

# Cognitive Neuropsychology of Language

Michael Thomas  
Birkbeck College

## Introduction

- Structure of the course
- Historical background to aphasia
- Two modern approaches
- Basic forms of aphasia

## Course

Disorders of Language, Spring 2004		
Lectures 10.00am to 11.30am, Thursdays Room 534 Birkbeck College Main Building (note except Week 9: Room 406)		
Wk1	Thursday 15 <sup>th</sup> Jan	Introduction to aphasia and its basic forms
Wk2	Thursday 22 <sup>nd</sup> Jan	Acquired Comprehension Deficits
Wk3	Thursday 29 <sup>th</sup> Jan	Guest Lecture: Dr. David Green: <i>Aphasia in bilinguals</i>
Wk4	Thursday 5 <sup>th</sup> Feb	Guest Lecture: Dr. Cathy Price: <i>Functional imaging of semantic retrieval</i>
Wk5	Thursday 12 <sup>th</sup> Feb	Guest Lecture: Dr. Sophie Scott: <i>Neurobiology of speech perception</i>
Wk6	Thursday 19 <sup>th</sup> Feb	READING WEEK
Wk7	Thursday 26 <sup>th</sup> Feb	Acquired Production Deficits
Wk8	Thursday 4 <sup>th</sup> Mar	Developmental disorders of the language system
Wk9	Thursday 11 <sup>th</sup> Mar	The right hemisphere: Speculation, plasticity, and recovery (Note: to be held in Room 406)
Wk10	Thursday 18 <sup>th</sup> Mar	Guest Lecture: Dr. Jennifer Aydelott: <i>Speech perception psycholinguistics and aphasia</i>
Wk11	Thursday 25 <sup>th</sup> Mar	Connectionist models of language deficits
Seminar 1	4-5pm on Thursday 5 <sup>th</sup> February	Category-specific deficits
Seminar 2	4-5pm on Thursday 4 <sup>th</sup> March	Treatment of aphasia

