

Myth: Language = intelligence

or, Language ability necessarily  
correlates with general  
intelligence

# Those dumb foreigners?

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# Double dissociation

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Language ability    Intelligence

Low

High

High

Low

# Double dissociation

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Language ability    Intelligence

Low

High

Feral children, Genie,  
Chelsea, aphasics, SLI

High

Low

Savants, Williams Syndrome

# 'Wild children'

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Psammetichus (Psammetik, 664-610 BC):  
2 children raised by an isolated silent shepherd  
supposedly said 'becos' (Phrygian for 'bread') [Herodotus]



Emperor Frederick II (1211), searching for  
the 'language of God', raised dozens of  
children in silence

# 'Wild children'

'Victor': the 'enfant sauvage' of Aveyron (1799, age ca. 11)



(ca. 1801)



(1969)



Kasper Hauser (1828)



(1974)

# 'Genie'

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- Isolated since age 20 months, tied to a potty chair, never spoken to, beaten if she made sounds
- Discovered at age 13 (in 1970) in Los Angeles, cognitive level of a 15-month-old, 54 in., 62 lbs. (Underwent therapy and studied until 1979)



# 'Genie'

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## Negation

- Perfect on comprehension tasks
- Production: No more ear hurt.  
No like hospital.  
Not good fish tank.

## Active vs. Passive voice

(1) ACTIVE: The boy is pulling the girl.

AGENT

PATIENT

SUBJECT

OBJECT

(2) PASSIVE: The girl is being pulled by the boy.

PATIENT

AGENT

SUBJECT

OBLIQUE

Result: Performance at chance (51% correct, 49% incorrect)  
(like 4-yr-olds, some aphasics)

- No production of passives

# Critical period: Genie

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## Wh-questions

- Picture task: “Who is the girl pulling?”  
“Who is pulling the girl?”

Result: Performance inconsistent. “usually unable to respond at all even though she had been answering various types of wh-questions for more than a year. The responses she did give did not reveal any consistent strategy”

Spontaneous:

Q: “When does Curtiss come?”

Genie: “Monday.”

Q: “Where is your toy radio?”

Genie: “On chair.”

- No reported spoken production; on word card task, Genie constructed “What is under the green box?”

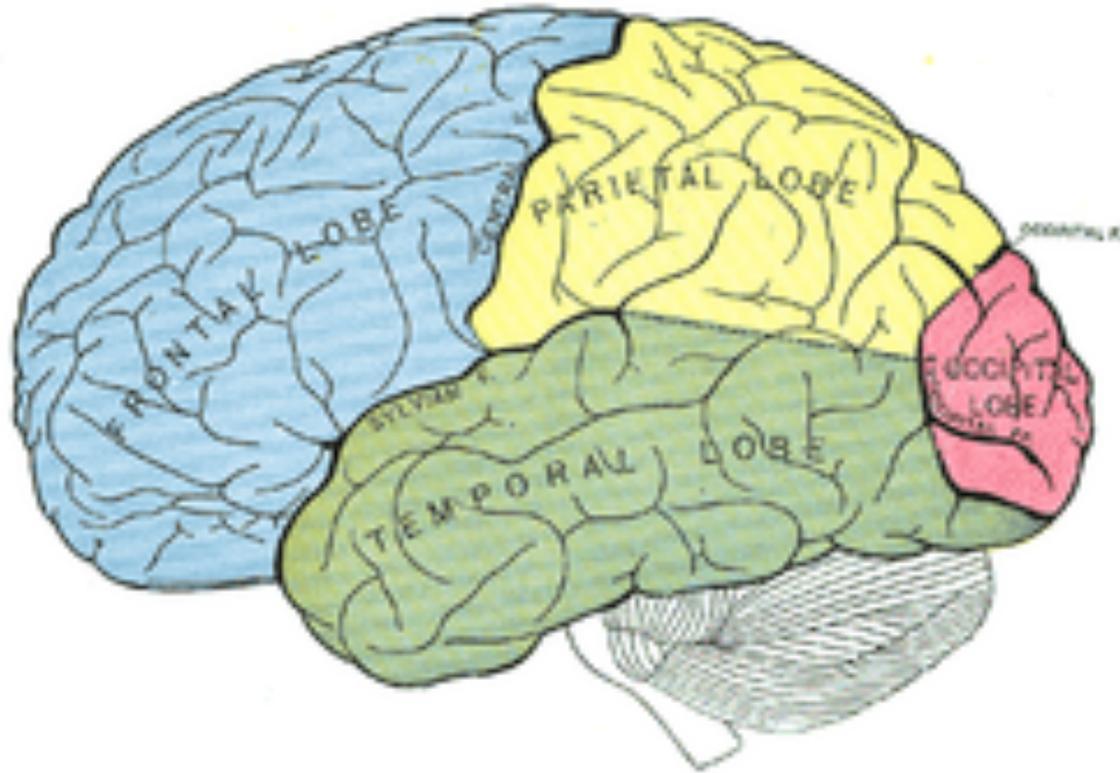
# Critical period: 'Chelsea'

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- born profoundly hearing impaired to hearing parents
- misdiagnosed as retarded, but raised by family normally (not institutionalized)
- hearing loss diagnosed at age 31, fitted with hearing aids
- after nine years with hearing aids and training (at age 40):
  - vocabulary about 2000 words
  - reading at grade 2 or 3 level
  - speaking clearly enough to shop, order in restaurants, hold a part-time job as a veterinarian's assistant
- after 12 years (at age 42)
  - production of syntactic structure about = 2.5-yr-olds
  - "hit ball"
  - "cupboard put food"
- function words and inflections largely absent, word order variable

