Kognitive Neuropsychologie

03.11. Geschichte der kognitiven Neurowissenschaft

10.11. Funktionelle Neuroanatomie

17.11. Methoden der kognitiven Neuropsychologie I

24.11. Methoden der kognitiven Neuropsychologie II

01.12. Visuelle Wahrnehmung

08.12. Objekterkennung

15.12. Auditive Wahrnehmung

05.01. Sprache

12.01. Aufmerksamkeit und Selektion

19.01. Kognitive Kontrolle

26.01. Gedächtnis & Lernen

02.02. Kognitives Altern

Vorlesung KNP

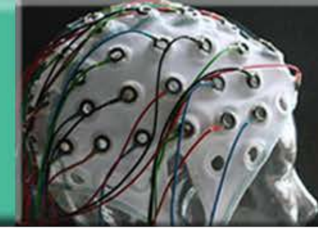
In TEAMS

Zugangscode für Anwesenheitskontrolle

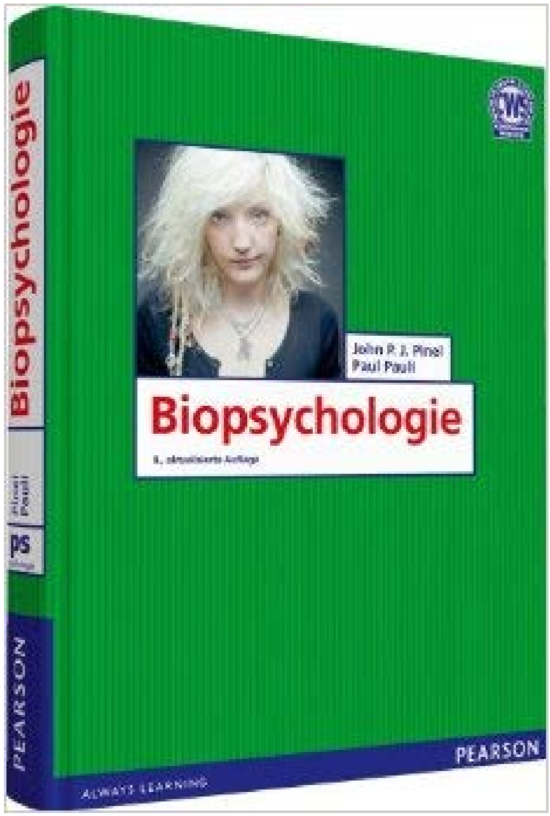
cv218me

- Ursachen von Gehirnerkrankungen
- Läsionsstudien
- Virtuelle Läsionen
- Strukturelle Bildgebung
- Funktionelle Bildgebung
- Elektrophysiolgie

- Ursachen von Gehirnerkrankungen
- Läsionsstudien
- Virtuelle Läsionen
- Strukturelle Bildgebung 🙂
- Funktionelle Bildgebung 🙂
- Elektrophysiolgie 🙂



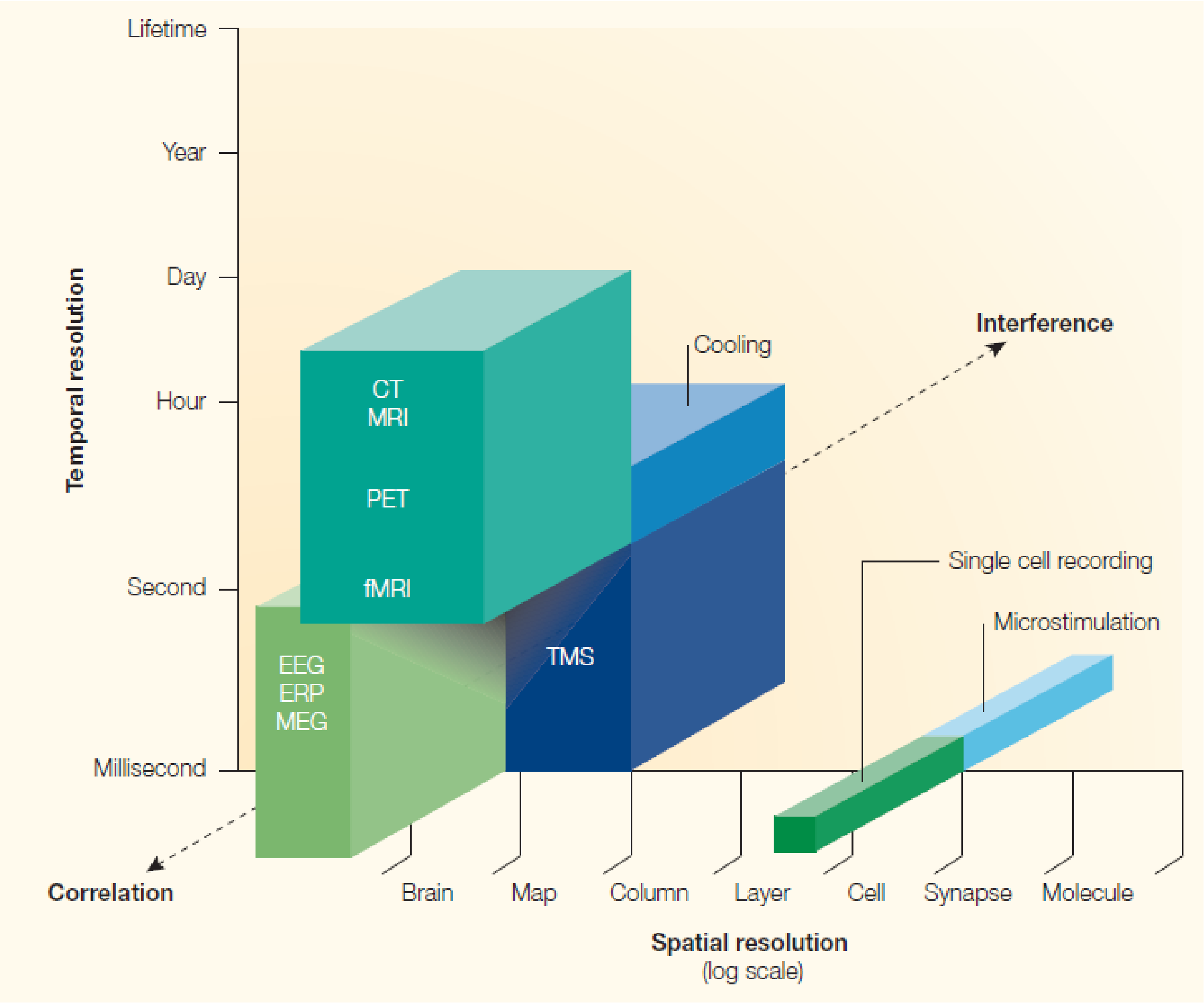
Literatur



Ward, J. (2010). The student's guide to cognitive neuroscience. (2nd Edition) Psychology Press. New York. (Kap. 4)

Birbaumer, N., Schmidt, R.F. (2006). Biologische Psychologie (6. Auflage), (Kap 20).

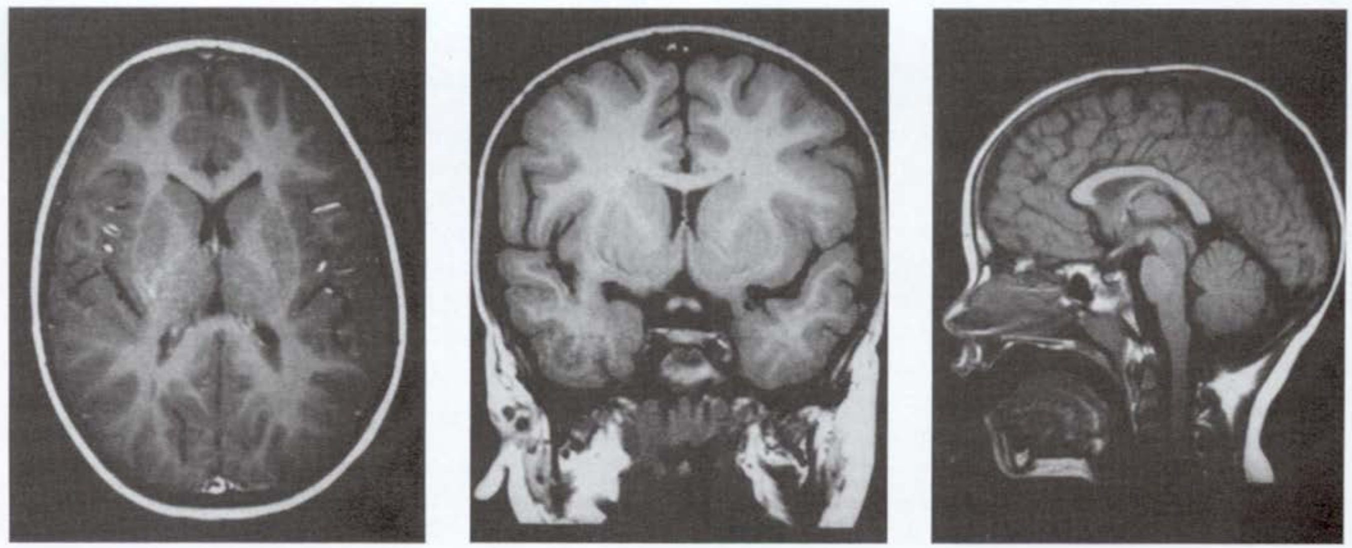
Bildgebende Verfahren: räumliche vs zeitliche Auflösung



Strukturelle Bildgebung: Verfahren

(b)

(b)



Computer-
tomogramm (CT)

Magnetresonanztomographie (MRT)

Magnetresonanztomographie (MRT / MRI):

Erfassung der Dichte und Schwingungseigenschaften magnetisch erregter (H^+) Wasserstoffkerne (Protonen).

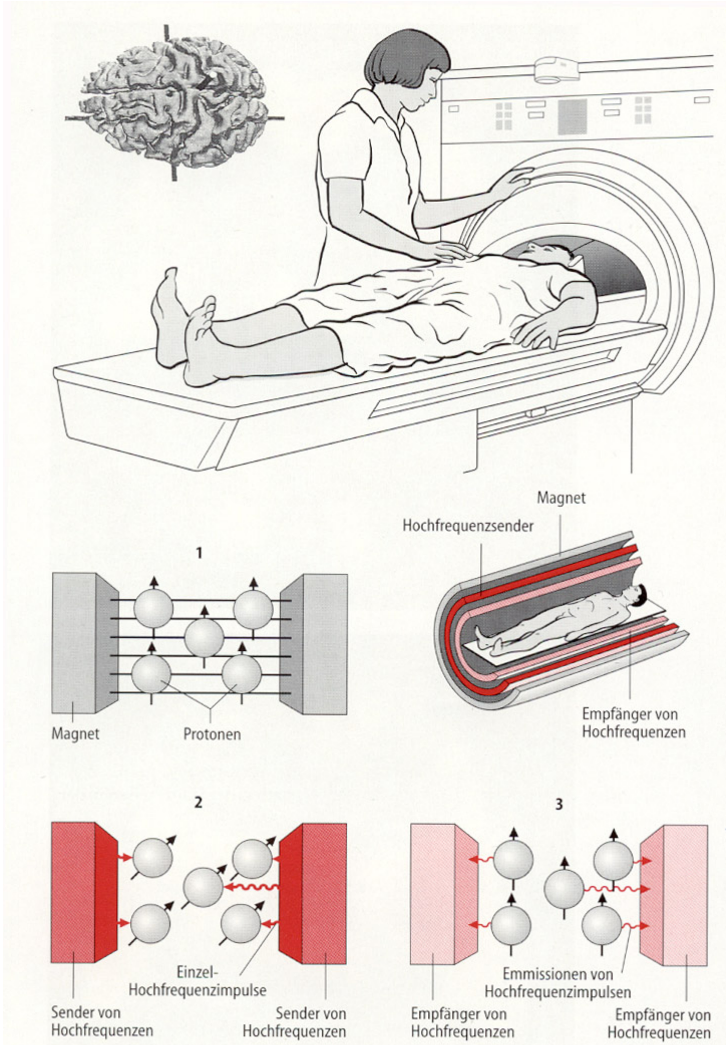


Abb. 21–23. Schematische Darstellung der Magnetresonanztechnik. Der Patient ist von Elektromagneten umgeben, die kurze, aber starke magnetische Feldimpulse (1–4 Tesla) erzeugen. Die Feldimpulse führen zur Auslenkung der Wasserstoffatome, die besonders in gut durchblutetem Gewebe vorhanden sind. Diese Kerne der H^+-Atome (Protonen) sind normalerweise in alle Richtungen ausgerichtet, das Magnetfeld lenkt sie in parallele Richtungen **(1)**. Starke Hochfrequenzradioimpulse treffen auf die Protonen **(2)**. In wenigen Sekunden kehren die Protonen in die Ausgangslage zurück und geben dabei schwache hochfrequente Radiowellen ab, die von einem sensitiven Empfänger registriert werden **(3)**