## Reading List

Disorders of Language: Reading List	
<p><b>General sources</b></p> <p>Faig, B. (2001) <i>The handbook of pediatric neuropsychology</i>. Hove: Psychology Press. (Chapter 9, 12, 13, 17)</p> <p>Hill, A. &amp; Young, A. W. (1996) <i>Brain cognitive neuropsychology: a practical approach</i>. Hove: Psychology Press. (Chapters 14, 9)</p> <p>Hill, A. (2002) <i>The handbook of adult language disorders</i>. Hove: Psychology Press.</p> <p>Anderson, D. (2001) <i>Neuropsychology: From theory to practice</i>. Psychology Press. Hove: Sussex. (Chapter 12, 10, 11)</p> <p>Kell, B. &amp; Whalen, T. (2001) <i>Psychology of human neuropsychology 2<sup>nd</sup> edition</i>. New York: Worth Publishers. (Chapter 9)</p> <p>Hill, A. (2002) <i>The main site for language</i>. London: Allen Lane.</p> <p><b>Notes for specific topics</b></p> <ul style="list-style-type: none"> <li><b>Neuro-anatomy</b></li> <p>Price, C. J., &amp; Friston, K. J. (2002) Emotion and cognitive anatomy. <i>Trends in Cognitive Sciences</i>, 6(2), 30-32.</p> <li><b>Psycholinguistics and aphasia</b> <p>Hill, F., Hill, C., Walsh, B., Arnold-Ulman, J., Doolan, N., &amp; Gernsbacher, M. A. (2001) Language deficits, handwriting and grammar: Evidence for a distributed model of language production in agrammatic patients and neurologically intact individuals. <i>Psychological Review</i>, 108(2), 267-284.</p> <li><b>Category-specific deficits</b> <p>Faig, B., Hill, C., &amp; Marshall-Crampton, W. (2002) Category specificity in brain and mind. <i>Brain Science</i>, 2(2), 17-24.</p> <p>Polzella, F. (2001) Brain reflections of words and their meaning. <i>Trends in Cognitive Sciences</i>, 5(2), 37-38.</p> <p>Hill, A. &amp; Crampton, A. (2001) The organization of category memory. In B. Rapin (Ed.), <i>The handbook of cognitive neuropsychology</i> (p. 42-60). Hove: Psychology Press.</p> </li></li></ul>	<p><b>Developmental disorders</b></p> <p>Thomas, M. &amp; B. Rapin (Eds.). (2002). An developmental disorders: The state of adult brain damage: Implications from computerized modeling. <i>Behavioral and Brain Sciences</i>, 25, 22-34, 37-700.</p> <p>Temple, C.M. (1997) Cognitive neuropsychology and its application to children. <i>Journal of Child Psychology and Psychiatry</i>, 38, 27-52.</p> <p>Anderson, W., Swisher, E., Stangor, J., &amp; Warriner, J. (2001) Developmental neuropsychology: A clinical approach. <i>Science, Behavior Psychology Press</i>. (Chapter 9)</p> <p>Hill, A., &amp; Hill, C. (2001) Language development in children with unilateral brain injury. In Nelson, C. K. &amp; Eisen, M. (Eds.), <i>Handbook of developmental cognitive neuroscience</i> (p. 207-216). Cambridge, Mass.: MIT Press.</p> <p>Tombs, A. E. (1998) Language in mental retardation: Association with and dissociation from general cognition. In A. Beitch, M. H. Bishop, &amp; B. E. Right (Eds.), <i>Handbook of mental retardation and development</i> (p. 200-211). Cambridge: Cambridge University Press.</p> <ul style="list-style-type: none"> <li><b>Bilingual aphasia</b></li> <p>Carlini, T. H., &amp; Kroll, J. F. (2001) Bilingual lexical access. In B. Rapin (Ed.), <i>The handbook of cognitive neuropsychology</i> (p. 323-345). Hove: Psychology Press.</p> <p>Green, D. W. &amp; Price, C. J. (2001) Functional imaging in the study of recovery from bilingual aphasia. <i>International Journal of Language and Cognitive Disorders</i>, 26(1), 201-208.</p> <li><b>Language in the right hemisphere</b> <p>Tombs, A. E., Foyhinde, W., Lefferts-Dale, M. T., &amp; Thompson, A. (2002) The onset and maturation of right hemisphere language disorders. In A. Hill, C. Hill, (Eds.), <i>The handbook of adult language disorders</i> (p. 429-448). Hove: Psychology Press.</p> <p>Anderson, D. (2001) <i>Neuropsychology: From theory to practice</i>. Psychology Press. Hove: Sussex. (Chapter 7)</p> <li><b>Recovery and rehabilitation</b> <p>Anderson, D. (2001) <i>Neuropsychology: From theory to practice</i>. Psychology Press. Hove: Sussex. (Chapter 10, 11)</p> </li></li></ul>

## Aphasia

- Same incidence as MS or Parkinson's
- 200,000 in UK; 1M in US
- 90% caused by stroke, mostly in elderly
- Loss of (aspects of) language
- Can be accompanied by paralysis / weakness of right arm and leg

## History

- Egyptians, Greeks, Romans
  - 2800 BC: loss of language + treatment in Egyptian papyrus
  - Hippocrates 400 BC: loss of speech 'aphonia'
  - Valerius Maximus, AD 30: selective problems with reading
- Confused with paralysis of tongue, deafness, mutism, stuttering
- Relation to brain?
  - heart seen as engine of thought (Aristotle)
  - mind seen as controlled by non-physical spirit (Descartes)

## History

- 19<sup>th</sup> century
  - Gall = well-developed mental faculties correspond to large areas of cortex; language in frontal lobes
  - 1825 French physician Jean-Baptiste Bouillaud delivers scientific paper with same conclusion
  - 1830 Marc Dax, language in left hemisphere