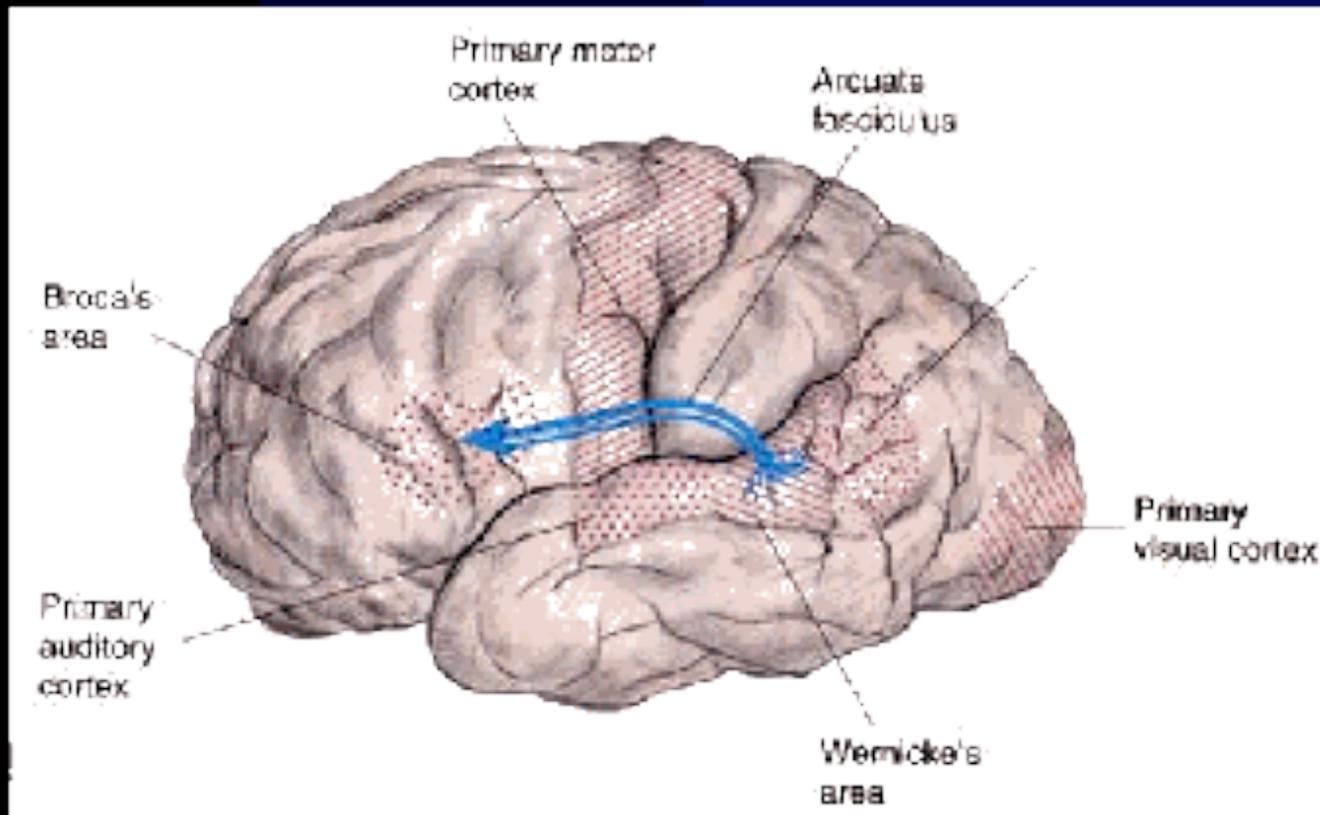
# Language in the brain

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# Language in the brain

## Wernicke-Geschwind Model



# Classical aphasiology

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Aphasia: an acquired language disorder (generally due to brain injury from trauma or stroke)



Paul Broca (1824-1880)  
French physician  
1861 post-mortem exam of 'Tan'



*Wernicke*

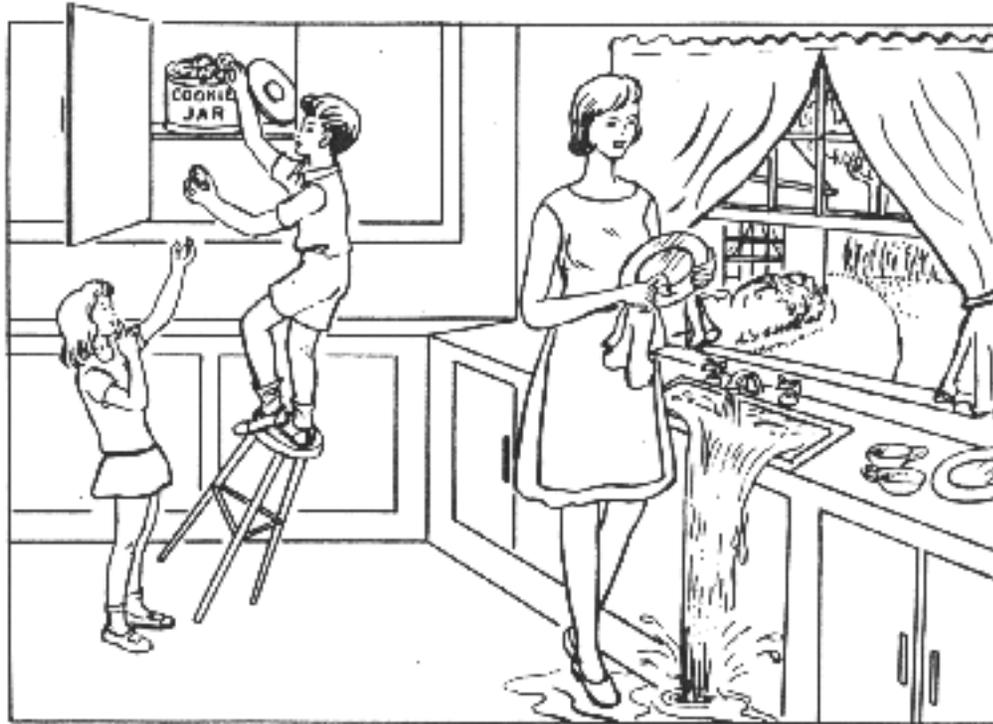
Karl Wernicke  
(1848-1905)  
German neurologist