Magnetresonanz und Relaxationszeiten: T1 und T2. Präzession und Relaxation

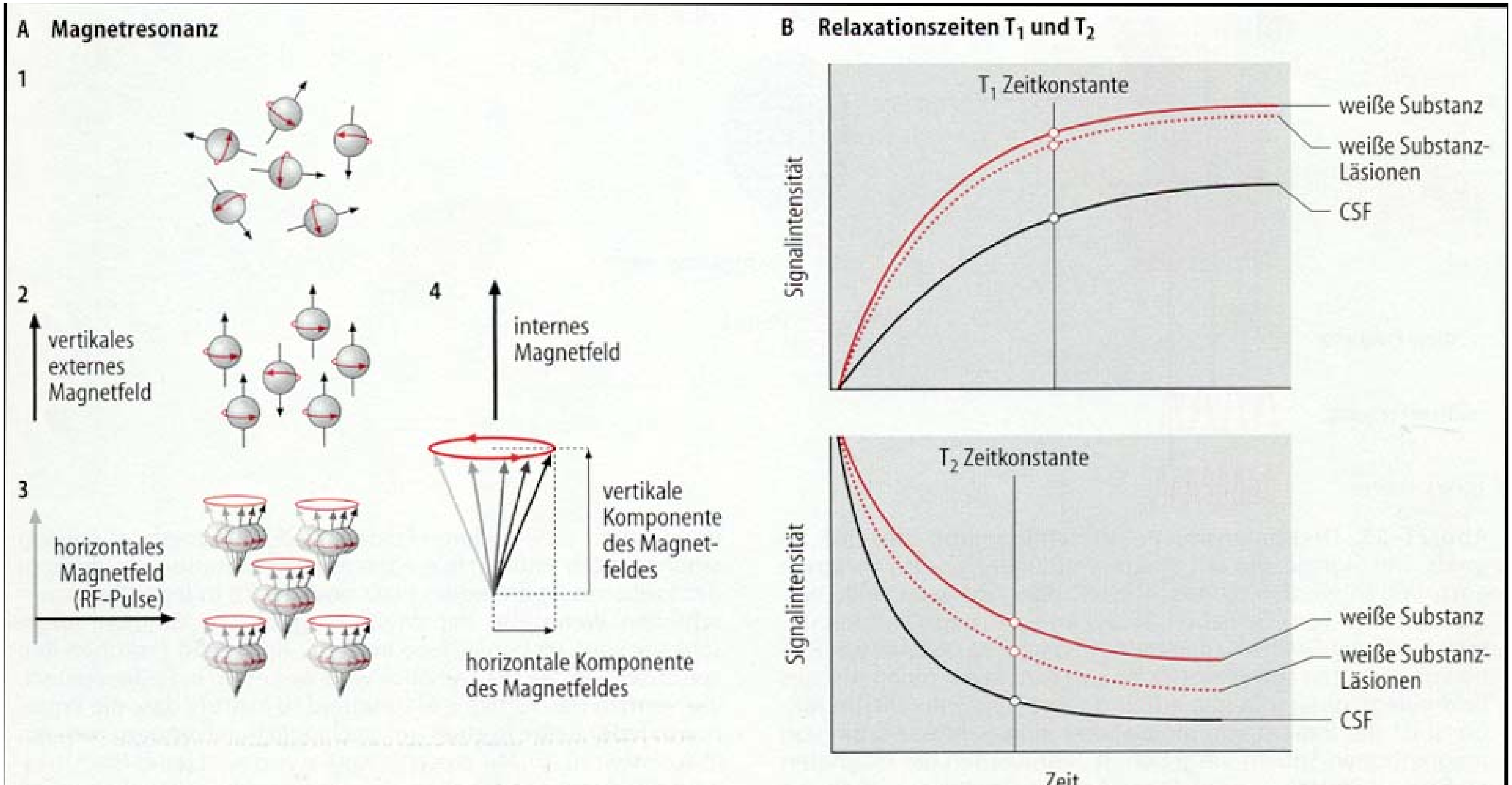


Abb. 21–24. A Verhalten von Protonen im magnetischen Feld und bei Auslenkung durch Radiofrequenzpulse. 1. Chaotische Ausrichtung und Rotation (spin) der Protonen im Magnet-freien Raum. 2. Parallele Ausrichtung im Magnetfeld (Alignment). 3. Ein Radiofrequenzpuls bringt die Protonen zur Rotation (Präzession). 4. MR mißt vertikale und horizontale Komponente der Auslenkung. B T_1 und T_2-transversale Relaxationszeiten (Erläuterung siehe Text)

Unterschiedliche Gewebstypen haben verschiedene Relaxationszeiten !!!

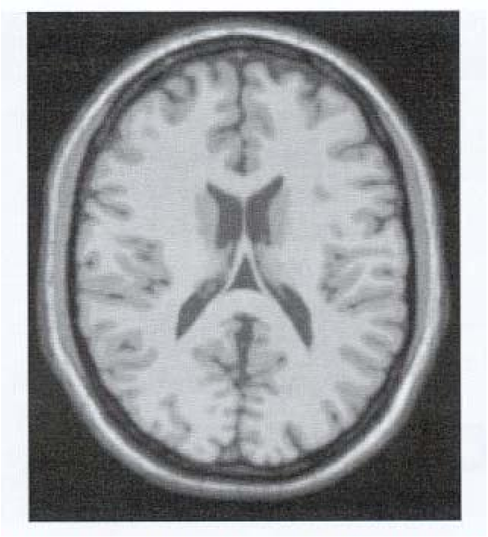
Gewebe	T_1 [s]	T_2 [ms]
CSF	0.8 - 20	110 - 2000
graue Substanz	1.09 - 2.15	61 - 109
weiße Substanz	0.76 - 1.08	61-100
Fettgewebe	0.2 - 0.75	53 - 94
Meningen	0.5 - 2.2	50 - 165

