What is between ‚*bio*' and ‚*linguistics*' ?

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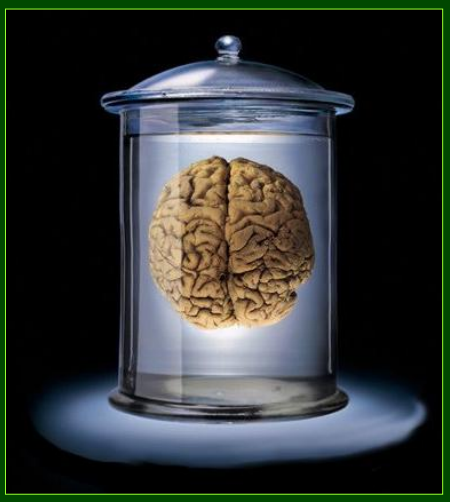
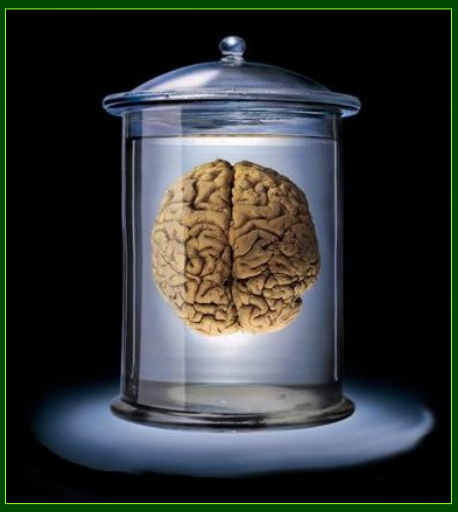


Contents

- On the notion ‚*biolinguistics*'
- ***Agrammatism***
  Two syndromes – a ***single*** *source*
- (Bio-) linguistic implications



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‚*Biolinguistics*' = ?

In the words of Boeckx & Grohmann (‚*Biolinguistics Manifesto*'):

- „The ***weak sense*** of the term refers to ‚*business as usual*' for ***linguists***, so to speak, to the extent they are seriously engaged in discovering the properties of grammar."
- „The **strong sense** of the term 'biolinguistics' refers to attempts to provide explicit *answers to questions* that necessarily require the combination of linguistic insights and insights from related disciplines (*evolutionary biology, genetics, neurology, psychology,* etc.)."

This position contrasts with:

T.W.Fitch, 2009, Prolegomena to a future science of biolinguistics
Biolinguistics 3.4: 283–320, 2009

„I consider it self-evident that the ***appropriate models*** for ***bio-linguistics*** **come from the natural sciences**, such as ***physics*** in the early twentieth century, and ***cellular*** *and* ***molecular*** **biology** or ***neuroscience*** today."

T.W.Fitch, 2009, Prolegomena to a future science of biolinguistics

„The historical success of this ‘normal science’ approach hardly needs emphasizing.“

„***Theorists*** in these fields consider the issues, define their terms, and propose hypotheses that generate ***testable*** predictions.“

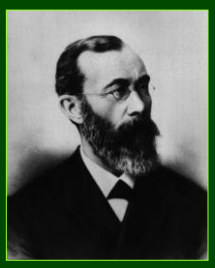
„Experimentalists implement empirical research programs to test the predictions, based on widely accepted norms of good experimental design (e.g., explicit consideration of, and controls for, alternative hypotheses) and inferential statistics.“

And where is linguistics? – still far away from ‚normal science‘

Parallels to the history of psychology

For the (late) 19th century ‘psychology’, ***introspection*** was the main access road to insights about the mind.

It was Wilhelm Wundt (1832 - 1920) who strongly emphasized that *introspection* needs to be controlled and integrated into a *systematic program of psychological experimentation.*



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Wundt, Wilhelm (1888):

Selbstbeobachtung und innere Wahrnehmung. [Self-observation and internal perception] **Philosophische Studien, Bd. IV. p. 292-309.**

„Es ist ganz in die Hand der Psychologen gegeben, dafür zu sorgen, daß diese Fehler mehr und mehr ganz verschwinden. Es ist dazu nur das eine nötig, daß sie [....] sich der experimentellen Methode [...] bemächtigen."