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# Classical aphasiology

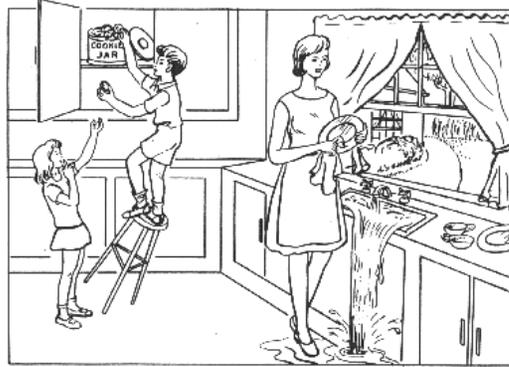
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## The cookie theft



# Classical aphasiology

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## Broca's aphasia:

B.L.: Wife is dry dishes. Water down! Oh boy! Okay Awright.  
Okay ...Cookie is down...fall, and girl, okay, girl...boy...um...

Examiner: What is the boy doing?

B.L.:Cookie is...um...catch

Examiner: Who is getting the cookies?

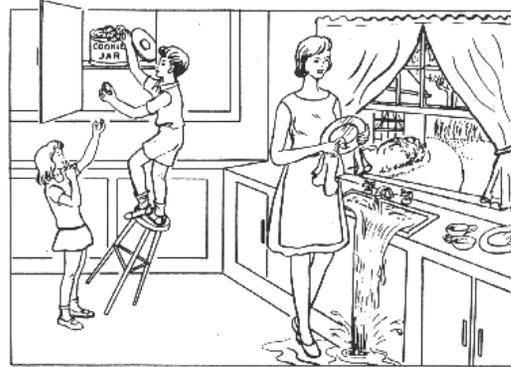
B.L.: Girl, girl

Examiner: Who is about to fall down?

B.L.: Boy...fall down!

# Classical aphasiology

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## Wernicke's aphasia:

H.W.:First of all this is falling down, just about, and is gonna fall down and they're both getting something to eat...but the trouble is this is gonna let go and they're both gonna fall down...but already then...I can't see well enough but I believe that either she or will have some food that's not good for you and she's to get some for her too...and that you get it and you shouldn't get it there because they shouldn't go up there and get it unless you tell them that they could have it. and so this is falling down and for sure there's one they're going to have for food and, and didn't come out right, the uh, the stuff that's uh, good for, it's not good for you but it, but you love it, um mum mum (smacks lips)...and that so they've...see that, I can't see whether it's in there or not.

Examiner:Yes, that's not real clear. What do you think she's doing?

H.W.:But, oh, I know. She's waiting for this!

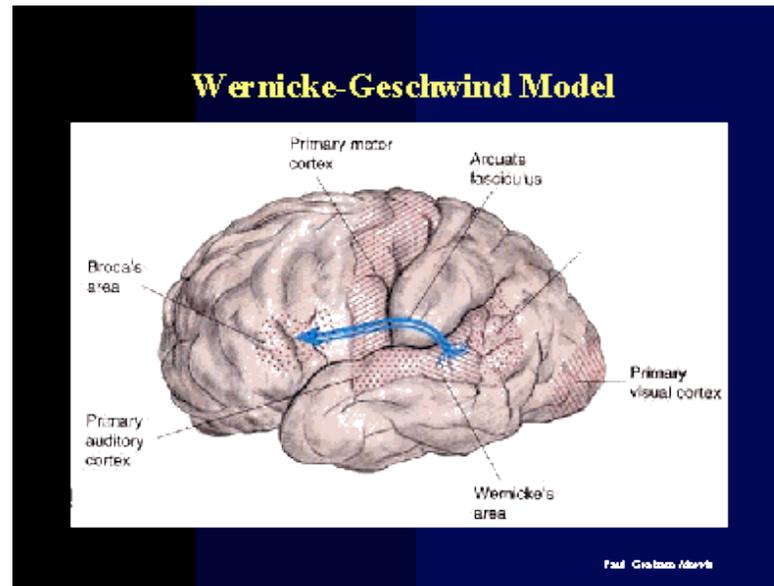
Examiner:No, I meant right here with her hand, right where you can't figure out what she's doing with that hand.

H.W.:Oh, I think she's saying I want two or three, I want one, I think, I think so, and so, so she's gonna get this one for sure it's gonna fall down there or whatever, she's gonna get that one and, and there, he's gonna get one himself or more, it all depends with this when they fall down...and when it falls down there's no problem, all they got to do is fix it and go right back up and get some more.

# Classical aphasiology

Broca's aphasia  
Front (frontal lobe)  
'production'  
expression  
motor  
'nonfluent'

Wernicke's aphasia  
Back (temporal lobe)  
'comprehension'  
reception  
sensory  
'fluent'



# Classical aphasiology

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Broca's aphasia

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'production'

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Wernicke's aphasia

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## Wernicke's aphasia:

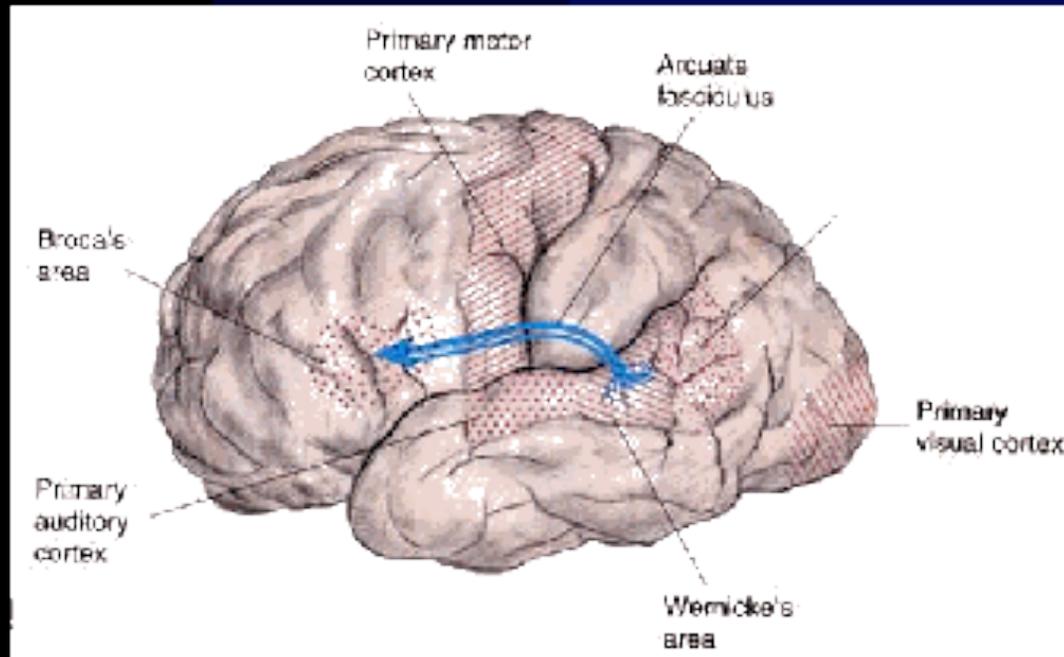
- poor comprehension (spoken & written)
- rapid and grammatical speech, low meaning-to-form ratio
- phonemic and semantic paraphrasis (circumlocution); neologisms
- poor repetition; don't detect spoken errors

## Broca's aphasia:

- speech is slow, labored, ungrammatical ('agrammatic'), telegraphic
- difficulty with 'function' words and morphology (e.g., *of, the, -s, irregular stems*)

# Classical aphasiology

## Wernicke-Geschwind Model



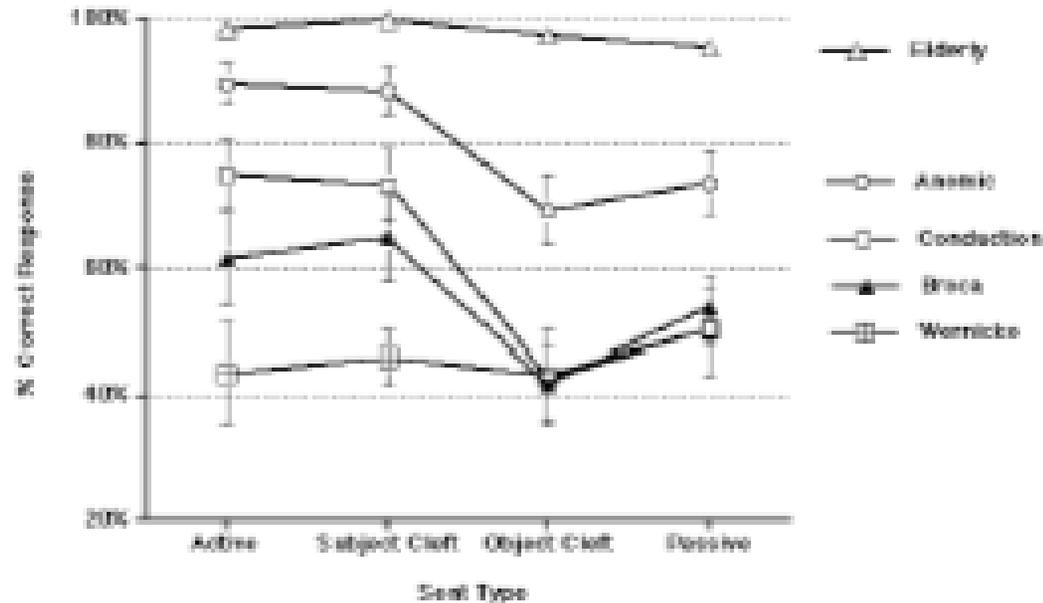
Faith Gibson / iStock

Broca's = speech motor (articulatory) difficulty (comprehension intact)

Wernicke's = Auditory difficulty (production intact)



# Broca's aphasia and grammar deficits



**Figure 5.** Percent correct response by sentence type for aphasic patients (grouped by the Western Aphasia Battery), and elderly controls (Exp. 1a).

[Dick, F. et al 2001. Language deficits, localization, and grammar: Evidence for a distributive model of language breakdown in aphasic patients and neurologically intact individuals. *Psychological Review* 108: 759-788]

# Accounts of Broca's aphasia

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1. Some part of the grammar is selectively impaired (e.g., noncanonical word order can't be normally computed)
2. Processing deficit similar to what can be induced in non-aphasics with signal degradation

# Localization (lateralization) and brain plasticity

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Age of trauma matters:

- Children who undergo left hemisphere removal surgery (functional hemispherectomy) before puberty can significantly (but perhaps not fully) reacquire language capabilities in the right hemisphere
- The degree of success in such cases is a function of age at surgery and etiology (reason for the hemispherectomy)

# Specific Language Impairment (SLI)

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- delayed onset of language
- lasting difficulties in understanding, producing, and judging grammatical sentences
- grammatical deficits
- speech dyspraxia (difficulty making the complex, oral motor movements necessary for speech)
- depressed nonverbal IQ
- nonverbal developmental learning disorders

By definition, Specifically Language Impaired people show such deficits despite the absence of cognitive problems like retardation, sensory problems like hearing loss, or social problems like autism.