Unterschiedliche Relaxationszeiten sind Grundlage des MR-Kontrastes

T_1

Wasser, Knochen, Luft (lange T_1) = dunkel

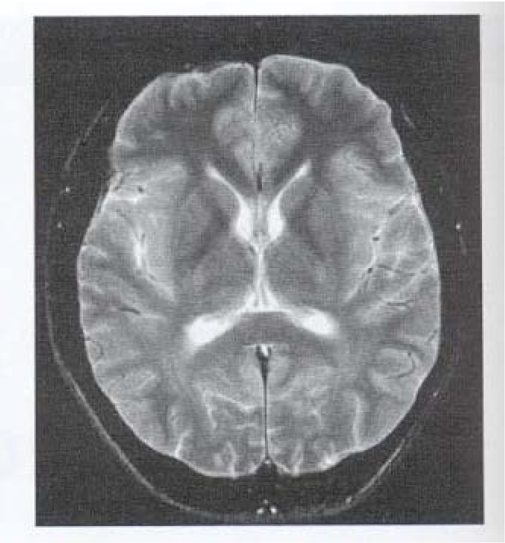
Fett (kurze T_1) = hell



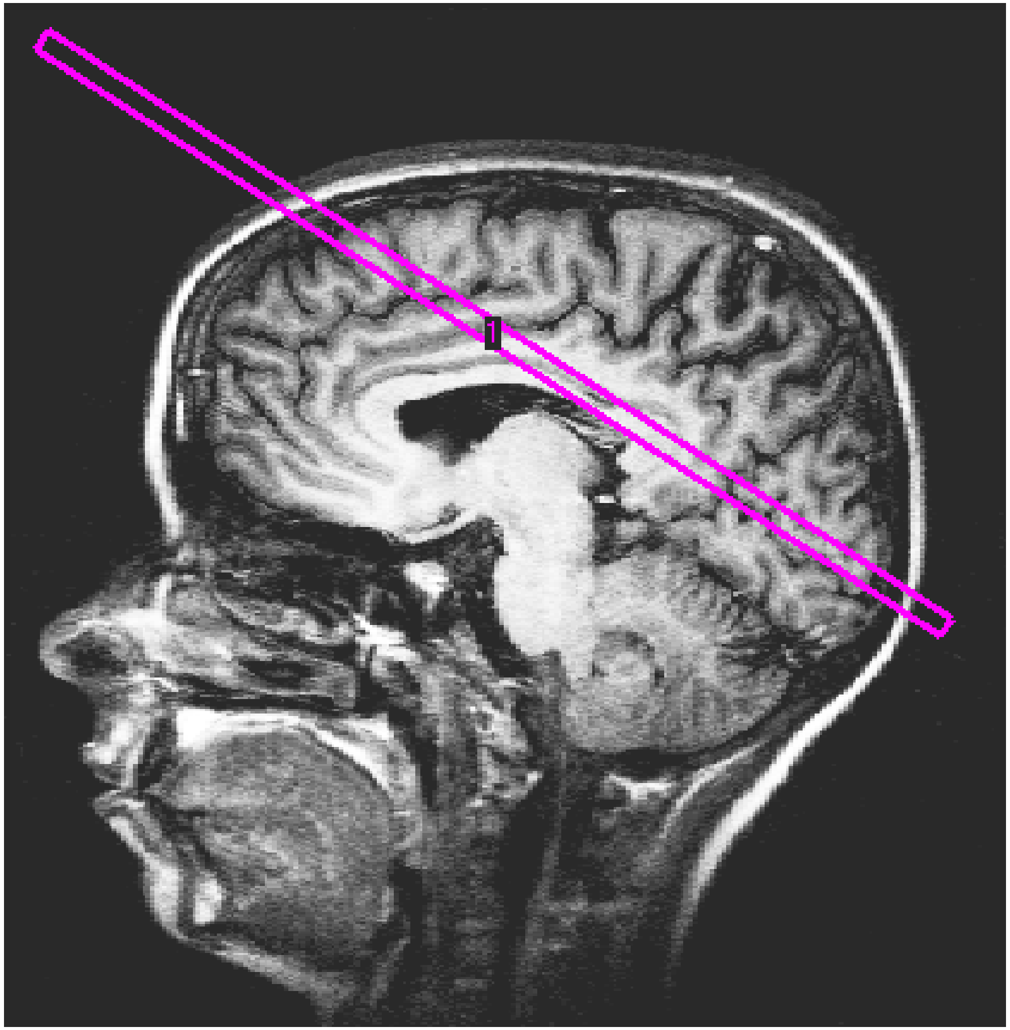
T_2

Wasser (lange T_2) = hell

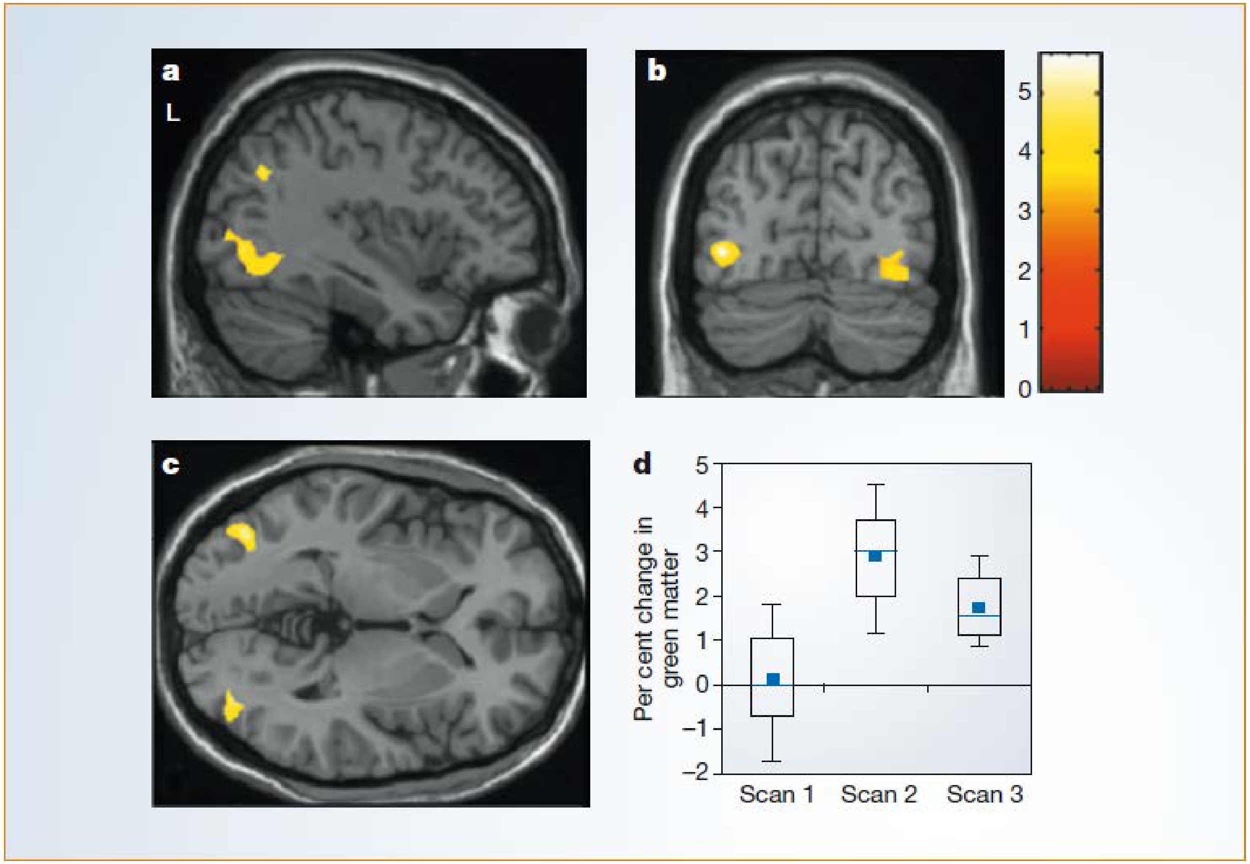
Knochen, Luft, Fett (kurze T_2) = dunkel



Strukturelle Magnetresonanztomographie

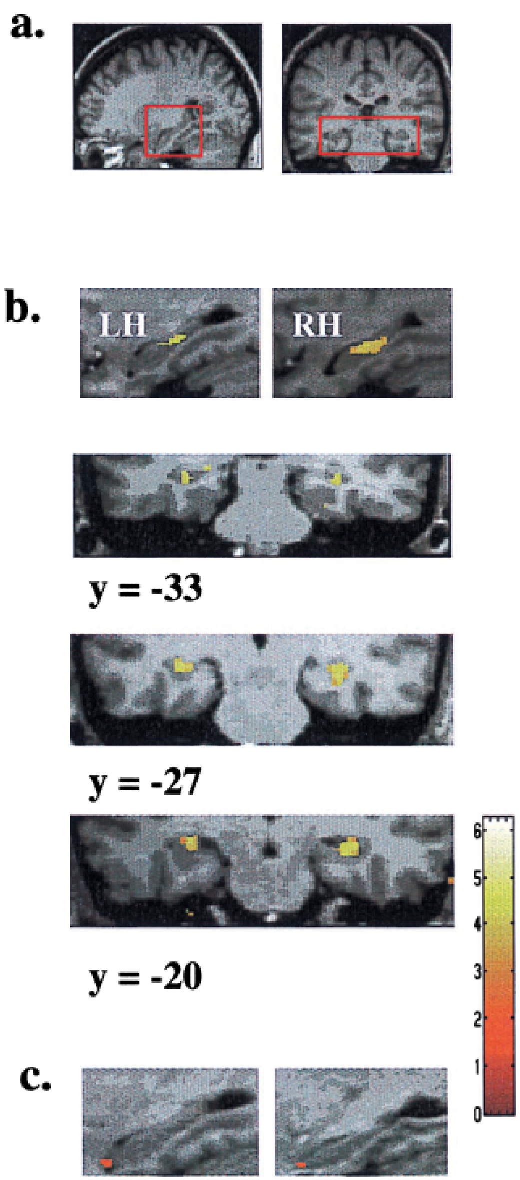


Strukturelle Bildgebung I:
Voxel Basierte Morphometrie (VBM)



Draganski et al. (2004)

Strukturelle Bildgebung I: Voxel-basierte Morphometrie



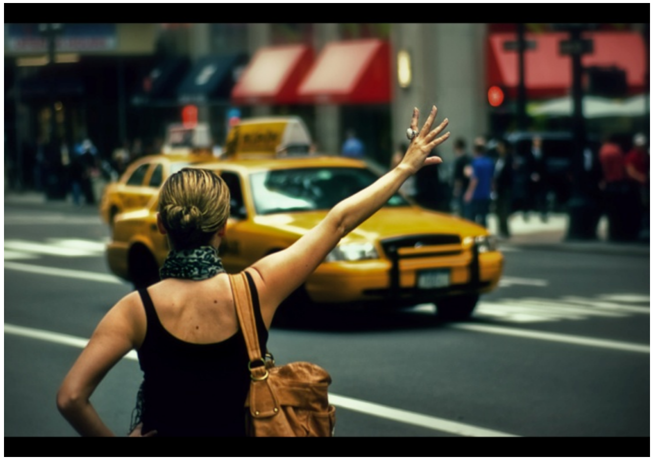


Fig. 1. VBM findings. (*a Left*) Sagittal section of an MRI scan with the hippocampus indicated by the red box. (*a Right*) Coronal section through the MRI scan, again with the hippocampi indicated. (*b*) The group results are shown superimposed onto the scan of an individual subject selected at random. The bar to the right indicates the *Z* score level. Increased gray matter volume in the posterior of the left and right hippocampi (LH and RH, respectively) of taxi drivers relative to those of controls, shown in the top of the figure in sagittal section. Underneath, the areas of gray matter difference are shown in coronal sections at three different coordinates in the *y* axis to illustrate the extent of the difference down the long axis of the hippocampus. (*c*) Increased gray matter volume in the anterior of the left and right hippocampi of controls relative to those of taxi drivers, shown in sagittal section. Note that, although the Talairach and Tournoux (11) coordinate system was used to describe the locations of VBM differences in stereotactic space, the images were normalized with respect to a template based on a large number of brains scanned in the same scanner used to collect the current data (see *Methods*). Thus, the coordinates given refer to our brain template and only approximately to the Talairach and Tournoux template.

PSYCHOLOGY

Strukturelle Bildgebung II: Pixel-Counting

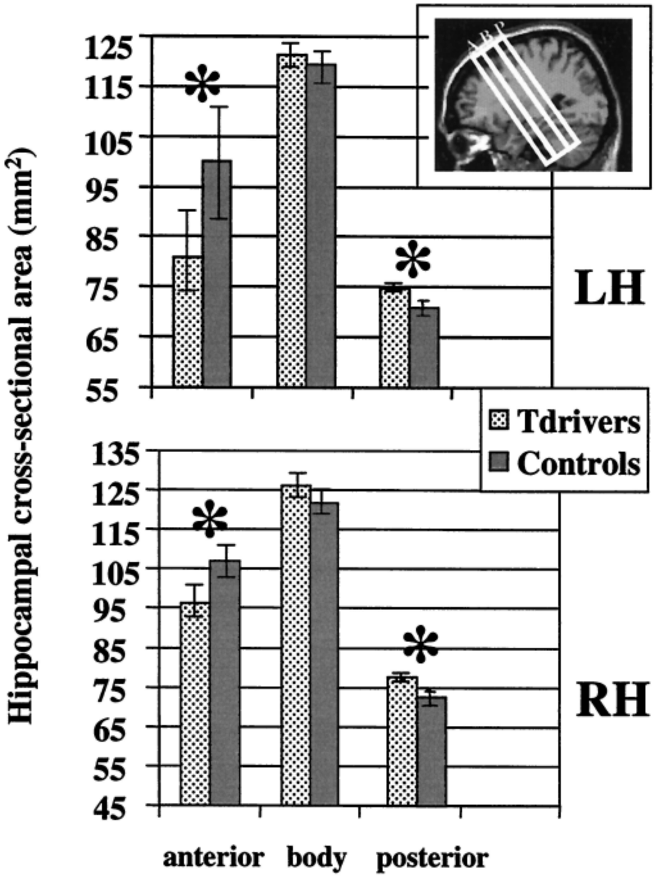
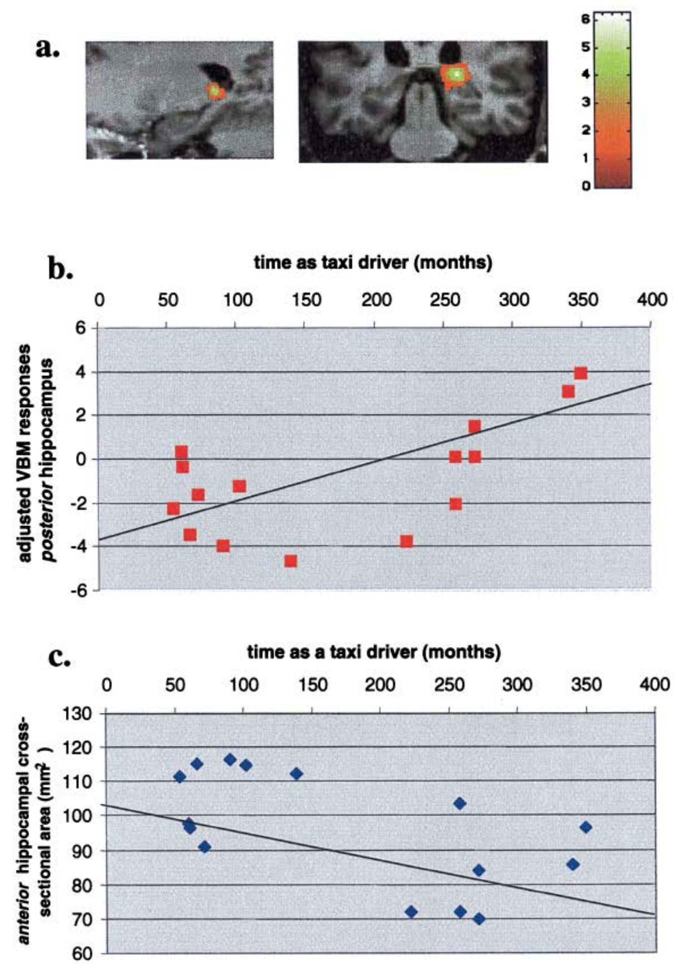


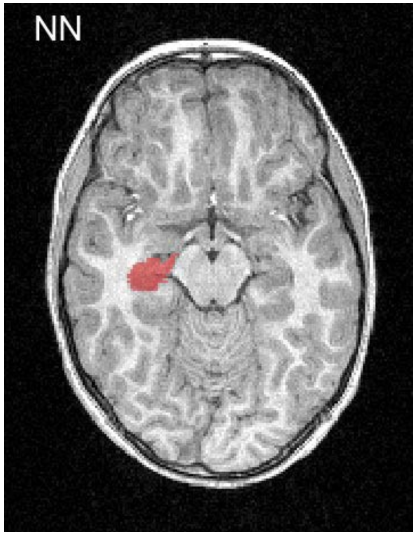
Fig. 2. Volumetric analysis findings. The orientation of the slices measured in the volumetric analysis with respect to the hippocampus is shown (*Top Right Inset*). A, anterior; B, body; P, posterior. (*Upper*) The mean of the cross-sectional area measurements (uncorrected for ICV) for the three regions of the left hippocampus (LH). (*Lower*) The means for the right hippocampus (RH). Taxi drivers had a significantly greater volume relative to controls in the posterior hippocampus, and controls showed greater hippocampal volume in the anterior. There was no difference between the two groups in the hippocampus body. *, $P < 0.05$.