It is totally in the hands of the psychologists to take care that these failures [=*introspection data* only] ***disappear more and more. The only thing they have to do is to seize the experimental method.***

„Es stehen dem gegenwärtig noch zwei Eigenschaften entgegen."

Presently, there are two properties that stand in its way:

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These are **not** the two properties

„Die eine Eigenschaft ist der ***Hochmuth***. Es gibt ja immer noch einige Leute, die das Experimentieren für eine banausische Kunst halten, mit der man sich nicht befassen dürfe, wenn man nicht des Privilegiums, im Aether des reinen Gedanken zu hausens, verlustig gehen wolle."

One property is arrogance. There are still some people who consider experimenting a philistine art which one must not deal with, if one does not want to risk loosing the privilege of residing in the pure ether of thoughts.

„Die andere Eigenschaft ist die ***falsche Bescheidenheit***. Jede Kunst scheint in der Regel dem, der sie nicht versteht, viel schwerer als sie wirklich ist."

The other property is mistaken modesty. Every art usually tends to appear to be more difficult than it really is to those who do not understand it.

Linguistic ‚business as usual' = ‚Biolinguistics' ? – No!

☞ ☞ ☞ ***Neither bottom up …***

In today's linguistics (esp. generative grammar theory, generative syntax), ***experimental data*** (psycho- & neuro-linguistic data, behavioral data, data from acquisition or impairments) have **no influence** on theory building **whatsoever in grammar theory.**

At best, experimental findings are quoted eclectically in support of one's hypothesis, if they can be made compatible with it, somehow.

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Linguistic ‚business as usual' = ‚Biolinguistics' ? – No!

☞ ☞ ☞ *... nor top down:*

Grammar theoreticians do not actively pursue or enable the experimental check of their theoretical constructs. They do not feel obliged to provide precise, experimentally testable predictions (& the data are not controlled at all).

(**Status quo:** The theory camp is overcrowded, but the experimental camp is severely underpopulated. Experimental data have not yet been honoured as THE relevant **success** & **falsification** criteria in standard scientific conduct).

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This ‚let the theory decide' attitude is understandable as long as one just fervently argues about *weakly* equivalent **grammatical calculi**, but it considers the brain as a black box (**viz.** dealing with ***in-put & out-put properties*** only, that is, with selected data from a few languages).

BUT

Francis Harry Compton **Crick:**

The difficulty of the method of the black box is this. If the interior of the box does not have a very simple structure, the method soon will reach a stage in which **different theories cover all observable results** sufficiently well. Attempts to decide between the theories fail because new experiments only produce new complexities. **One has no other choice than groping one's way into this box**.

(*Spektrum der Wissenschaft* 11, 1979. Translation by HH).

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In sum: Linguistics ‚as usual' is NOT biolinguistics !

There is ***only one sense*** of ‚**biolinguistics**', and there is a lot in between **'bio(logy)'** and ‚**linguistics**' **:**

- **Molecular & cellular biology and genetics**
- Neurobiology
- Neurophysiology & computational neuro-science
- Cognitive neuroscience
- Neurolinguistics (neural correlates)
- Psycholinguistics (behavioral correlates)
- **Theoretical Linguistics**

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….. or in Shakespearian diction

There are more things in between bio- and linguistics, Horatio, than are dreamt of in your philosophy!

….. and in the diction of Georg Christoph Lichtenberg (1742-1799)

And there are more things in our philosophy than shall ever appear between bio- and linguistics!

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A case for ***biolinguistics*** & the ***topic*** of this talk:

Aggrammatism = Impaired ***grammar*** ?

- ☒ **SLI** (= specific language impairment): ***developmental*** or ***genetically*** transmitted SLI (KE family, FoxP2-debate)
- ☒ **Broca** aphasia (as ***acquired SLI***)
- Identical ***sources*** (neuronal, behavioral) ?
- Identical (psycho-/neuro-) linguistic ***model*** ?
- Insights for linguistic **theory building** ?