# Specific Language Impairment (SLI)

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1. People with SLI judge examples like the following as acceptable:

The boy eat three cookie.

Yesterday the girl pet a dog.

2. Very poor performance on 'wug' test:

wug    wugness                    zash    zatches

zat    zackle

zoop    zoopes

tob    tobyes

3. Absent tense inflection

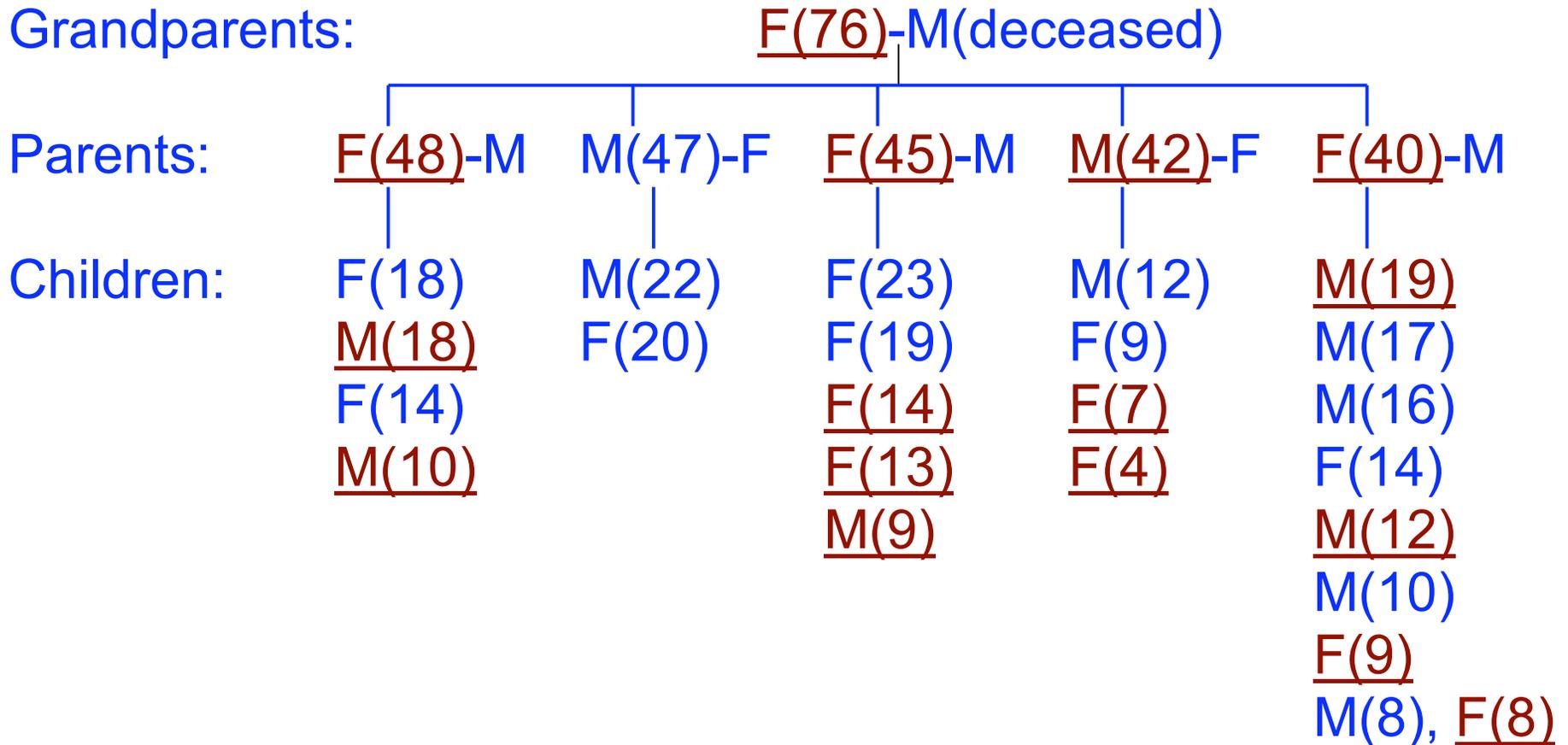
Q: Every day he walks eight miles. Yesterday he...

Response: "Walk."

Tense inflection *more* frequently absent with regular verbs than with irregulars

# Specific Language Impairment (SLI)

SLI found in KE family (affected members underlined, age in 1992 in parentheses)



Mutation in FOXP2 gene on 7q31 (a dominant gene)

# Twin studies

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Heritability: Measure of phenotypic variance that is due to genetic variance

Monozygotic (MZ) ('identical') twins are linguistically more similar to one another than dizygotic ('fraternal') twins

- environment is the same
- MZ twins share 100% of DNA, DZ 50%

Mean proband concordance rates for language disorders:

80% for MZ twins

46% for DZ twins

Is high language ability with low general intelligence possible?

# Christopher

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## Clinical history

- Born 1962; moderately brain-damaged at birth, possibly hydrocephaly, possibly due to maternal factors (mother 45, had German measles early in pregnancy)
- MRI in 1993 showed moderate cerebral atrophy with wide sulci
- Studied beginning at age 30

# Christopher

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Nonverbally, Christopher is severely impaired

- institutionalized
- cannot find his way around, poor eye-hand coordination
- IQ (Raven's Matrices, nonverbal): 75, 76
- IQ (WISC-R, performance, nonverbal part): 42, 67, 52
- Columbia Greystone Mental Maturity Scale: 68 (= mental age of 9.2 and IQ of 56)
- Embedded Figures Test (match of geometric shapes with likes embedded in more complex designs): 1 out of 12 correct
- Fails conservation of number tasks (normally passed by age 5)
- Fails 'Sally-Anne' and most related tests for appropriate attribution of beliefs to others different from one's own

# Christopher

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Verbally, Christopher is gifted

- Verbal WISC-R: 89, 102, 98
- Has some knowledge (ranging from fluency to bare elements) of 16 languages: Danish, Dutch, Finnish, French, German, Greek, Hindi, Italian, Norwegian, Polish, Portuguese, Russian, Spanish, Swedish, Turkish, Welsh

Translations:

Greek

(1) Otan perase t'amaksi, epsakse ja tis pantufles tis, ala ena paljopedho ihe pari ti mja ke efevje jelontas.