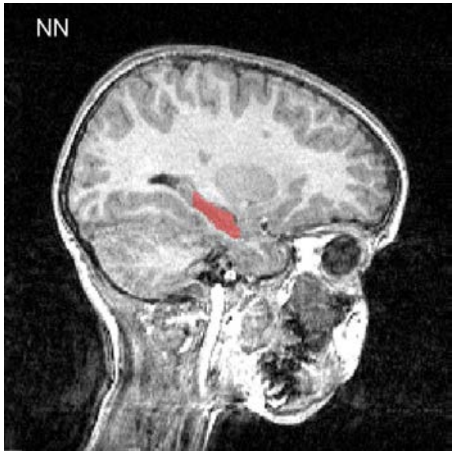


Strukturelle Bildgebung II:
Hippocampus Volumetrie

No evidence for group differences in absolute and adjusted right Hc volumes!

Control group: 2.57 cm^3 (.33)
FS group: 2.37 cm^3 (.37)

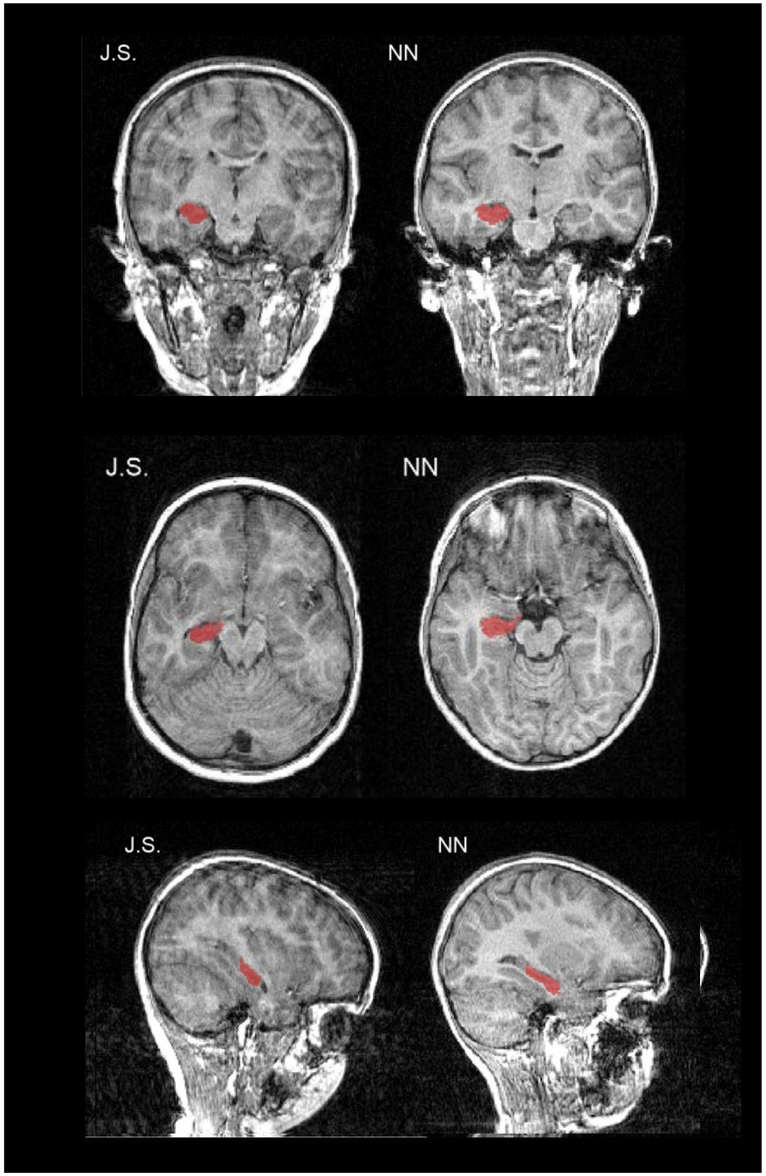




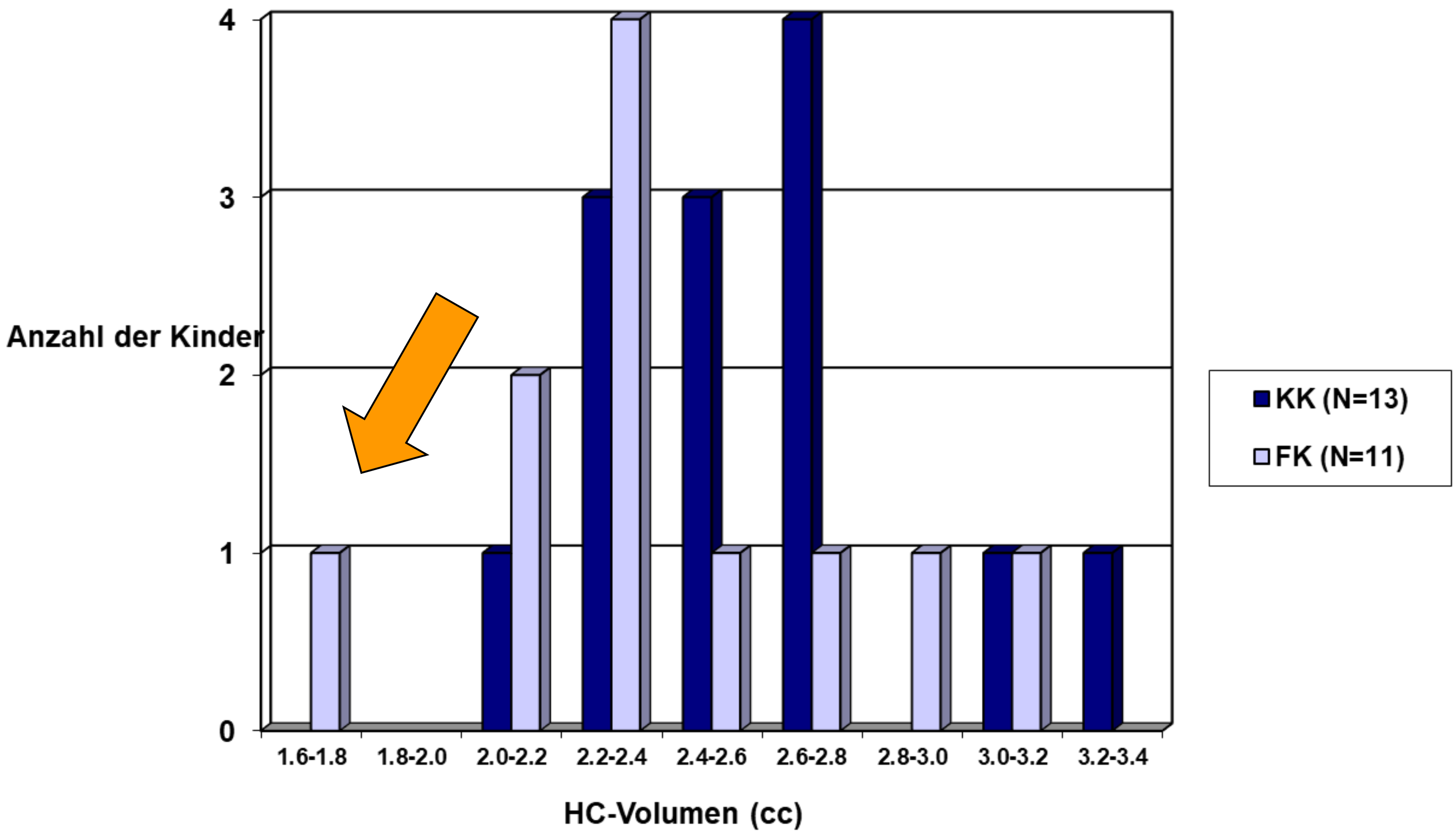
But: Patient J.S.

- 7 Jahre 11 Monate
- Grundschule 2. Klasse
- 1 Fieberkrampf > 15 min (24 Monaten)

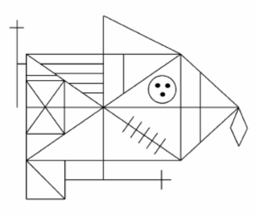
- Hc Volumen < 2 SD des Mittelwerts: 1.72 cm^3