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Specific language impairment (SLI)

SLI: a developmental disorder of language *in the* ***absence*** of manifest ***neurological damage, hearing deficits, environmental deprivation, or mental retardation***

(Bishop 1992; Leonard, 1998)

Several factors have complicated the efforts to provide a unified theory of SLI:

1) Disorder is not restricted to language
2) Disorder is quite heterogeneous
3) Neural bases of disorder have been relatively ignored

(Ullman & Pierpont, 2005)

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Domain (language (grammar)) specific views on SLI

- **Feature deficit model** (syntactic & semantic): Gopnik 1990. Feature **blindness**. *Language Acquisition* 1: 139-164 **[cf. Color blindness]**
- **Rule deficit model:** Gopnik & Crago. 1991. *Cognition* 39: 1-50
- **Specifier-head relations impairment**: Rice & Oetting 1993. *J. o. Speech & Hearing Research* 36.
- **Agreement deficit model** (no uninterpretable features): Clahsen, Bartke & Göllner 1997. *Journal of Neurolinguistics* 10: 151-171
- **Agreement-and-tense-omission model (extended optional infinitives):** Wexler & Schütze & Rice (1998) *Language Acquisition* 7: 317-344
- **Uninterpretable-feature deficit model:** Tsimpli and Stavrakaki (1999), Tsimpli (2001).
- **Dependency deficit model:** Van der Lely & Battell (2003) *Language* 79:153-181

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Common strategy

The *description* of the deficit is elevated to the status of an *explanatory* cause:

⇨ ⇨ *Agrammatism is ‚caused' by a deficit in grammar* ⇦ ⇦

☹ **Great, but how ? - A somewhat** narrow explanatory circle, if the ((non-)evident) theoretical assumptions are not justified by independent evidence adduced from neuro-/psycho-linguistic investigations.

Synopsis of SLI as a *grammar-specific* deficit

- Particular aspects of grammar only: Clahsen 1989; Clahsen, Bartke & Göllner 1997. Gopnik & Crago 1991; Tsimpli and Stavrakaki 1999, Tsimpli 2001, Rice & Oetting 1993. Rice, Wexler et al. 1995, Wexler & Schütze & Rice 1998.
- Grammar in general: Gopnik & Crago 1991; Van der Lely 1994; Van der Lely & Battell 2003; Ullman & Gopnik 1999.

☺ They account for grammatical impairments in SLI

☹ They do *not account* for

- *full range* of language deficits (*syntactic, morphological, phonological*), including lexical retrieval (word finding problems)
- non-linguistic deficits

domain-general accounts of SLI:
= non-linguistic processing deficits

- Working memory capacity (Gathercole and Baddeley 1990; Montgomery 1995)
- Reduced processing rate: capacity limitations (Bishop 1994, Kail 1994, Leonard et. als. 1992, Norbury et als. 2001)
- Temporal processing deficit (Tallal and Piercy 1978; Tallal, Miller et al. 1993)
- Auditory (temporal processing) deficit: Merzenich & Jenkins & Johnston & Schreiner & Miller & **Tallal** 1996

☺ Account for processing deficits

☹ But, processing deficits do not necessarily co-occur with linguistic deficits

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The position I favour: **Defect in the *‚operating system'***

Procedural Deficit Hypothesis (PDH)
(Ullman & Gopnik, 1999; Ullman & Pierpont, 2005)

SLI is largely explained by **abnormalities of brain structures** of the ***procedural memory*** *system (PMS).*

‚Procedural memory': a network of interconnected structures rooted in *frontal & basal-ganglia circuits*, that subserves the ***learning*** *and* ***execution*** of motor and **cognitive skills**

- The **PDH** can account for much of the SLI data, and in particular for
- the **neural abnormalities** as correlates of SLI, and
- the **consistency *and* heterogeneity** of the particular linguistic *and* non-linguistic deficits found in SLI

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Immediate implication for **agrammatism** in aphasia:

Here is the implication I want to pursue in this talk:

If the ***Procedural Deficit Hypothesis*** (PDH) is an adequate account for SLI as *developmental aggrammatism*, it should prove an adequate account for *acquired agrammatism* as well (viz. agrammatic aphasic syndromes), in terms of

- brain sites & (functional) structures involved
- neuronal networks and their cognitive functions
- linguistic and non-linguistic correlates
- the specific linguistic phenomenology

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Procedural memory system (PMS)

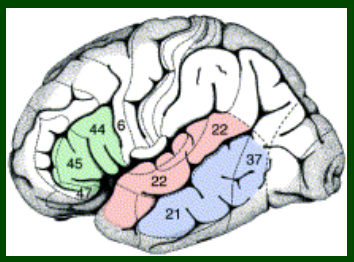
(Schacter & Tulving eds. 1994, Squire & Zola 1996; Ullman 2004; Ullman & Pierpont 2005)

Def.: Brain system implicated in the **learning** of new, and **control** of established, motor and **cognitive skills**, especially those involving **sequences** and **rules**.