*When the car passed, she looked for her slippers, but a naughty child had taken on and was leaving laughing.*

C: 'When she passed the car ... when the car passed, she was looking for her slippers but an old child had taken one away and left ... and was laughing.'

# Christopher

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## Dutch

- (2) ‘In elk geval,’ zegt ze ‘ik zal de ketel opzetten voor een kopje thee.’ ‘Ja graag, en dan moet ik eens opstappen. Ze zal niet weten waar ik blijf.’  
*‘Anyway,’ she says, ‘I will put on the kettle for a cup of tea.’ ‘Yes, thanks; and then it will be time for me to go. She’ll be wondering when I’m coming.’*
- C: ‘ “In any case,” he --she says, “I will put the kettle on for a cup of tea.”  
“Yes, please, then I must stop. You know, you you you should not -- she shall not know where I am.” ’

## Turkish

- (3) Tatilde, herkes görmediği yerleri gezmeğe gider. Hem bilgilerini geliştirirler, hem eğlenirler ve hem de yeni yeni yerler görürler.  
*On holiday, everyone goes to visit places they haven’t seen. Either they are strengthening their knowledge, or they are enjoying themselves, or they are looking at totally new places.*
- C: ‘On holiday when I was staying in different places I saw different places. The people were were scientists and some are students and some are new [inaudible] new places.’

# Christopher

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## Novel tests:

- Rapidly acquired a new language, Berber [Afro-Asiatic]
- Correctly posited that Berber is null-subject, despite deliberate absence of relevant data in the input

## 'Null subjects': (Spanish, Italian, Greek)

- (1) Una persona inteligente habla español.  
*a person intelligent speaks Spanish*  
'An intelligent person speaks Spanish.'
- (2) El/Ella habla español.  
*He/she speaks Spanish* 'He/she speaks Spanish.'
- (3) Habla español.  
*speaks Spanish* 'He/she speaks Spanish.'

# Christopher

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Failed to acquire 'impossible' rules in a made-up language (while controls did), 'Epun'.

SV(O) positive (present and future)

VS(O) negative (present and future)

(O)SV positive (past)

(O)VS negative (past)

Negation Rule: To construct a negative clause in Epun, move the verb to the pre-subject position

Past Rule: To construct a transitive sentence in the past tense, mark the verb with *ha-* and move the object to initial position

# Williams Syndrome

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Williams Syndrome (WS) an inherited condition (1 in 20000 births, deletion of 15 or more genes from one of the two copies of chromosome 7)

## Physical abnormalities:

- Characteristic facial appearance (“pixie-like”, “elfin”: elongated mouth, upturned nose, small chin, round ears); Heart and blood vessel problems (aortic stenosis), Hypercalcemia (elevated blood calcium levels); Low birth-weight / low weight gain; dental and kidney abnormalitie; Hernias; Hyperacusis (sensitive hearing); Musculoskeletal problems

## Cognitive abnormalities:

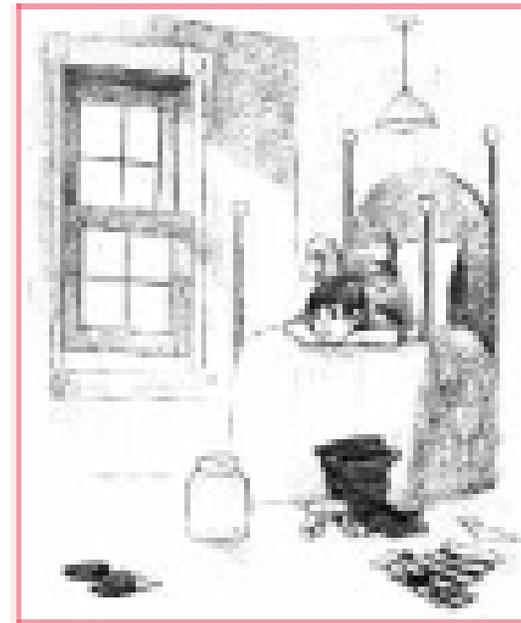
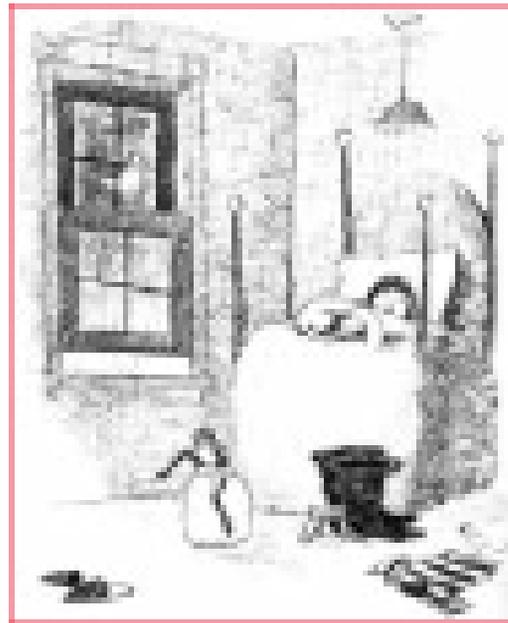
- Significant retardation (the average IQ is about 60), incompetence at simple everyday tasks (tying shoelaces, finding one's way, adding two numbers, and retrieving items from a cupboard)
- Social warmth and gregariousness (excessively social personality)
- Developmental delay, learning disabilities and attention deficit
- Fluent, (hyper)articulate language abilities