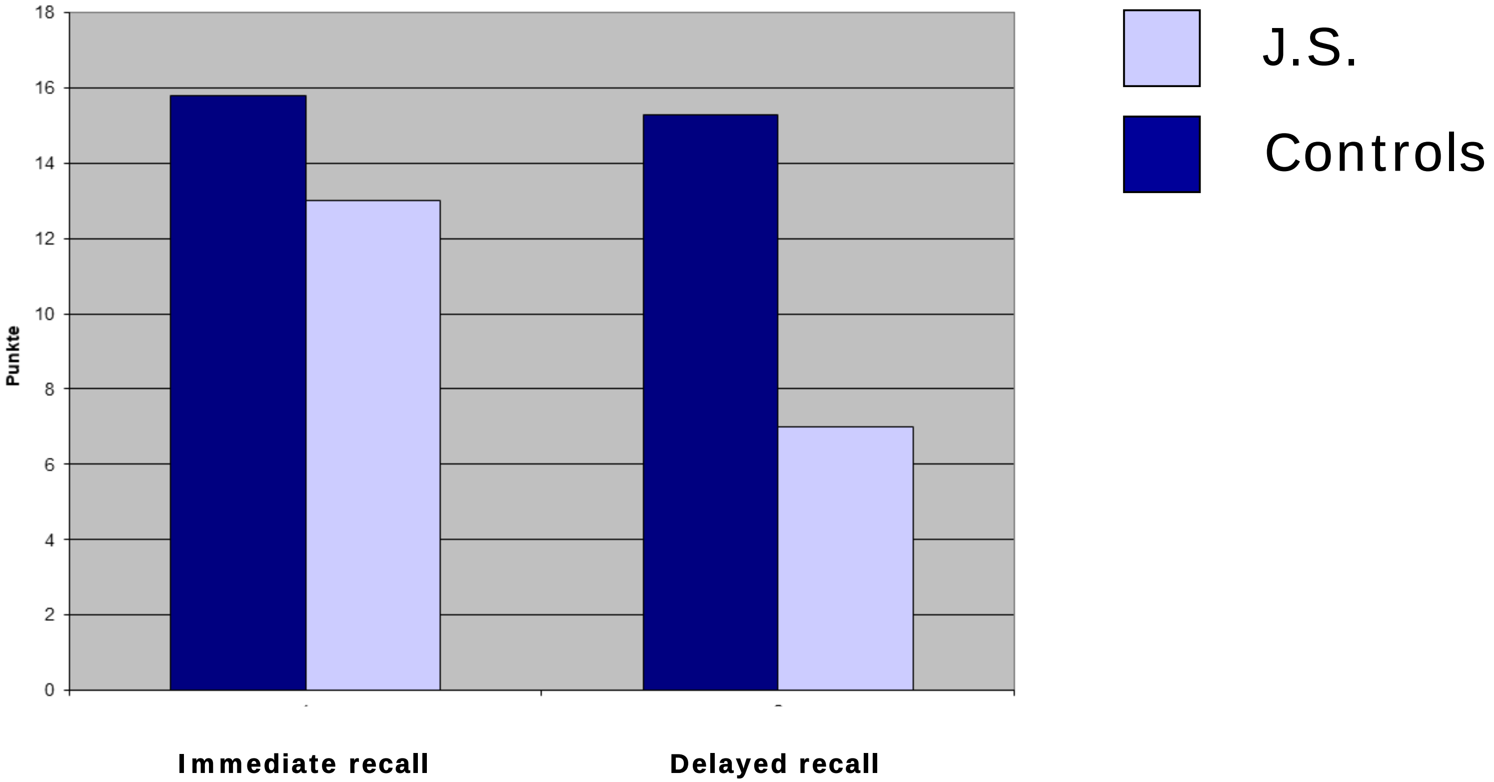


Hippocampus Volumetrie



J.S. Visual Episodic Memory





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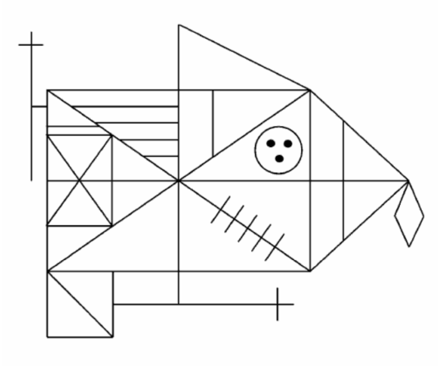
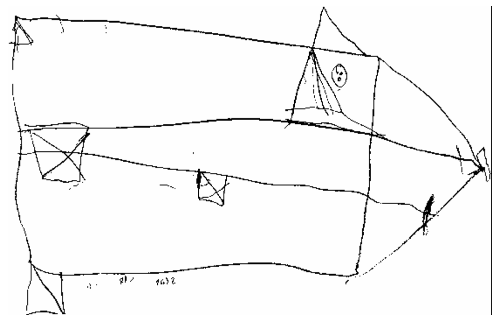
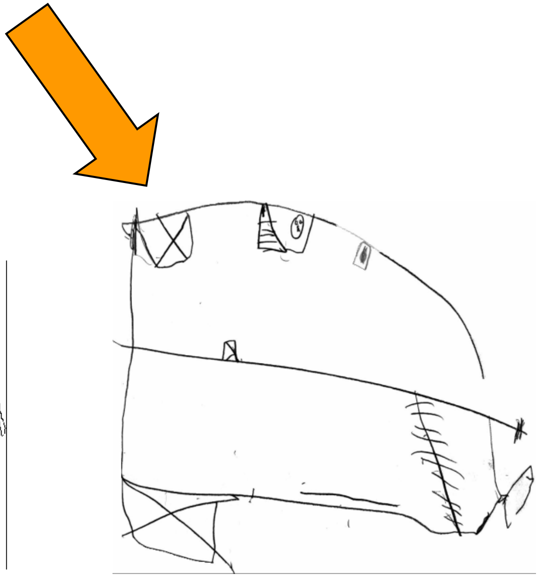
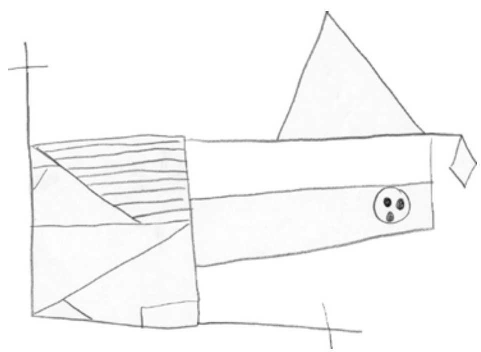


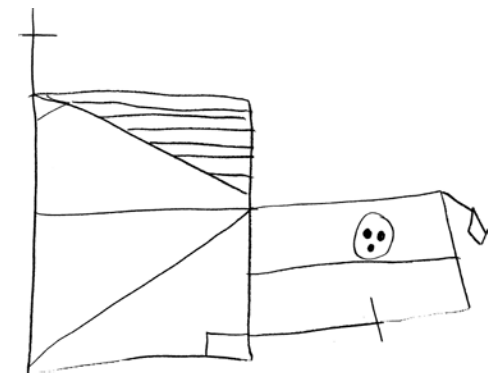
J.S.





Controls



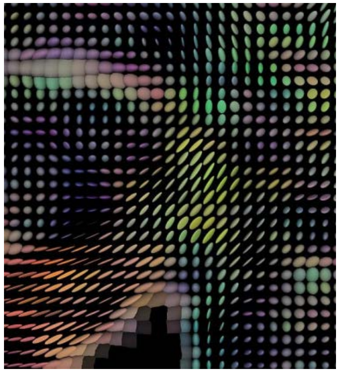


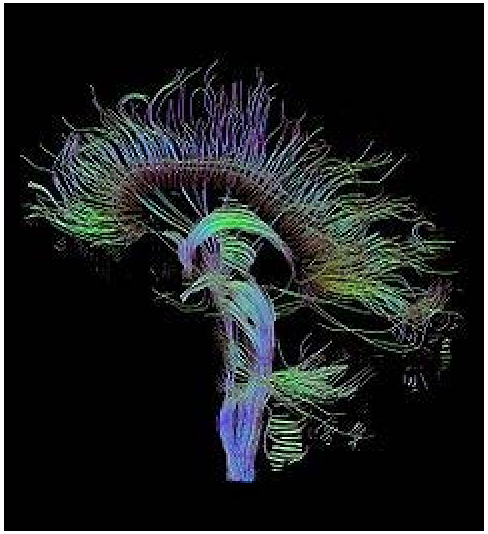
Immediate

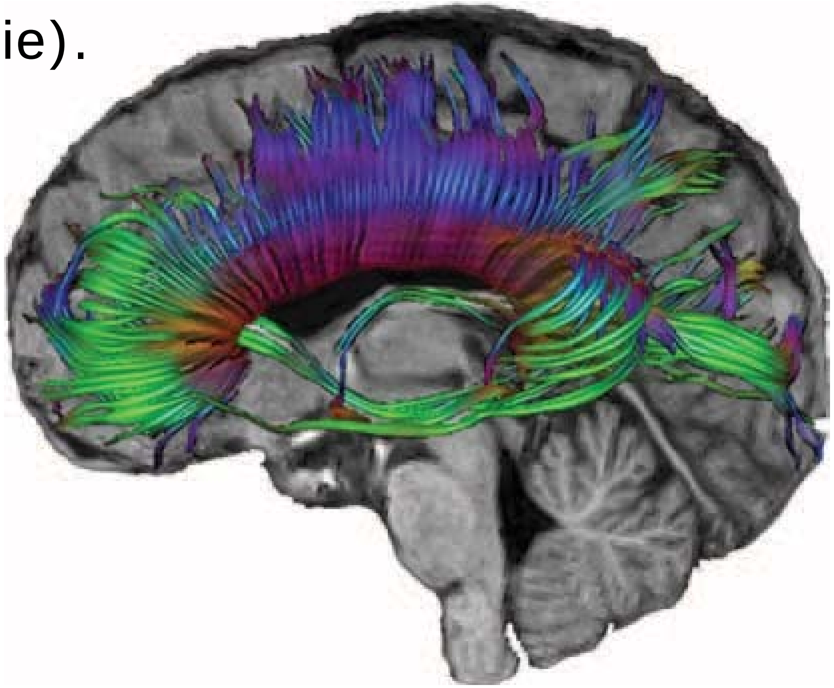
Delayed

Strukturelle Bildgebung III:
Diffusions-Tensor-Bildgebung (DTI)

– Bestimmung der Vorzugsrichtung der Molekularbewegung von Protonen in der weißen Substanz (Anisotropie).







MR Spektroskopie

Def: MR Verfahren zur Sichtbarmachung der chemischen Zusammensetzung des Gewebes (Moleküle; Neurotransmitter).

Metaboles Mapping:
z.B. Analyse von Tumorstoffwechsel Vorgängen

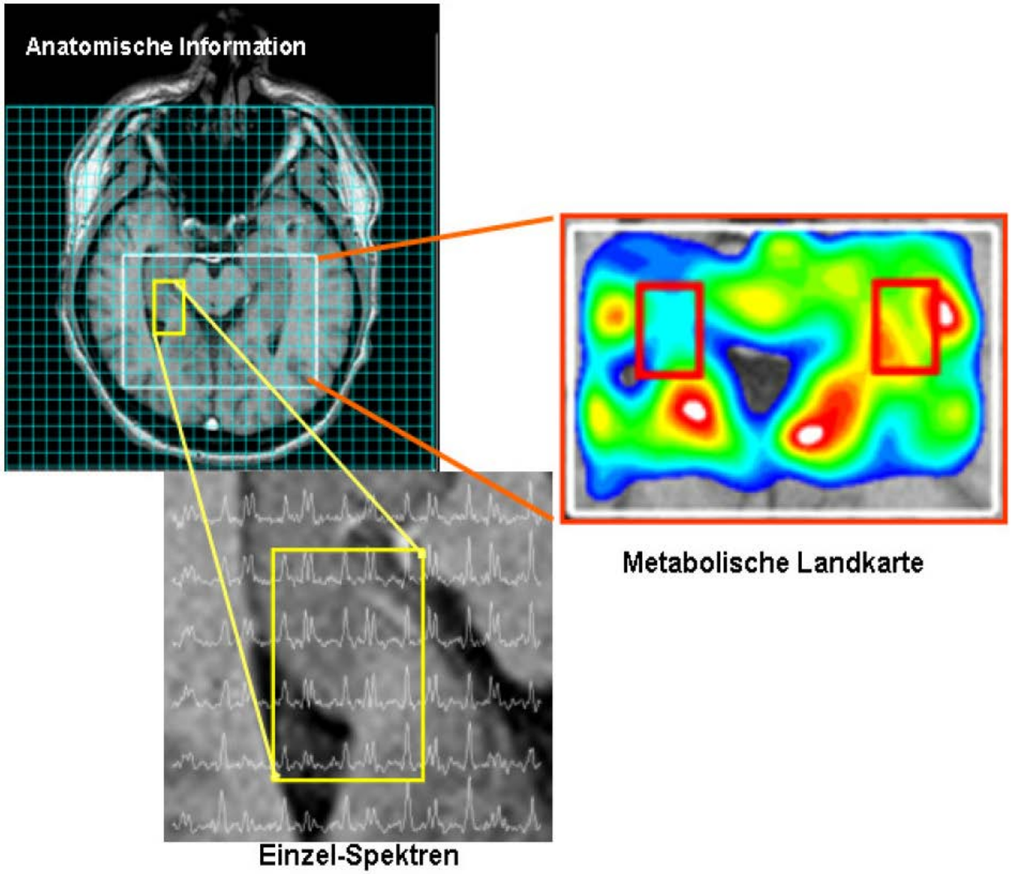
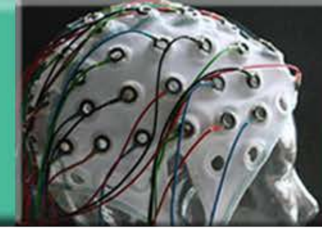
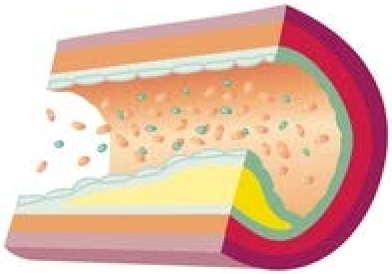


Abb. 1: Metabolische Landkarte des Hippocampus mittels MR-Spektroskopie (bei langen Echozeiten): Die anatomische Information der MR-Bildgebung (links) lässt sich zusammen mit der biochemischen Information mit der gleichen Messmethode exakt erfassen. Das prominenteste Metaboliten-Signal (rechtes Bild) stammt von N-Acetyl-Aspartat (NAA), das als neuronal/axonaler Funktions- bzw. Untergangsmarker gilt.