It is **composed of a network of brain structures:**

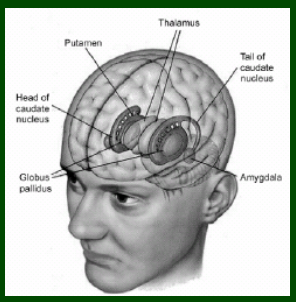
(1) rooted in left frontal **BA 44**/ premotor/ **basal-ganglia** (caudate) circuits

(2) also: supramarginal g. (BA 40), superior temporal cortex (incl. superior temporal sulcus), cerebellum (dentate nucleus).

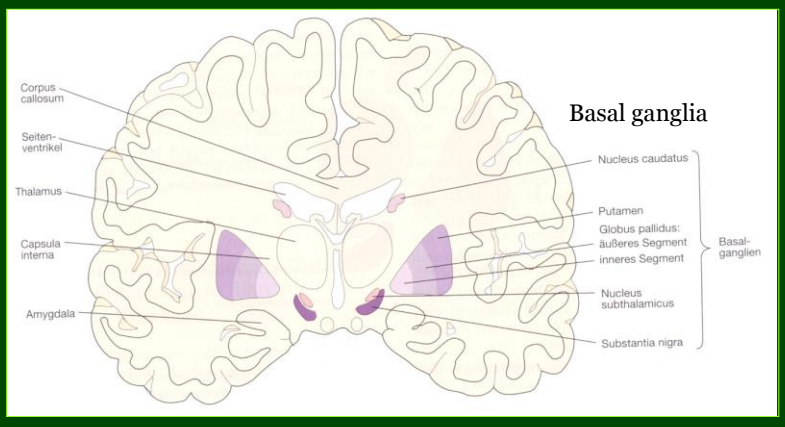


BA 44 & 45 Broca's area

Caudate nucleus
Putamen
Globus pallidus



Basal ganglia, striatum



Striatum = nucleus caudatus & putamen

Linked to frontal cortical regions via parallel, segregated „**channels**" (‚circuits', ‚loops'): Alexander & Crutcher 1990, Middleton & Strick 2000.

These brain structures *also* subserve other functions:

- Specific aspects of language (especially Broca's area, caudate)
  - Grammar: rule-governed composition, across domains (syntax, morphology, phonology)
  - Lexical retrieval – but *not* lexical knowledge (declarative memory)
- Dynamic mental imagery – but *not* static mental imagery
- Working memory
- Rapid temporal processing (Ullman and Pierpont, 2005)

Note:

I see this approach as an ***interactive* model**:

The ‚**procedural memory system**' is the ‚**operating system**' for the **modularily** organized specific **knowledge systems**.

Grammar is one of these knowledge systems. It is ***compiled*** by the PMS.

SLI is a domain specific impairment to the extent that in SLI, the PMS does **not fully support** the specific domain (viz. grammar) in a **problem-free manner.** A defect in PMS surfaces as a syndrom of specific grammar impairments.

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Procedural deficit hypothesis (PDH)

Ullman & Pierpont 2005; Ullman 2004.

- SLI heterogeneity: variability in which *structures* are affected
  But for most procedural language disorders: abnormalities to frontal / basal-ganglia, especially Broca's area & caudate nucleus.
- Additional heterogeneity: variability in which ***channels*** are affected
- Etiology: diverse, including genetic dysfunction (FOXP2) and early insults (e.g., auto-immune); striatum is extremely vulnerable to damage in developmental disorders.
- *Compensation* by the spared ***declarative*** memory system:
  - memorize complex forms as chunks ("walked", "the cat")
  - learn rules explicitly ("add ‚*-ed*' to verb if event has occurred")

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Sources of SLI evidence (Details in Ullman & Pierpont 2005)

- Neuro-anatomical facts
- EEG-studies
- Behavioral evidence (grammar, non-language)
- Procedural learning deficits
- Motor deficits
- Imagery
- Working memory deficits
- Rapid temporal processing deficits
- Spared declarative memory

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Philip Lieberman 2002, *American Journal of Physical Anthropology* 119: 36–62

"Data from studies of Broca's aphasia, Parkinson's disease, hypoxia, focal brain damage, and a genetically transmitted brain anomaly (the putative language gene, family KE), and from comparative studies of the brains and behaviour of other species, demonstrate that the **basal ganglia** sequence the discrete elements that constitute a complete motor act, syntactic process, or thought process.