# Williams Syndrome

Stimulus: Three drawings of boy, dog, frog

**Task: INVENT A STORY FOR THE PICTURES**



# Williams Syndrome

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Stimulus: Three drawings of boy, dog, frog

Williams subject, age 17, IQ 50 “Once upon a time when it was dark at night, the boy had a frog. The boy was looking at the frog, sitting on the chair, on the table, and the dog was looking through, looking up to the frog in a jar. That night he slept and slept for a long time, the dog did. But the frog was not gonna go to sleep. The frog went out from the jar. And when the frog went out, the boy and the dog were still sleeping. Next morning it was beautiful in the morning. It was bright, and the sun was nice and warm. Then suddenly when he opened his eyes, he looked at the jar and then suddenly the frog was not there. The jar was empty. **There was no frog to be found.**”

Down Syndrome subject, age 18, IQ 55 “The frog is in the jar. The jar is on the floor. The jar on the floor. That’s it. The stool is broke. The clothes is laying there.”

# Modularity

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Two kinds of modularity:

1. **grammar** modularity

modularity of the subcomponents of the grammar with respect to one another

2. **mind** modularity (Fodorian)

modularity of the subcomponents of the mind with respect to one another

# Modularity

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modularity of the subcomponents of the grammar with respect to one another

2. **mind** modularity (Fodorian)

modularity of the subcomponents of the mind with respect to one another

Two different ways of asking about whether X is modular:

- A. Is X independent as analyzed as a static system (i.e., are there distinct, at least partially non-overlapping vocabularies and operations that X is stated over/makes use of)?
- B. Is X independent when used in the course of producing or comprehending an utterance?

# Modularity

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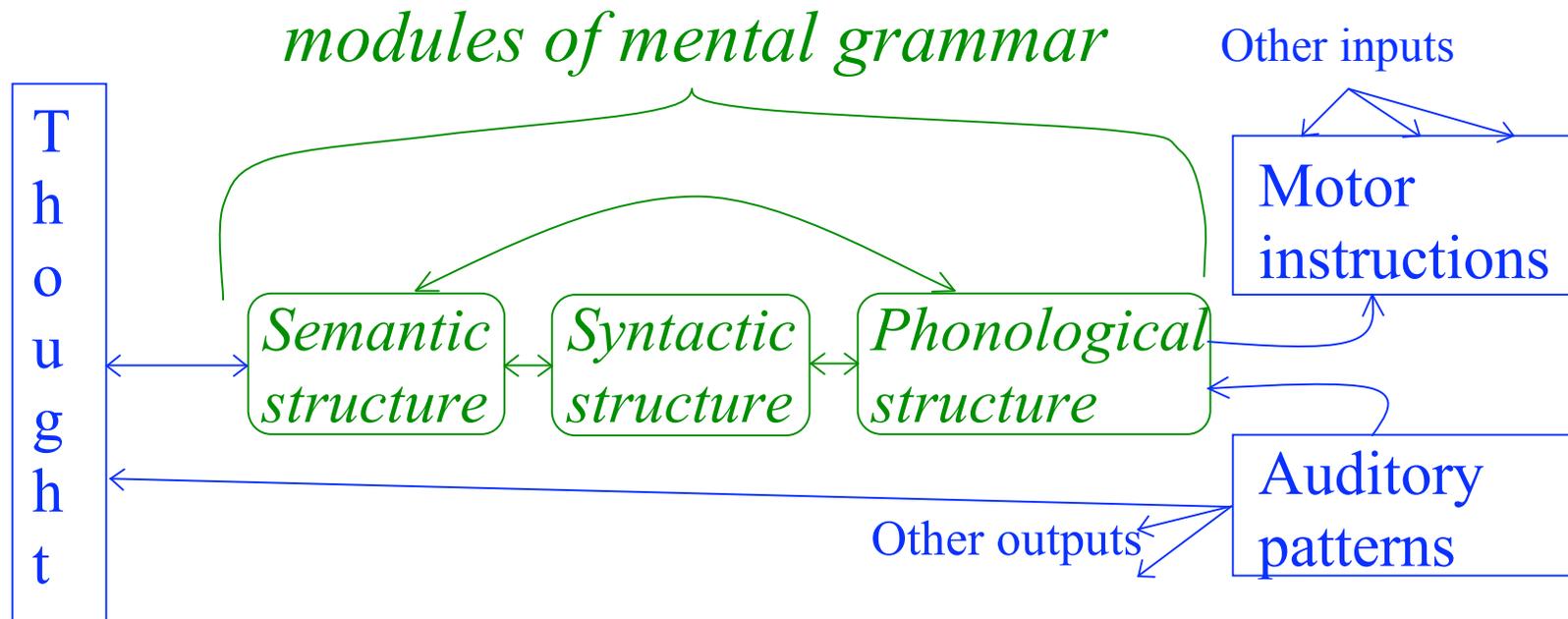
modularity of the subcomponents of the mind with respect to one another

Separate Qs:

i. Is processing serial or parallel?

ii. To what extent are different mental functions localized in different brain regions?

# Modularity



‘Language module’

number reasoning

emotion

perception

general reasoning

social reasoning

memory

# Modularity: Syntax

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Syntax is 'modular': at least partially independent of phonology and semantics

'Phonology-free' syntax:

(0) bear<sub>N</sub> bear<sub>V</sub> bare<sub>A</sub>

Rules such as question formation, passive, etc. are *never* sensitive to the phonology of the items involved:

An impossible language:

(1) Which boy will you pick?

(2) Will you pick which toy?