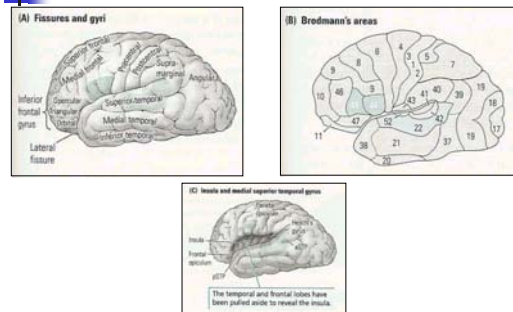
## History

- 1861 Paul Broca
  - post-mortem reports of two patients with impaired language function
  - Tan (named after one of few utterances)
  - 1863, 8 more patients
  - All cases, damage = left anterior lesion
  - Additional patient, right anterior lesion + no language impairment

## History

- Conclusion= impaired language **production** associated with left anterior damage to third frontal gyrus
- Suggestion of second type: posterior damage, impaired associations between language and thought
- Did not offer specific localisation

## Orienting our brain areas



## History

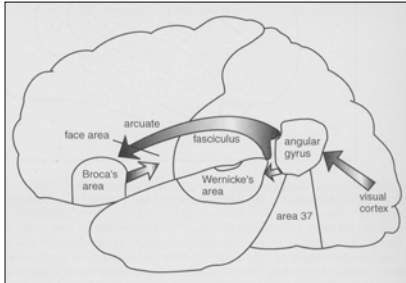
- 1884 Carl Wernicke
  - Aphasia + predominant difficulty with **comprehension** = lesions to left superior temporal lobe
  - Further type predicted, due to disconnection between anterior and posterior areas (conduction aphasia)
- 1885: Lichtheim proposes diagrammatic form of model

## History

- 1965: Geschwind extends theory to produce

"Wernicke-Geschwind" model

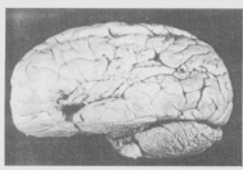
## The Wernicke-Geschwind model



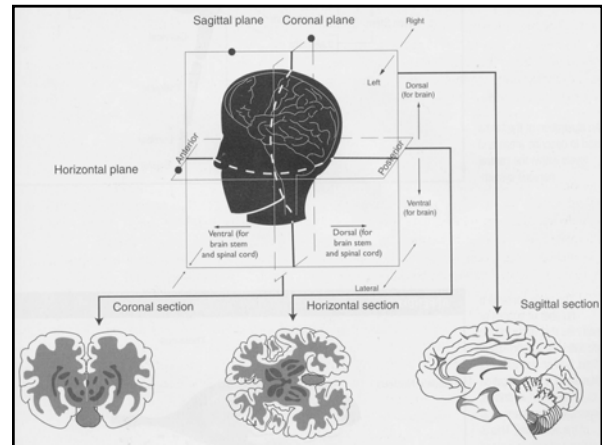
## History

- 1885-1965: Why the 60-year delay?
- Early writings of Broca and Wernicke controversial
  - e.g. Pierre Marie (1906) proposed that:
    - All aphasia has some comprehension deficit
    - Broca's aphasics = interference with more posterior zone
    - Broca's area purely for motor aspects of speech
    - Critical lesions in Broca's aphasia are sub-cortical

## The brain of Paul Broca's patient, Tan



- Note the gross subcortical extent of the lesion in the coronal section – Tan case study supports Marie?



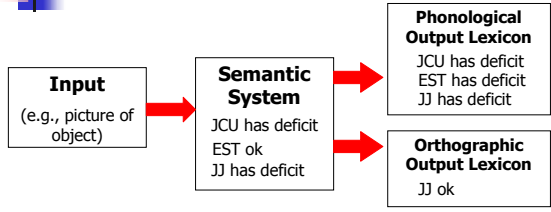
## Why the 60-year delay? (cont)

- 1860s John Hughlings Jackson - rejection of localisationist approach
- Head (1926) - more psychological description of aphasia, irrespective of neural correlates
- 1940s - Behaviourist approach rejects mentalistic analysis
  - External S-R schedules of reinforcement