Imaging studies of intact human subjects and electrophysiologic and tracer studies of the brains and behaviour of other species ***confirm*** these findings."

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- Grodzinsky, Y. (2000). The neurology of syntax: Language use without ***Broca's area.*** *Behavioral and Brain Sciences* 23:1:1-21

"The experimental record indicates that most human linguistic abilities are not localized in this region. Most of syntax (long thought to be there) is not located in Broca's area and its vicinity (operculum, insula, and subjacent white matter)."

"This cerebral region, implicated in Broca's aphasia, has a highly specific role in syntactic processing: It is the neural home to receptive mechanisms involved in the computation of the relation between transformationally moved phrasal constituents and their extraction sites (Trace-Deletion Hypothesis)."

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A footnote on the plausibility of a *trace deletion hypothesis*':

a. Why should traces be assumed to be successfully computed, if they are to be ***deleted*** afterwards?

b. What would be the ***basic defect*** then? Obviously, a **lack of inhibition** (but not an innovative rule „Let's delete traces!")

c. Bizarre consequence: TDH implies that UG contains a trace-deletion operation that is generally ***inhibited,*** **and** that this inhibition is out of function in Broca's aphasia (?).

The zero hypothesis is cheaper!

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Double dissociation

- Lesion at Broca's Area without Broca aphasia
- Boca aphasia without damage in Broca's area

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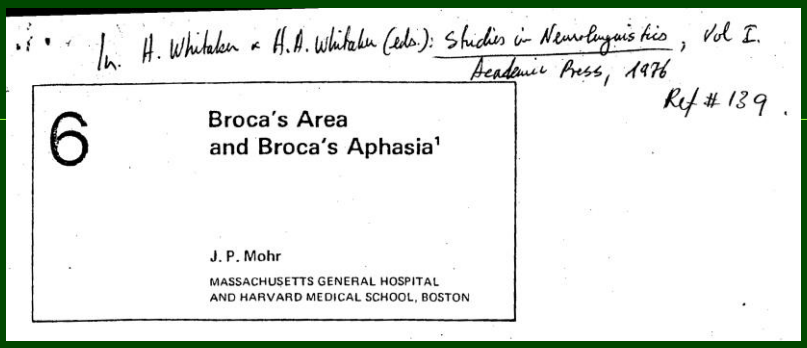

In H. Whitaker & H.A. Whitaker (eds.): Studies in Neurolinguistics, Vol I. Academic Press, 1976

Ref # 139.

6

Broca's Area and Broca's Aphasia[1]

J. P. Mohr

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Broca Aphasia

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These studies, taken together with a review of the literature, suggest that destruction of Broca's area and its immediate surround, even deep into the brain, does not reliably produce the protracted mutism, later emerging dyspraxic speaking, and condensed simplified grammatical language functions currently envisioned as characteristic of the syndrome of Broca's aphasia. Instead, little persisting deficit in articulation seems to occur, and frequently no significant persisting disturbance in language function is present. The syndrome currently referred to as Broca's aphasia arises instead from a considerably larger brain injury that encompasses most of the operculum, insula, and subjacent white matter, far exceeding Broca's area. It conforms more to the large zone of damaged brain actually present in Broca's original cases.

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Plaza, M. & P. Gatignol & M. Leroy & H. Duffau. 2009. **Speaking without Broca's area after tumor resection**. *Neurocase*, 15, 294 - 310 .

Case of a right-handed patient who received surgical treatment for a left frontal WHO grade II glioma. The tumor and the surgery destroyed the ***left inferior and middle frontal gyrus***, the **head** of the **caudate nucleus**, the anterior limb of the **internal capsule** and the **anterior insula**.