# Modularity: Syntax

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There are syntactic facts that cannot be explained in non-syntactic terms (facts about memory, perception, sound, meaning)

## Case in German

- (1) Du wirst dem Jungen helfen. (German)  
you will [the boy].DATIVE help 'You will help the boy.'
- (2) Welchem Jungen wirst du helfen?  
[which boy].DATIVE will you help

## object-verb agreement in Swahili

- (3) Ni-li-ki-soma ki-tabu 'I read the book.'  
1s-PAST-ObjAgr-read CLASS-book
- (4) a. Colorless green ideas sleep furiously.  
b. \*Ideas green furiously colorless sleep.

# Modularity again

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Language ability    Intelligence

Low

High

Feral children, Genie,  
Chelsea, aphasics, SLI

High

Low

Savants, Williams Syndrome

→ *double dissociation*

- Language abilities seem to be able to be to some extent selectively spared or impaired with respect to other mental faculties

# Modularity again

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## 1. **grammar** modularity

modularity of the subcomponents of the grammar with respect to one another

Where  $X \in \{\text{syntax, phonology, semantics, ...}\}$

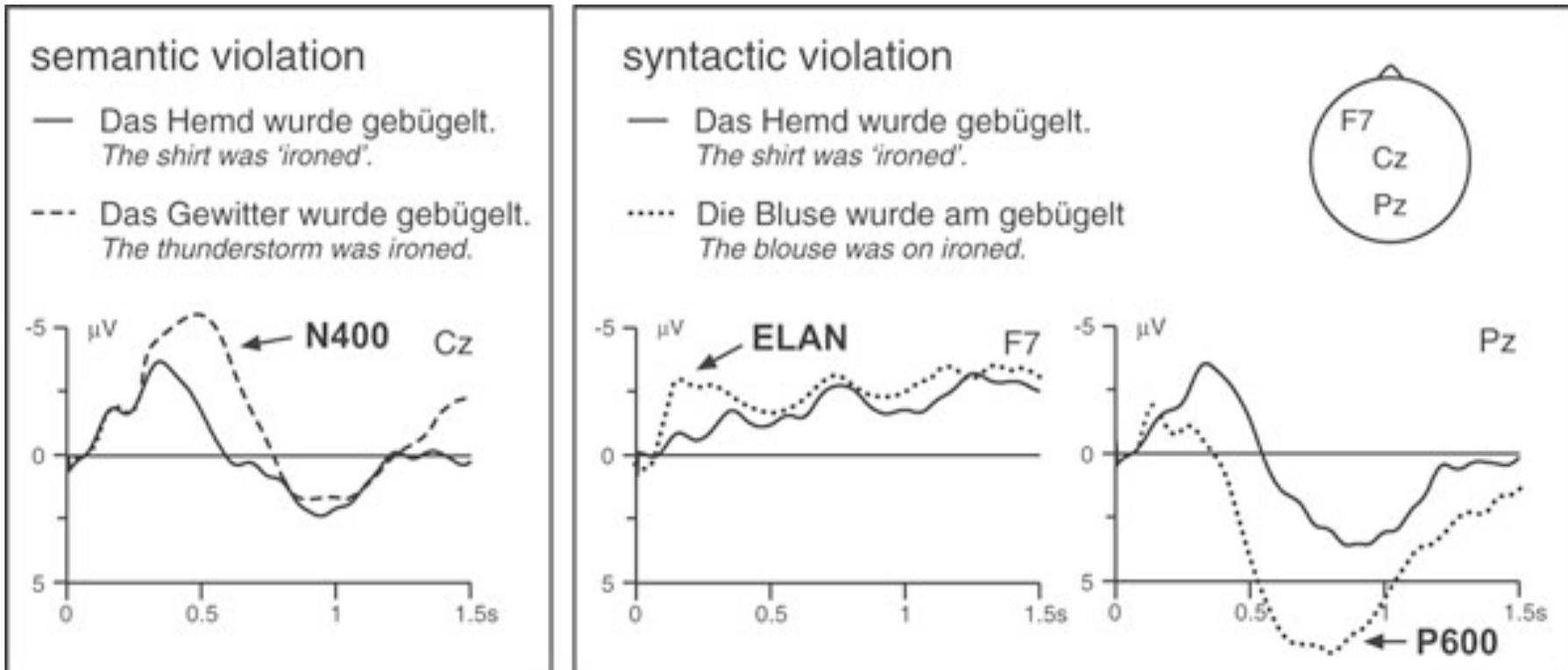
A. Is X independent as analyzed as a static system (i.e., are there distinct, at least partially non-overlapping vocabularies and operations that X is stated over/makes use of)?

**YES**

B. Is X independent when used in the course of producing or comprehending an utterance?

**hard to tell**, since processing can and often does occur on several levels in parallel, and very quickly

# Event related potentials



[Angela D. Friederici, 2004, The neural basis of syntactic processes, in M. Gazzaniga (ed.), *The cognitive neurosciences*, 3rd ed., MIT Press.]

(ELAN = early left anterior negativity)

# Modularity again

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2. **mind** modularity (Fodorian)  
modularity of the subcomponents of the mind

Where  $X \in \{\text{language, motor control, social reasoning, ...}\}$

- A. Is X independent as analyzed as a static system (i.e., are there distinct, at least partially non-overlapping vocabularies and operations that X is stated over/makes use of)?

For language, probably **YES** (does social reasoning make use of concepts like *vowel, subject, nominative, noun*?)

- B. Is X independent when used in the course of producing or comprehending an utterance?

**NO**

# Modularity

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Language ability and other aspects of cognition can be at least partially separate

# Broca's aphasia in American Sign Language

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- ASL signers suffer the same kind of deficits with injury to Broca's area: 'agrammatic' signing, difficulty with morphology, inflections
- Other motor tasks are not affected
- Wernicke's aphasia in ASL signers leads to 'fluent' but incomprehensible signing, great difficulty in understanding others' signs
- Damage in right hemisphere affects deaf and hearing the same: difficulty with spatial tasks, continuity, etc., but leaves language (spoken or signed) intact