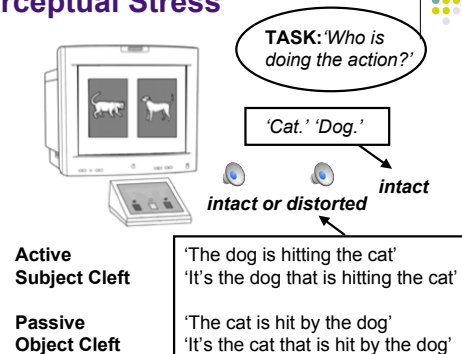*Moll, Cardillo, & Aydelott Utman (2001)*

Summary

competing signal modulates contextual priming effect

- forward speech reduces **inhibition**
  - ➡ increased attentional demand
- backward speech has **no effect**
  - ➡ demand depends on semantic content
- forward speech presented to *same ear* reduces **facilitation**
 - ➡ reduced intelligibility

Moll, Cardillo, & Aydelott Utman (2001)

'Whodunit' Task with Perceptual Stress

TASK: *'Who is doing the action?'*

'Cat.' 'Dog.'

→ *intact*

intact or distorted

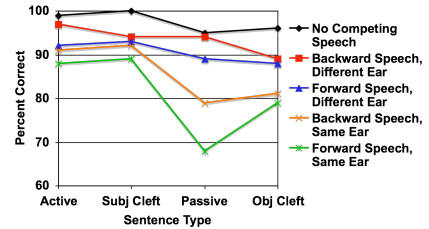|	
Active Subject Cleft	'The dog is hitting the cat' 'It's the dog that is hitting the cat'
Passive Object Cleft	'The cat is hit by the dog' 'It's the cat that is hit by the dog'

'Whodunit' Task with Perceptual Stress

- healthy young adults listening to degraded speech show poorer performance on complex sentence types

Dick, Bates, Wulfeck, Aydelott Utman, & Dronkers (2001)
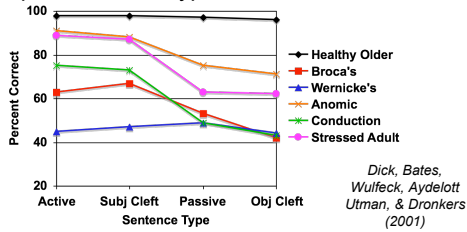
'Whodunit' Task with Competing Speech

Leech, Aydelott, Symons, Carnevale, & Dick (in press)

Verbal and Nonverbal Comprehension in Aphasia

related distractor
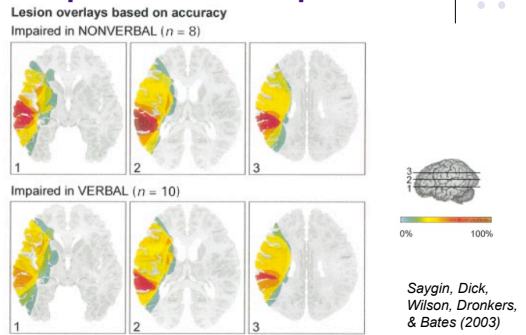
verbal cue
'cow mooing' [spoken words]

non-verbal cue
'moo-oo!' [cow sound]

unrelated distractor

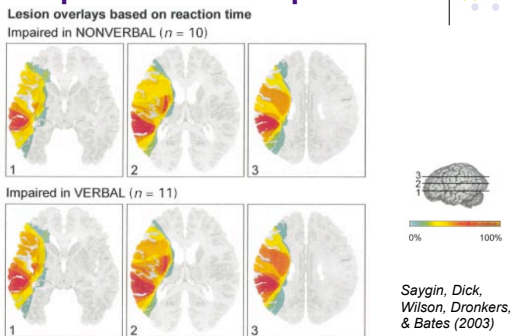**TASK:**
'Which picture matches the sound?'

Saygin, Dick, Wilson, Dronkers, & Bates (2003)

Verbal and Nonverbal Comprehension in Aphasia

Lesion overlays based on accuracy
Impaired in NONVERBAL (n = 8)

Impaired in VERBAL (n = 10)

Saygin, Dick, Wilson, Dronkers, & Bates (2003)

Verbal and Nonverbal Comprehension in Aphasia

Lesion overlays based on reaction time
Impaired in NONVERBAL (n = 10)

Impaired in VERBAL (n = 11)

Saygin, Dick, Wilson, Dronkers, & Bates (2003)

Conclusions

- apparent 'language-specific' deficits may result from **domain-general disturbances**
- normal language comprehension may be selectively vulnerable to **general cognitive stress**