Mikroangiopathie

Erkrankung der kleinen Blutgefäße / Arteriosklerose





Quelle: DAK

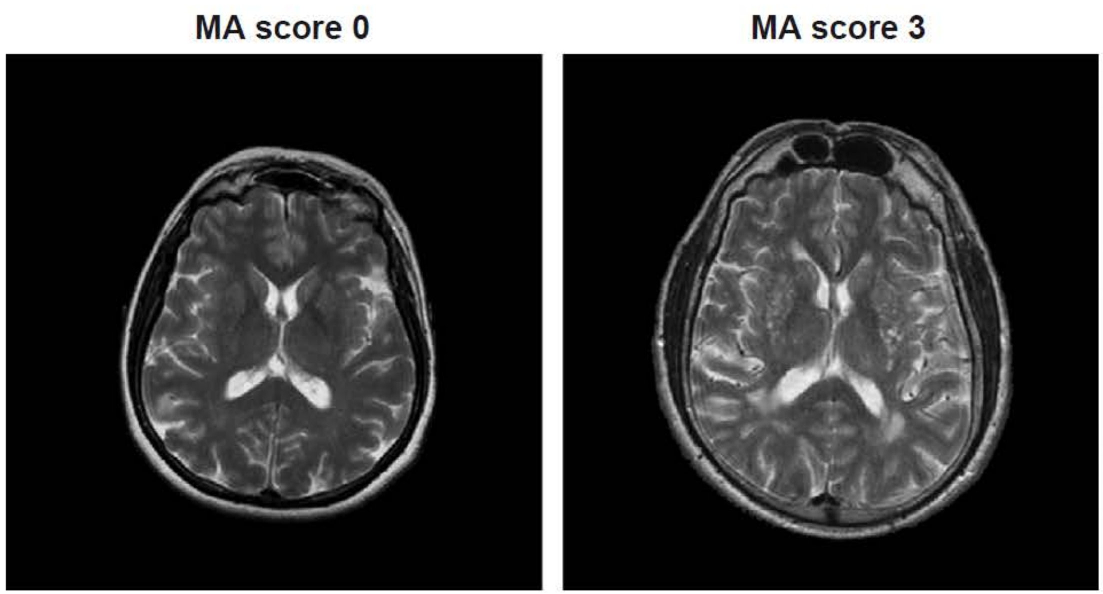
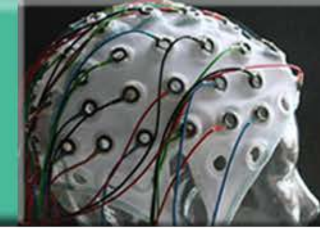
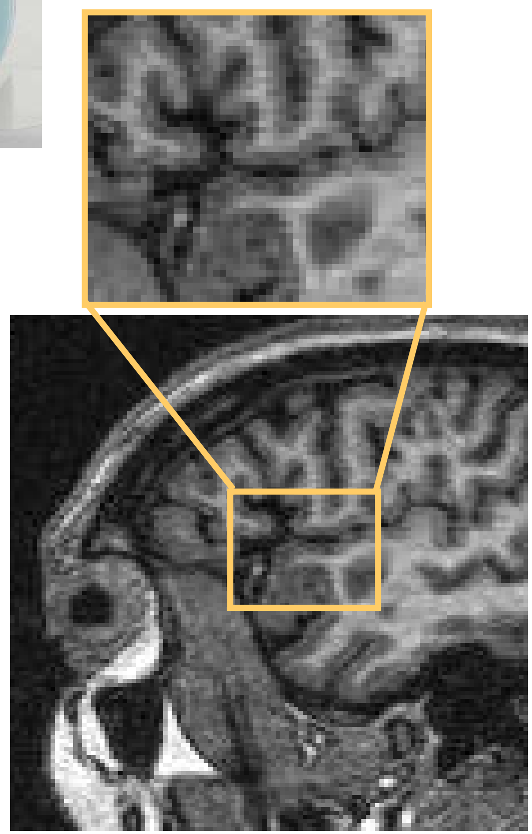


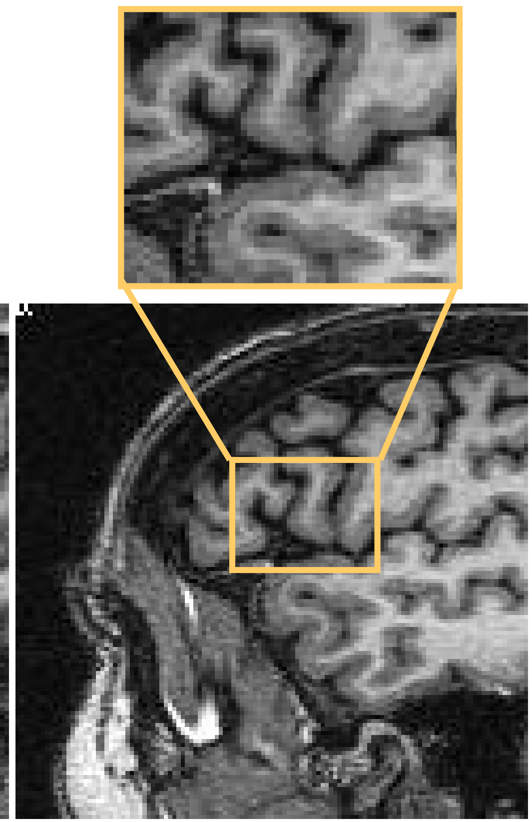
Fig. 2. T2-weighted MR scans of two participants, classified as low (score: 0, left) or high (score: 3 right) on the microangiopathy scale. While there were no small vessel abnormalities in the participant with score 0, the participant with score 3 shows hyperintensity in the periventricular white matter and in subcortical regions. For details, see Methods section.

MRT: Effekt der Feldstärke
1,5 Tesla vs 3 Tesla

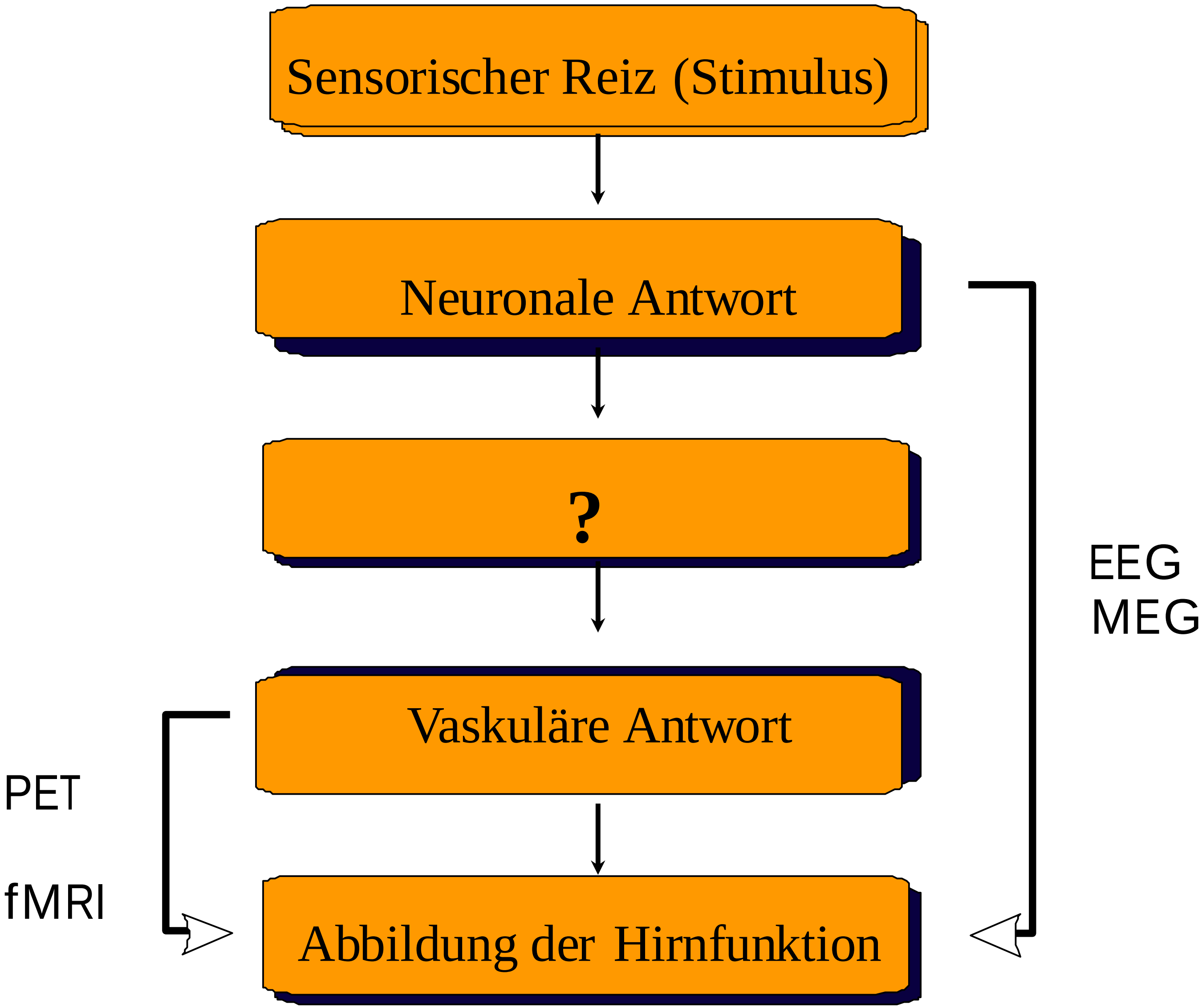


1.5T **3.0T**

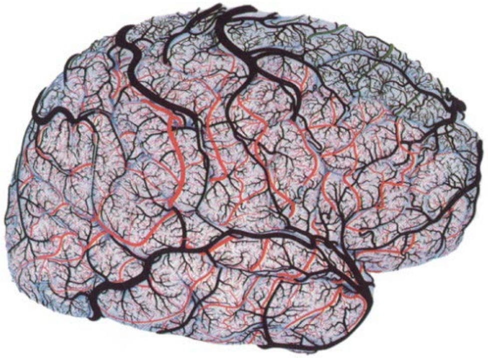


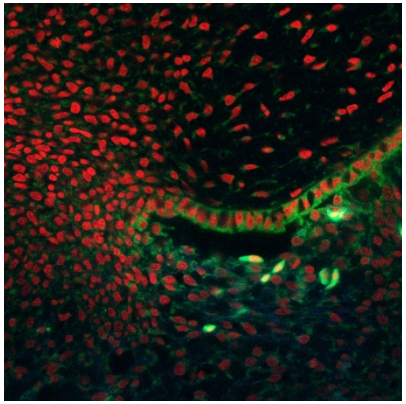


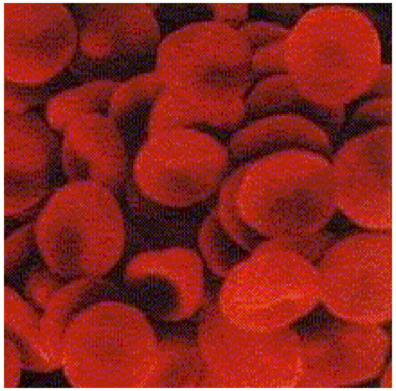
Neurovaskuläre Kopplung



O_2 Verbrauch des Organismus







- Hämoglobin (oxy Hb / desoxy Hb)
- Ruhe: 250 ml / min
  davon 20% (=50ml) für Gehirnstoffwechsel
- Großhirnrinde: 8 ml / 100g / min
- Weiße Substanz: 1ml / 100g / min

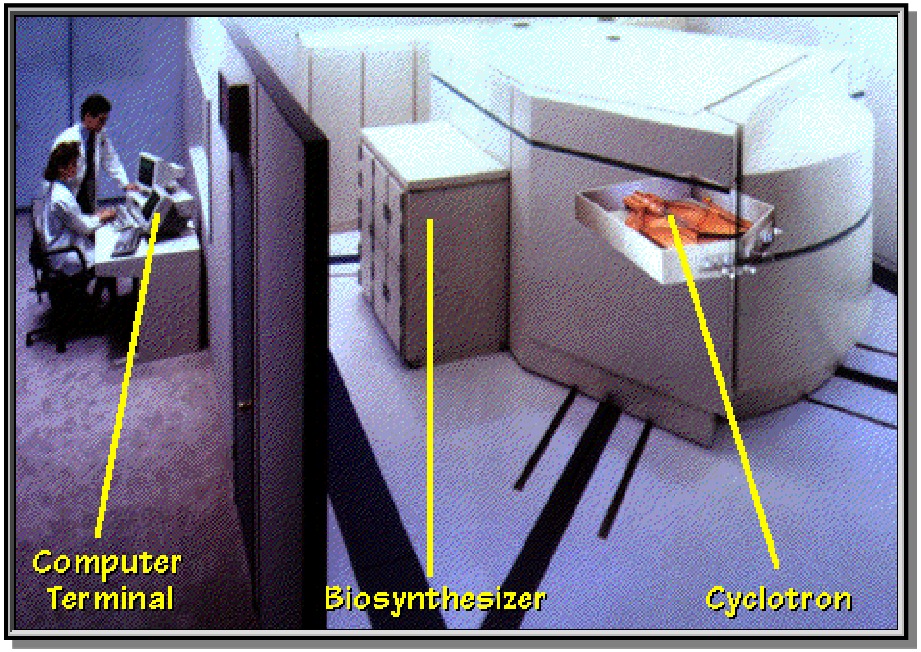
Positronen in Radioisotopen

... sind positiv geladene Elektronen und damit deren Antiteilchen

... ^{15}O (Isotope)

... Kern hat 8 Protonen und 7 Neutrone

... werden durch Kernreaktionen künstlich hergestellt (Zyklotron)

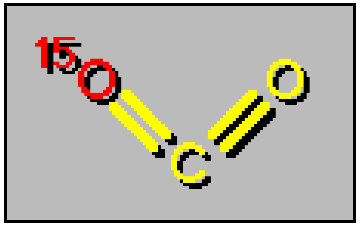


Markierung von Biomolekülen mittels Isotopen (Tracer)