Post surgery: "A **subtle fragility** was observed in **two language devices,** i.e., **reported speech** and **relative clauses,** related to **minor working memory deficits."**

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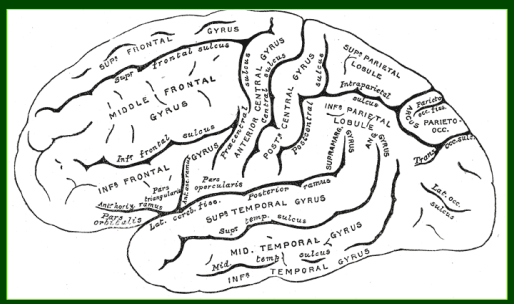

The inferior frontal gyrus includes the following cytoarchitectonic areas:

- ***Brodmann area 44***
- ***Brodmann area 45***
- ***Brodmann area 47***
- ***cytoarchitectonic areas of the deep frontal operculum***

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❑ Caplan,D. & N. Hildebrandt & N. Makris. 1996. **Location of lesions in stroke patients with deficits in syntactic processing in sentence comprehension *Brain***, Vol. 119, No. 3, 933-949.

46 patients with left-hemisphere strokes and 14 with right-hemisphere strokes. 21 control subjects: ability to use syntactic structures. **Results**: syntactic processing involves an extensive neural system, whose most important region is **the left peri-sylvian cortex.** When these results are combined with those of other studies, the picture that emerges is one in which, within this cortical region, this system manifests features of both **distributed and localized processing**.

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Broca Aphasia

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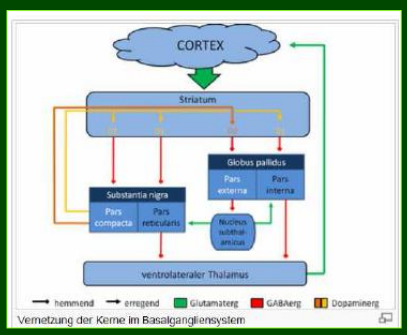

Vernetzung der Kerne im Basalgangliensystem

DBS (deep brain stimulation) of the nucleus ventralis intermedius (VIM) provides positive proof for language processing activities: preceding ELAN, and P600.

Michael Wahl. 2008. *EKP-Befunde subkortikaler Syntaxverarbeitung*. in: Michael Wahl | Judith Heide | Sandra Hanne (Hrsg.) Spektrum Patholinguistik. Vol.1 (2008). 119-130

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❑ Nishitani,N. 2006. **Biological significance of Broca's region.** *Rinsho Shinkeigaku.* 46(11):851-3.

BA and the **primary motor area (M1)** were activated approximately at the same level, when a subject observed and performed the same actions by herself as ones of another person. In case that she imitated actions of another person, activities of BA and M1 increased significantly **(Human Mirror Neuron System: HMNS; see macaque slide, below**).

These results converge on a central role of Broca's area as an orchestrator of time sensitive perceptual and motor functions underlying verbal and non-verbal communication.

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- DOMINEY P.F., HOEN M., BLANC J.-M. and LELEKOV-BOISSARD T. 2003. Neurological basis of language and sequential cognition: Evidence from simulation, **aphasia**, and ERP studies. *Brain and Language, 83:* 207-225.
- GOSCHKE T., FRIEDERICI A., KOTZ S.A. and VAN KAMPEN A. 2001. Procedural learning in **Broca's aphasia:** Dissociation between the implicit acquisition of spatio-motor and phoneme sequences. *Journal of Cognitive Neuroscience, 13:* 370-388.
- SQUIRE L.R. and KNOWLTON B.J. 2000. The medial temporal lobe, the hippo-campus, and the memory systems of the brain. In Gazzaniga MS (Ed), *The New Cognitive Neurosciences*. Cambridge, MA: MIT Press.

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❑ Ralph-Axel Müller & Surina Basho. 2004. Are nonlinguistic functions in "Broca's area" prerequisites for language acquisition? FMRI findings from an ontogenetic viewpoint. *Brain and Language* 89: 329-336

Three functional MRI (fMRI) datasets on lexicosemantic decision, tone discrimination, and visuomotor coordination for potential overlap of activation. A single site of convergent activation across all three paradigms was found in the left inferior frontal lobe (area 44/45).

This result is discussed in the context of animal and human studies showing inferior frontal participation in visuomotor and audiomotor functions as well as working memory. We propose that Broca's area involvement in lexical semantics and syntax emerges from these nonlinguistic functions, which are prerequisites for language acquisition.