## Two modern approaches

- Syndrome approach
  - Groups patients according to symptoms, looks for common patterns of underlying damage
- Cognitive neuropsychology
  - Single case studies looking for dissociations between psychological components of language system
  - Less concerned with relation to underlying substrate
- Approaches interact; imaging may bring them together
  - by showing distributed networks of brain areas that implement functional modules

## Cognitive neuropsychology



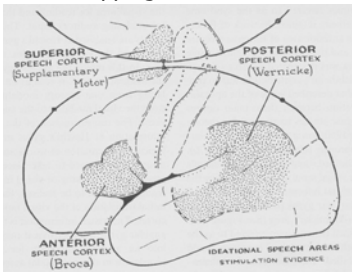
Patient JCU: naming problem with semantic errors (Howard & Orchard-Lisle, 1984)  
 Patient EST: could give precise semantic info about objects unable to name (Kay & Ellis, 1987)  
 Patient JJ: naming problems, unable to give meanings, but could write word forms (Hillis & Caramazza, 1991)

## Syndrome approach

- Let's identify the broad types of language breakdown
- First, what are the language 'areas' of the brain?

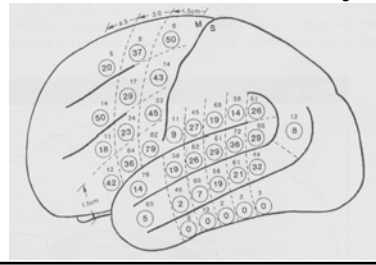
## The language areas

- Electrical mapping: Penfield and Roberts (1959)



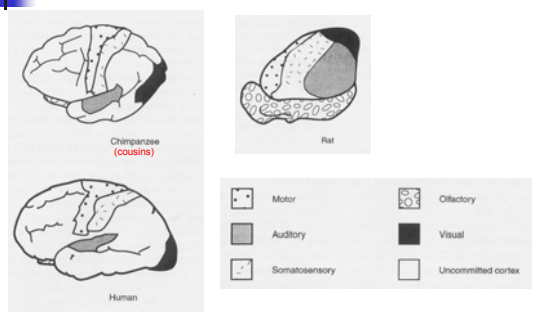
## The language areas

- Electrical mapping: Ojemann et al. (1989)  
 nos. in circles = consistent failure in naming following stimulation

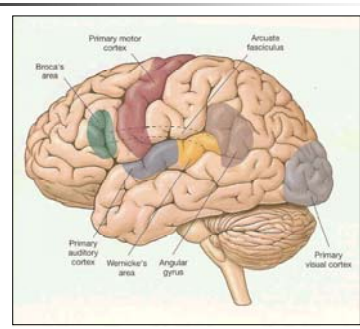


Bigger language areas?  
 or  
 Individual variability?

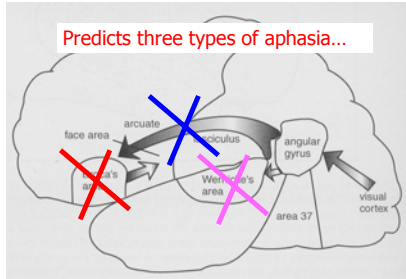
## Cross-species comparison



## Language areas



## Types of Aphasia: The Wernicke-Geschwind model



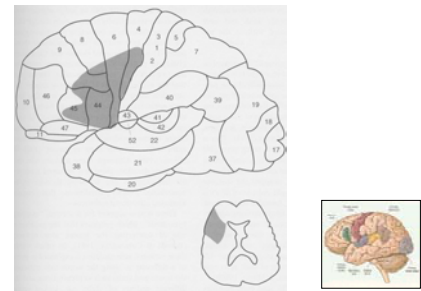
## Basic forms of aphasia

- Broca's aphasia
    - Agrammatism
  - Wernicke's aphasia
    - Jargon aphasia
  - Conduction aphasia
  - Word deafness
  - Global aphasia
  - The Transcortical aphasias
    - Transcortical motor aphasia
    - Transcortical sensory aphasia
  - Subcortical aphasia
  - Right hemisphere damage
- The Perisylvian aphasias
- Extrasyllvian aphasias