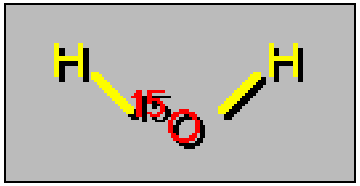
Sauerstoff	Kohlenstoff	Fluor

Sauerstoff

Kohlendioxid

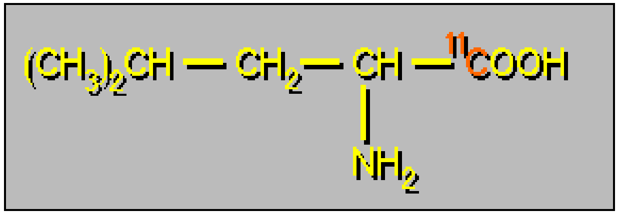


Wasser

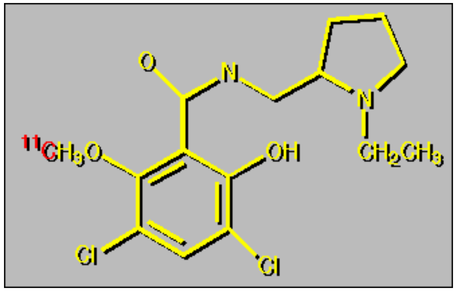


Kohlenstoff

Leucine

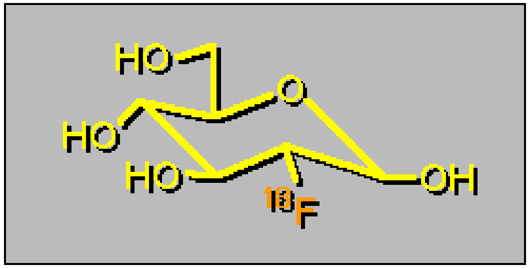


Raclopride

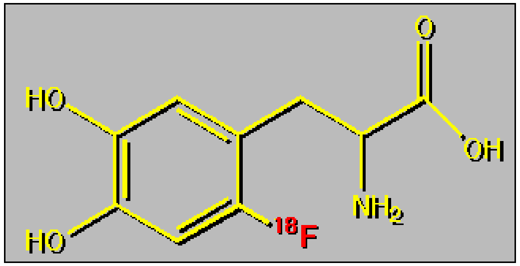


Fluor

Fluorodeoxyglucose

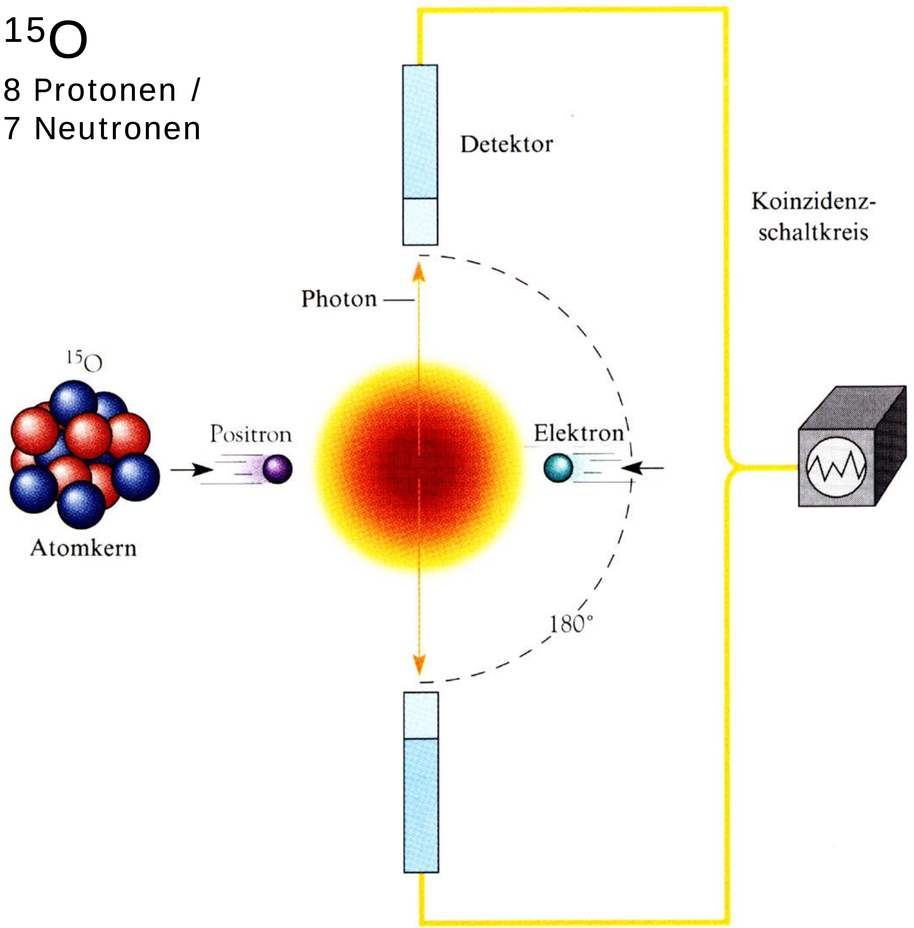


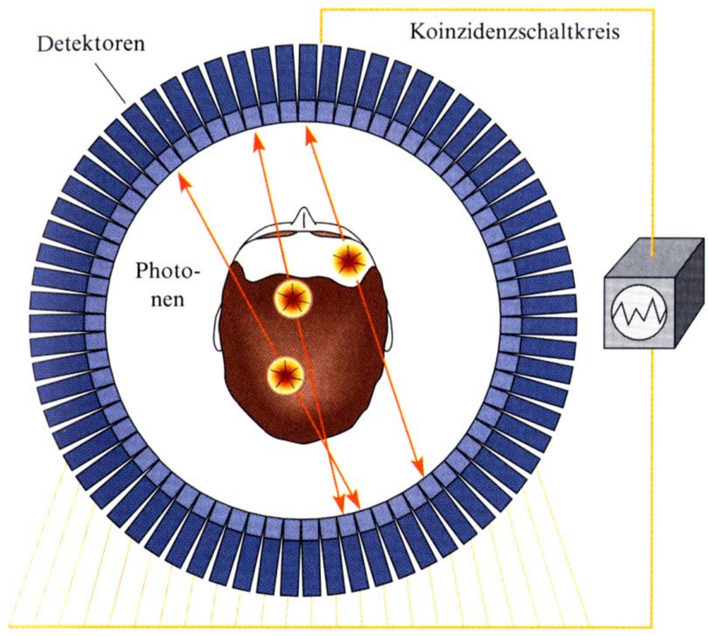
Fluordopa



Positronen-Emissions-Tomographie (PET)

^{15}O
8 Protonen /
7 Neutronen

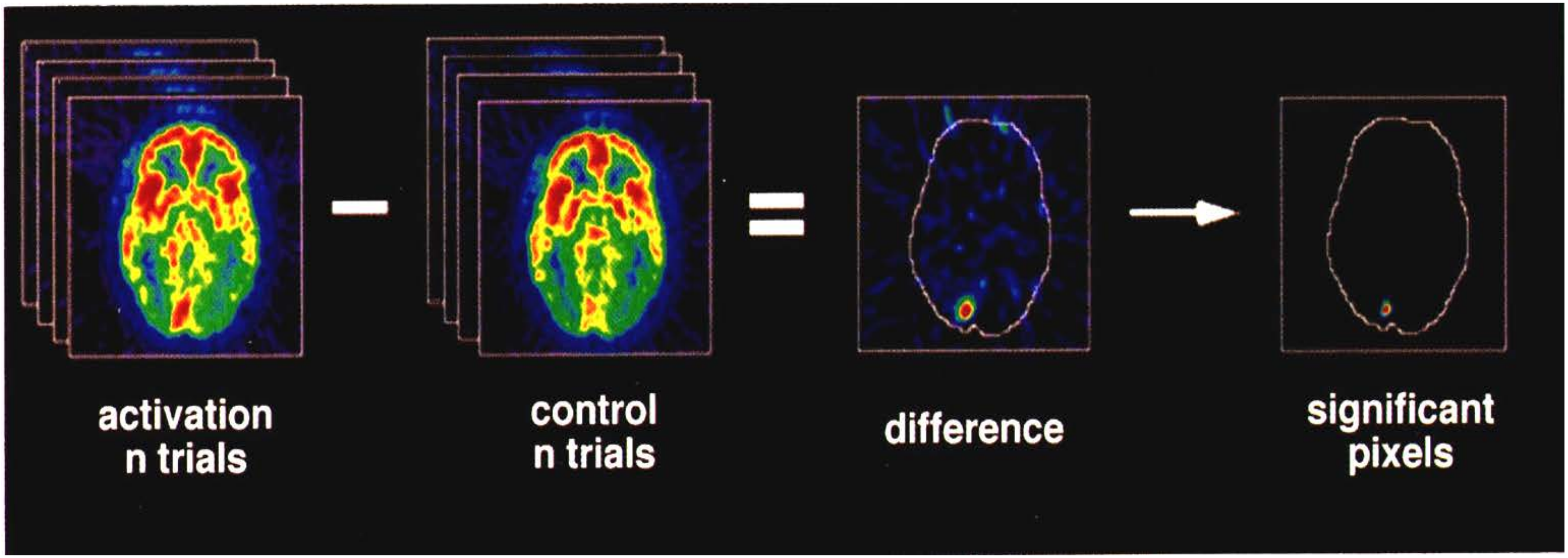




Der PET Scanner

Kognitive Subtraktion

- Subtraktion
- Statistischer Vergleich



Funktionelle Magnet-resonanztomographie (MRT)

- Erhöhter zellulärer Energiebedarf bei neuronaler Aktivierung.
- Zunahme von sauerstoffarmem (deoxy.) Hämoglobin (Hb).
- Blutflußzunahme übersteigt die erhöhte Sauerstoffzufuhr erheblich.
- Deoxy. Hb nimmt ab. => langsamere T2 Relaxationszeiten
- Konzentrationsänderung des desoxy. Hb ruft Magnetfeld-inhomogenitäten hervor (intrinsisches Kontrastmittel).
- **Blood-oxygen-level-dependend (BOLD) -Signal**).

Verteilung im Gehirn

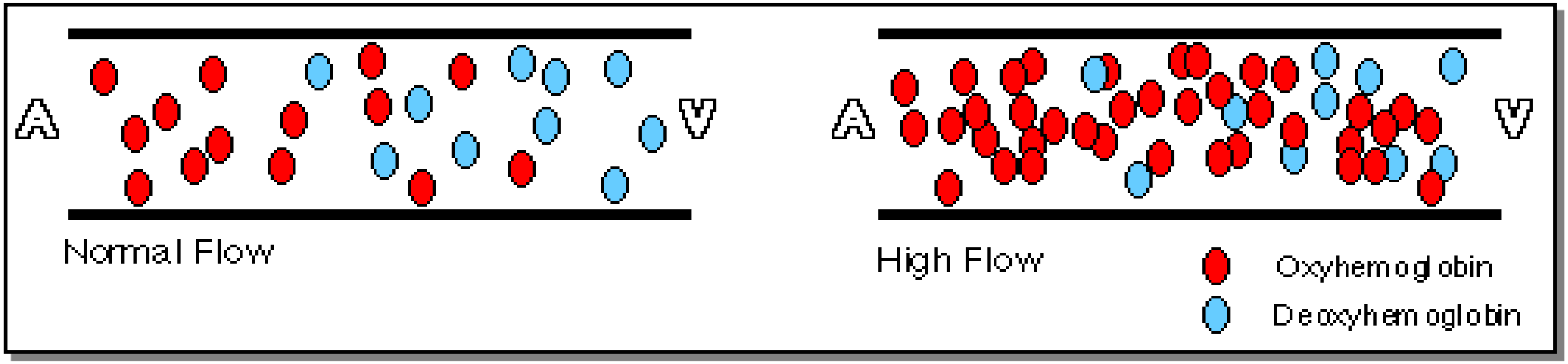
HbO_2 versorgt den Gewebs-Stoffwechsel durch den Blutkreislauf mit Sauerstoff (O_2)