Broca Aphasia

- Neuro-anatomical investigations
- EEG-studies
- Behavioral evidence (grammar, non-language)
- Procedural learning deficit
- **Working memory deficits**
- Imagery
- Motor deficits
- Rapid temporal processing deficits
- Spared declarative memory

❑ Baldo J. V. & N. F. Dronkers. 2006. **The Role of Inferior Parietal and Inferior Frontal Cortex in Working Memory.** ***Neuropsychology*** **20: 529–538**

„Our findings are generally consistent with previous functional neuroimaging studies that have reported similar networks underlying working memory, namely, parietal regions and anterior, usually IF regions (Hickok, Buchsbaum, Humphries, & Muftuler, 2003; Honey et al., 2000; Jonides et al., 1998; Paulesu et al., 1993; Postle, Berger, & D'Esposito, 1999; Salmon et al., 1996).

By showing that patients with focal lesions in these regions have specific working memory deficits, our results suggest that these regions are not just involved in a large network but are crucial for the execution of working memory tasks."

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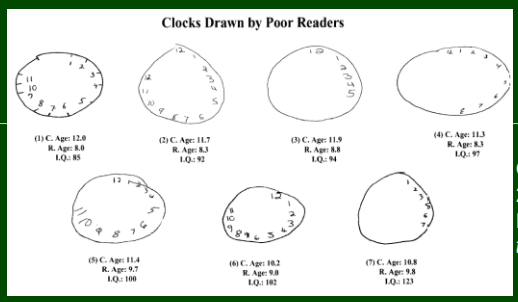
Imagery: no literature located. Not even on *clock drawing*.



G.F. Eden, F.B. Wood, and J.F. Stein. 2003. Clock Drawing in Developmental Dyslexia. *Journal of learning disabilities*. 36: 216–228

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- Binkofski,F. & G. Buccino. 2004. **Motor functions of the Broca's region**. *Brain Lang.* 89: 362-9.

  We summarize the evidence that the *motor related part of Broca's area* is localized in the opercular portion of the inferior frontal cortex, mainly in area 44 of Brodmann. According to our own data, there seems to be **a homology between Brodmann area 44 in humans and the monkey area F5.**

  The non-language related motor functions of Broca's region comprise complex hand movements, associative sensorimotor learning and sensorimotor integration.

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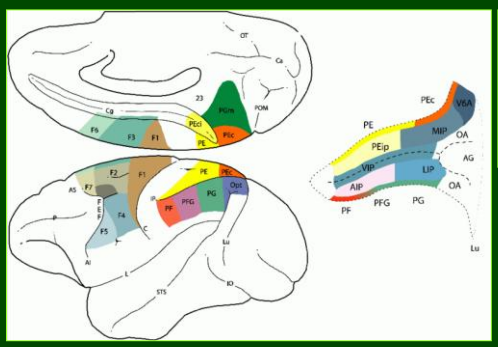

Mesial and lateral views of the macaque brain showing the cytoarchitectonic parcellation of the frontal motor cortex (areas indicated with F and Arabic numbers)

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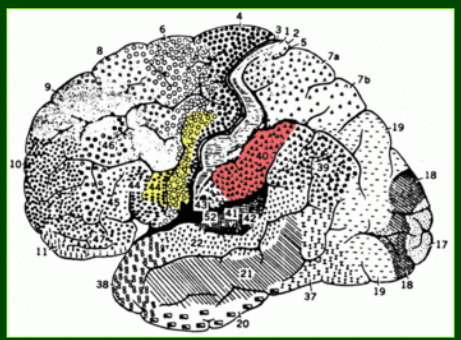

Mirror neuron system* in humans. Lateral view of human brain showing the areas (*colored*) that form the *mirror neuron system.

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Swinney, D. & E.Zurif. The Neurological Organization of Lexical and Structural Operations in Sentence Comprehension: Findings and Methodological Considerations. In: Dieter Hillert (Ed.) Linguistics and Cognitive Neuroscience. Opladen: Westdeutscher Verlag

"[…] the brain region implicated in Broca's aphasia is not the locus of syntactic representations per se, but rather appears to provide the resources that sustain the normal (automatic) operating characteristics of the lexical and structural processing systems (namely, rapid temporal-processing)."