## Broca's aphasia

- Symptoms:
  - Difficulties in **production** (lack of function words and inflections), some problems in comprehension of syntax (e.g., reversible sentences)
  - Non-fluent / Agrammatism
  - **Repetition difficulties**
- Type of damage:
  - In excess of Broca's area. Arterial system means motor areas typically also damaged
- Problems with simple model:
  1. Lesion location – need to damage more than original Broca's area; Broca's alone = articulation difficulties
  2. Term too broad, individual variability of agrammatism: small vs. large Broca's patients; function word/inflection deficit dissociate from word order deficit; (syntactic) comprehension deficits

## Broca's aphasia



## Broca's aphasic

- Cinderella's story (from Saffran, Berndt, and Schwartz, 1989)

"a mother/... three kids/ ... bad mother/one kid beautiful/... rich/Italian/ ... mother/ ... stepmother/ ... talk about Cinderella/Cinderella/clean my house/ ... you Cinderella/close the door/ ... Cinderella like jail/ ... mother ... three kids/ ... I love mother/ ... Cinderella walk ball/ ... people ball/ ... rich people/ ... man and Cinderella dance dance dance party/ ... one/ ... dance dance dance/ ... dance every time/ ... ball beautiful people/ ... people watched Cinderella/ ... Cinderella ... beautiful clothes ... and garments/ ... twelve o'clock night/ Cinderella/ oh no/ oh no/ I'm sorry/ I'm sorry people/ I love you baby/ ... walk walk/ tumble/ ... one shoe bye-bye/ ... Cinderella ... pumpkin cab/ ... oh shoe/ oh please/ oh well/ walk pumpkin car/."

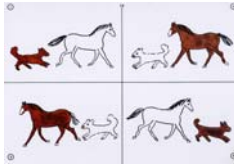
## Patient with **small** Broca's aphasia

- Initial speech assessment (Andrews, 2001, p.309)

- HH: Sometimes I say "yes" ... [halts in mid sentence] when I mean "no". I realise immediately afterwards that I have said the wrong thing and ... correct myself.
- DA: Does this happen often?
- HH: ... [Appears to be thinking about what to say and lunges forward as if forcing out the word] "No" (we both saw the humour in the situation, but he refrains from elaborating).
- DA: How does this affect your everyday life?
- HH: It's a problem when ... converse with the mates.

## (Subtler) comprehension deficits

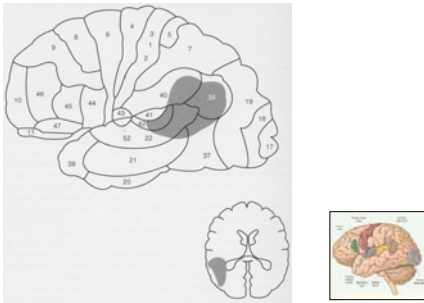
- Problems with syntactic aspects of comprehension
  - "Point to the picture that goes with *The brown dog is chased by the white horse*"



## Wernicke's aphasia

- Symptoms:
  - Comprehension difficulties
  - Fluent (sometimes excessive), word finding difficulties, paraphasias, excess of grammatical words but paucity of meaning; some syntactic difficulties
  - Severe: 'jargon' aphasia: neologisms (new words) + lack of awareness
  - Repetition difficulties
- Type of damage:
  - In excess of original Wernicke's area. Posterior superior temporal gyrus still appears crucial
- Problems with simple model:
  - Patients appear to be aware of meaning they are trying to produce: Not semantic deficit but communication with phonological output system?
  - Lack of awareness of jargon implies 'unconscious' route to production