Broca Aphasia

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Continued:

Swinney, D. & E.Zurif. The Neurological Organization of Lexical and Structural Operations in Sentence Comprehension: Findings and Methodological Conside-rations. In: Dieter Hillert (Ed.) Linguistics and Cognitive Neuroscience. Opladen: Westdeutscher Verlag

"neurological specialization within the language system turns **not on where** different general knowledge sources (e.g. syntax, semantics) are localized, but rather **on the anatomical distribution** of fairly **elemental processing resources** such as those involved in **rapid temporal integration** of language information, as seen in **lexical access and structural integration."**

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Ullman,M. & S.Corkin & M.Coppola, G.Hickok & J.H.Growdon & W.J. Koroshetz & St. Pinker. 1997. A neural dissociation within language: Evidence that the **mental dictionary** is part of **declarative memory,** and that **grammatical rules** are processed by the **procedural system**. *Journal of Cognitive Neuroscience* 9(2): 266-276.

Evidence is presented that the lexicon is part of a **temporal-parietal/medal-temporal**"declarative memory" system and that grammatical rules are processed by a fronto/basal-ganglia "procedural" system.

Grammatical difficulties in anterior aphasia, and the general impairment of procedures in Parkinson's disease, led to the opposite pattern (viz. Less errors with irregular verbs, more with regular and esp. with novel verbs.

Summary of the comparison of SLI and Broca's

- ☑ Neuro-anatomical facts
- ☑ EEG-studies
- ☑ Behavioral evidence (grammar, non-language)
- ☑ Procedural learning deficits
- ☑ Motor deficits
- ⌛ Imagery
- ☑ Working memory deficits
- ☑ Rapid temporal processing deficits
- ☑ Spared declarative memory

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Summary of the comparison of SLI and Broca's

Result

Agrammatic behaviour* is *domain-specific,* but the impaired domain is not the mental GRAMMAR. Grammar is just the *affected* domain. G**rammar deficits are ultimately ***epiphenomenal.

The crucial domain is the ensemble of *procedural memory processes*, *their domains of application, their neural bases, their on-line applictions, …..*

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Circumstantial evidence – Monkeys & FoxP2

• Broca's area - homologous with the 'mirror neuron' gestural imitation system in area F5 of the macaque monkey brain – establishes a plausible evolutionary basis for a **syntactic pattern recognition system** that provides a 'first-pass' parse of language input.

• Studies of **FOXP2** expression in the brain of mice, rats, and humans show that it is expressed in **cortical regions, thalamus, inferior olives, cerebellum, and the basal ganglia, especially the striatum**, Lai, Gerrelli, Monaco, Fisher & Copp 2003; Takahashi, Liu, Hirokawa & Takahashi 2003.

• The structures in which the transcript was found are intimately connected and related **mainly with motor functions**."

"It is as senseless to consider FOXP2 a "language gene" as it would be to consider it a "circulatory gene" or a "digestion gene". (p. 194)
M.Nadal & G.Amengual-Bunyola & C.Ramis & M.Capó & C.J.Cela-Conde **2006.** Recent genetic contributions to the study of language. **Ludus Vitalis, XIV pp. 187-204.**

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Implications

- A grammar model must ultimately prove its success also as part of the neuro-cognitive modelling of language processing in the brain.
- Time has come for grammar theory to give up its ‚splendid isolation' and produce testable predictions (black box dilemma) for the grammar & the PMS interface
- If the PMS is the ‚operating system' for grammar, grammar theory must look out for system-compatible models of grammar & have them tested.

And what do we have to ask ourselves well after the lunch break?

- What are the interface conditions for the PM-system and the grammar system? How can we find it out?
- What is the role of the PM-system as a selection filter in the cognitive evolution of grammars? In particular:
- Does the PM-system subserve a highly complex ***generative derivational machinery***

  or
- Is the PM-system the *orchestrator* of a structurally constrained ***string-to-structure pattern mapping*** system?
- For me it is evident that it must be the latter (H. Haider 2010)

  - but this is another, lengthy story.

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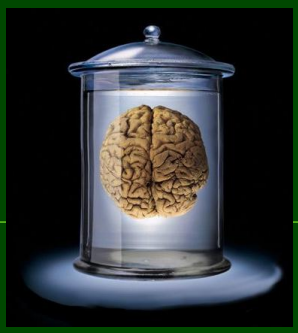
you will find them on my homepage.

Make your search engine look up name + title, or use:

www.sbg.ac.at/spr



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