## Wernicke's aphasia



## Comprehension in Wernicke's aphasia

SP: Could you tell me where you are?  
 Frank: ... Yes, er, I just don't feel too good.  
 SP: Are you in hospital at the present time?  
 Frank: ... That is really one thing, really I feel bad you know. Mm ... I'm not really feeling too good.  
 SP: What's wrong with you, Frank?  
 Frank: Well I don't know, to be honest you just er, there will be a few days I feel shy. Saturday was bad, I get bad, Sunday and today.  
 SP: Where do you live?  
 Frank: ... I don't know, to be honest, we've got a lot of things my dad.  
 SP: Do you live in East Keilor?  
 Frank: ... Sorry? Yeh well fair outside things, you can't do warn. I can talk but I can't show up myself. I can't put the voice. It would be one thing if I could talk. But I can't talk so people can see it.  
 SP: Are you married, Frank?  
 Frank: ... I was news to due to be.

## Patient with Wernicke's (jargon) aphasia

Interviewer: Can you tell me your address, Tom?  
 Tom: Four and pleasant, Plain Sodars. [There is no such district]  
 Interviewer: How long have you lived there?  
 Tom: I think that was only five, no eight prentices. Small plut be in there.  
 Interviewer: How old are you?  
 Tom: 80, 85 no 83 cheldren. [His age is 83 years old]  
 Interviewer: What month is it?  
 Tom: Today? Well that would be ten. If I say, it used to be called Naym Prentice.  
 Interviewer: If I said it was May, what would you say?  
 Tom: That's correct, Naym Prentice.  
 Interviewer: Could you count up to ten?  
 Tom: A, B, C, D, E, F, M, P, M.  
 Interviewer: No, say after me: 1, 2.

[Tom then proceeds to count fluently with only a few errors]

## Comparison

- Broca's vs. Wernicke's aphasics

## Cookie theft (from Boston aphasia exam)



## Wernicke's vs. Broca's aphasia

### Description of cookie theft story

#### Wernicke's patient (Goodglass, 1983)

"Well this ... mother is away here working her work out o'here to get her better, but when she's looking, the two boys looking in the other part. One their small tile into her time here. She's working another time because she is getting, too."

#### Broca's patient (Helm-Estabrooks et al., 1981)

"Well ... see ... girl eating no ... cookie ... no ... ah ... school no ... stool ... ah ... tip over ... and ah ... cookie jar ... ah ... kid ... no ... see ... water all over ... spilled over ... yuck ... Mother ... daydreaming."

## Basic forms of aphasia

- Conduction aphasia
- Word deafness
- Global aphasia
- The Transcortical aphasias
  - Transcortical motor aphasia
  - Transcortical sensory aphasia
- Subcortical aphasia
- Right hemisphere damage

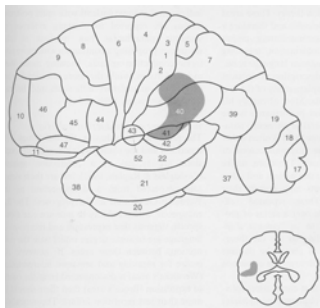
The Perisylvian aphasias

Extrasylvian aphasias

## Conduction aphasia

- Symptoms:
  - Comprehension and production relatively intact
  - Repetition is predominant impairment
- Type of damage:
  - Supramarginal gyrus and insula (close to arcuate fasciculus)
- Problems with simple model:
  - W-G model suggests disconnection but why is expression okay? Shouldn't concepts be disconnected from syntax and articulation, impairing production?
  - Possibly problem with working or short-term memory

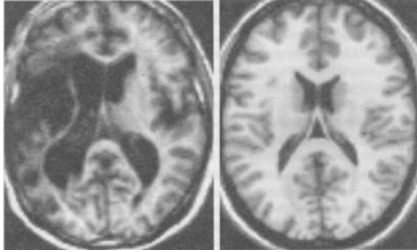
## Conduction aphasia



## Other perisylvian aphasias

- Global aphasia
  - Complete loss of language
  - If recovery, comprehension before production, to state like Broca's
- Type of damage:
  - Damage of all language areas
- Pure word deafness
  - Patients unable to hear phonological form of words
  - Production may be faultless
- Type of damage:
  - Bilateral lesions to posterior temporal plane (Heschl's gyrus)

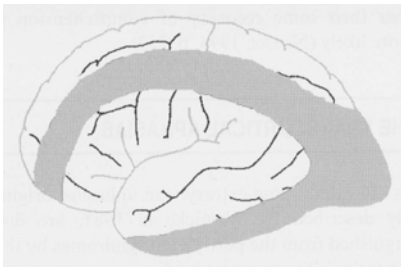
## Global aphasia



## Transcortical aphasias

- Known since Wernicke's time that aspects of Broca's and Wernicke's aphasia could appear in patients who had a **preserved ability to repeat back**.
- Due to damage outside perisylvian area – watershed infarction
- Position of damage (anterior / posterior) determines type of deficit
  - Transcortical motor aphasia (Broca-like)
  - Transcortical sensory aphasia (Wernicke-like)

## Transcortical aphasias



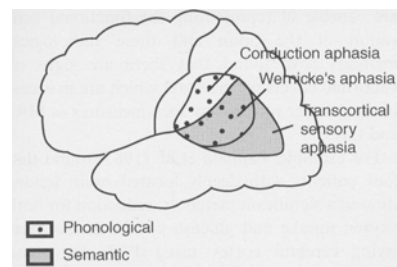
## Transcortical aphasias

- Transcortical Motor Aphasia
  - Type 1
    - Dysexecutive production problems (echolalia, perseveration)
    - Prefrontal lesion superior to Broca's area
  - Type 2
    - Motor initiation symptoms
    - Reduced motivation and drive, lower limb paralysis
    - Lesions in anterior cingulate and left supplementary motor area

## Transcortical aphasias

- Transcortical Sensory Aphasia
  - Type 1
    - Comprehension problems, extreme difficulty naming objects / pictures, semantic paraphasias, visual object agnosia
    - Damage inferior and posterior to Wernicke's area
  - Type 2
    - Word finding difficulties, few content words, difficulty with complex relational sentences
    - Superior angular gyrus and posterior parietal damage

## TSA vs. Conduction vs. Wernicke's aphasia





## Subcortical aphasia

- Can aphasia be due to sub-cortical damage (e.g., to thalamus)?
- Does it play a processing role or just connectivity?
- Nadeau and Crosson (1997) have argued subcortical damage associated with
  - Anomia in spontaneous language
  - Poor verbal fluency
  - Problems in confrontation naming

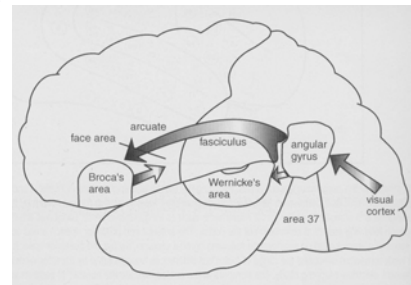
## Subcortical aphasia

- But
  - could be remote effects on distant cortical areas
  - or metabolic effects on adjacent cortical areas
- thalamus may play role in boosting focus or selectivity of function
- may be part of sub-cortical circuit for complex motor articulation

## Right hemisphere

- Damage to RH associated with deficits in prosody (production and comprehension)
- Limited speech expression
  - Swearing, emotionally charged words, singing, stereotyped phrases
- RH comprehends overall context or theme
- RH damage associated with
  - Deficits in thematic inferences
  - Deficits in non-literal language processing
  - Reduced sense of humour

## The Wernicke-Geschwind model



## Modifications to Wernicke-Geschwind model

- Broca's area associated with articulation deficits. Agrammatism requires larger area of damage
- Broca's aphasics also have comprehension deficits for information related to syntax
- Conduction aphasia not disconnection but impairment in phonological working memory
- Jargon aphasia implies dissociable conscious and unconscious routes from posterior areas to production areas
- Subcortical structures implicated in connectivity between regions
- Right hemisphere plays a role in prosody and thematic processing

## Modified model (Andrews, 2001)