Sauerstoff-Verbrauch in ‚aktiven' Hirn-Regionen steigt

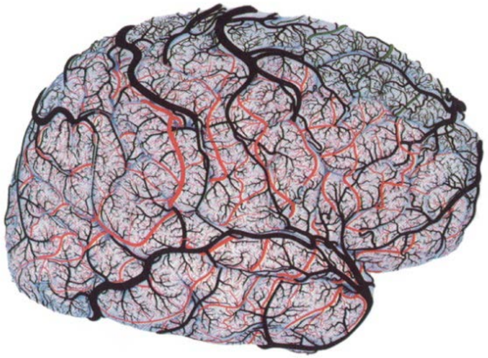
[der Anstieg an Deoxy-Hb durch Stoffwechselaktivität selber ist zu gering, um ein für fMRT brauchbares Signal zu produzieren]

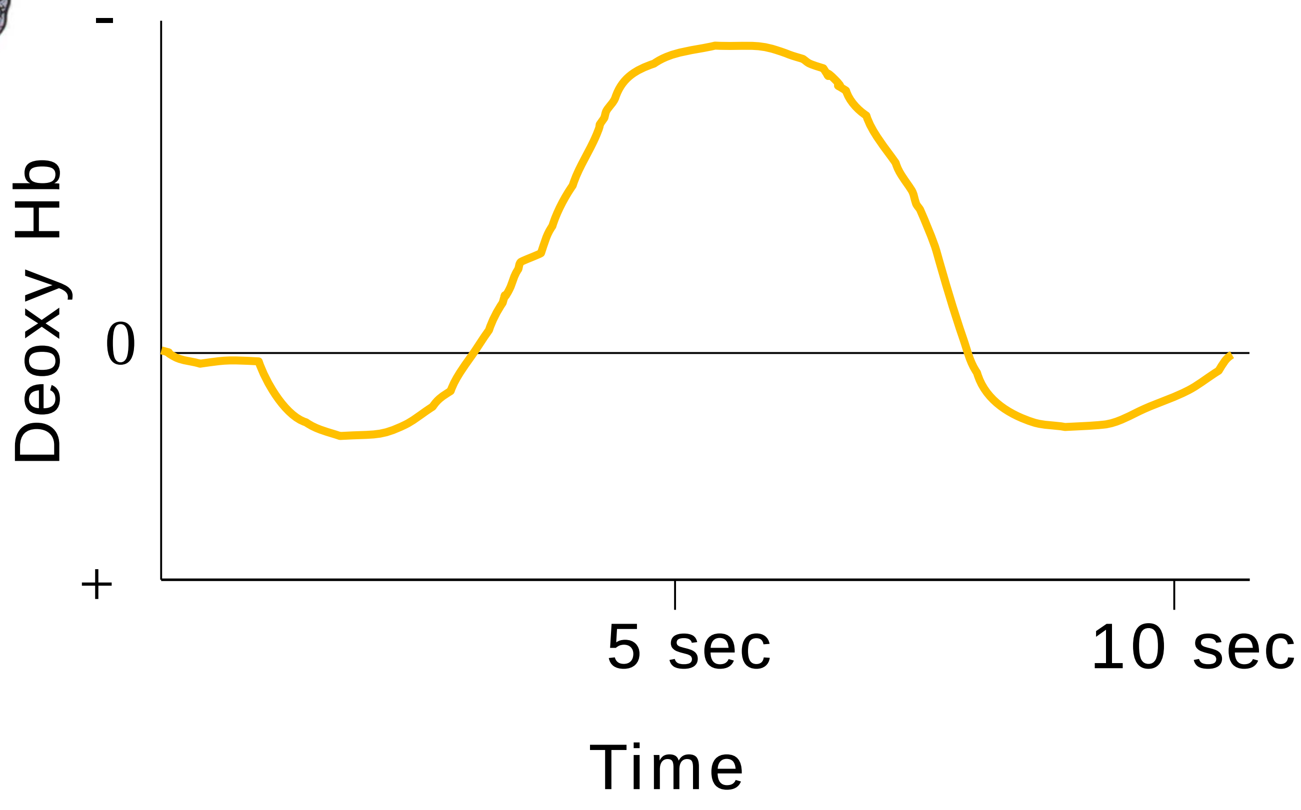
paradoxer Anstieg des lokalen Blutflusses und der Blutmenge

→ Deoxy. Hb nimmt ab

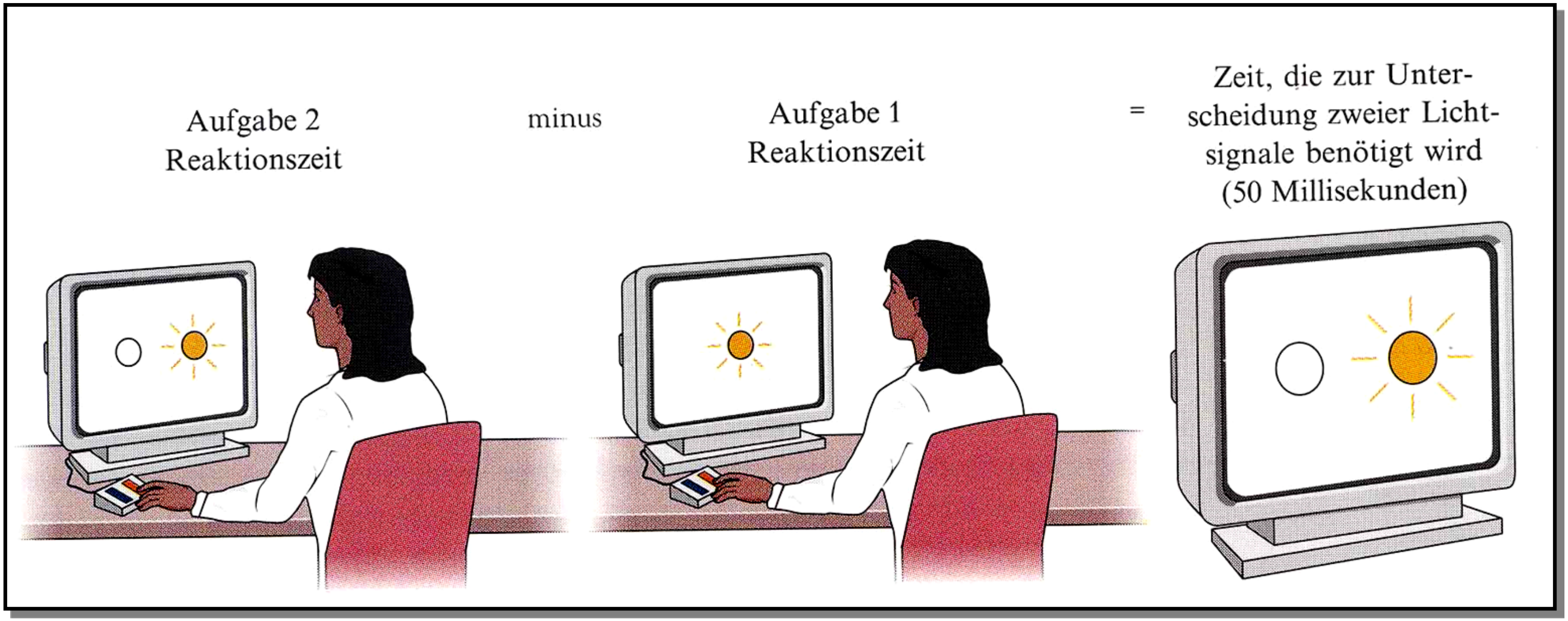


Der BOLD Effekt
(blood oxygen level dependent)





Die Logik der kognitiven Subtraktion



(F.C. Donders 1868)

Subtraktionslogik

What regions of the brain are used for recognising words?

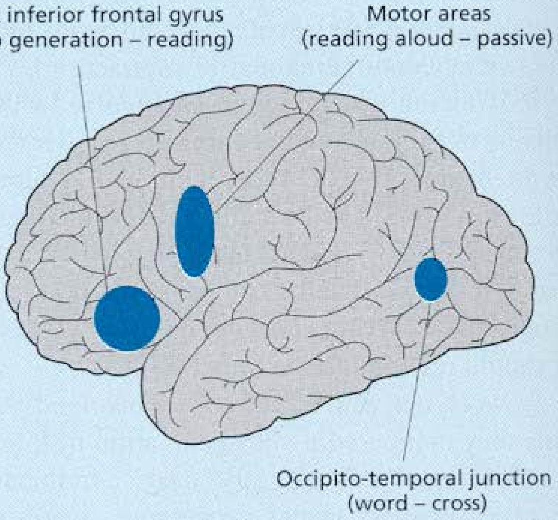
EXPERIMENTAL		BASELINE
• passive viewing of written words	–	• passive viewing of fixation cross (+)
Cognitive components		*Cognitive components*
~~visual processing~~		~~visual processing~~
word recognition		

What regions of the brain are used for saying words?

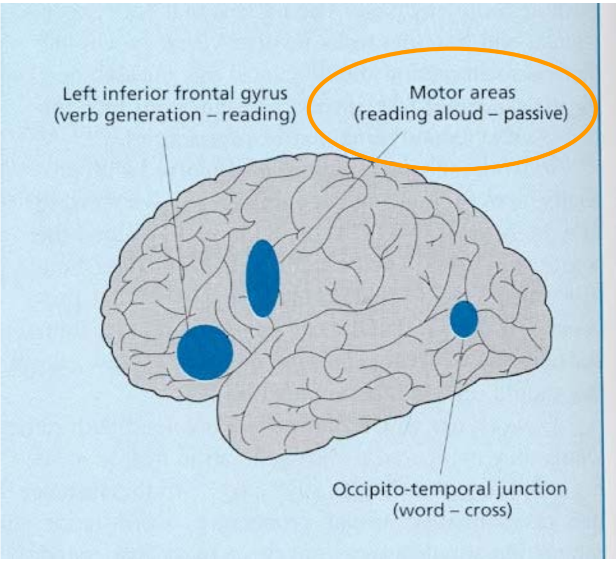
EXPERIMENTAL		BASELINE
• read aloud a written word	–	• passive viewing of a written word
Cognitive components		*Cognitive components*
~~visual processing~~		~~visual processing~~
~~word recognition~~		~~word recognition~~
phonology/articulation		

What regions of the brain are used for retrieving meaning?

EXPERIMENTAL		BASELINE
• generate an action e.g. see CAKE, say "eat"	–	• read aloud a written word
Cognitive components		*Cognitive components*
~~visual processing~~		~~visual processing~~
~~word recognition~~		~~word recognition~~
~~phonology/articulation~~		~~phonology/articulation~~
retrieve meaning		



Subtraktionslogik



Probleme:

- Pure Insertion (recognize word vs +)
- Interaktionen
- Wahl der Baseline ist entscheident
  - Wortproduktion: 1) Abrufen aus dem mentalen Lexikon
    2) Vorbereitung & Ausführung eines motorischen Kommandos
    3) Hören

Lesen (1,2,3) – Sehen

Besser und spezifischer:

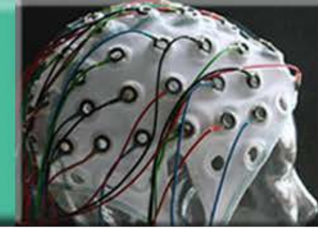
Lesen (1,2,3) – Lesen eines konstanten Wortes (2,3)

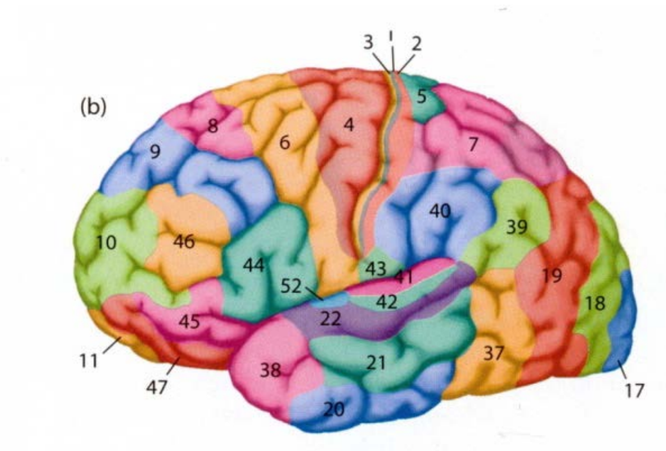
Jenseits kognitiver Subtraktionen

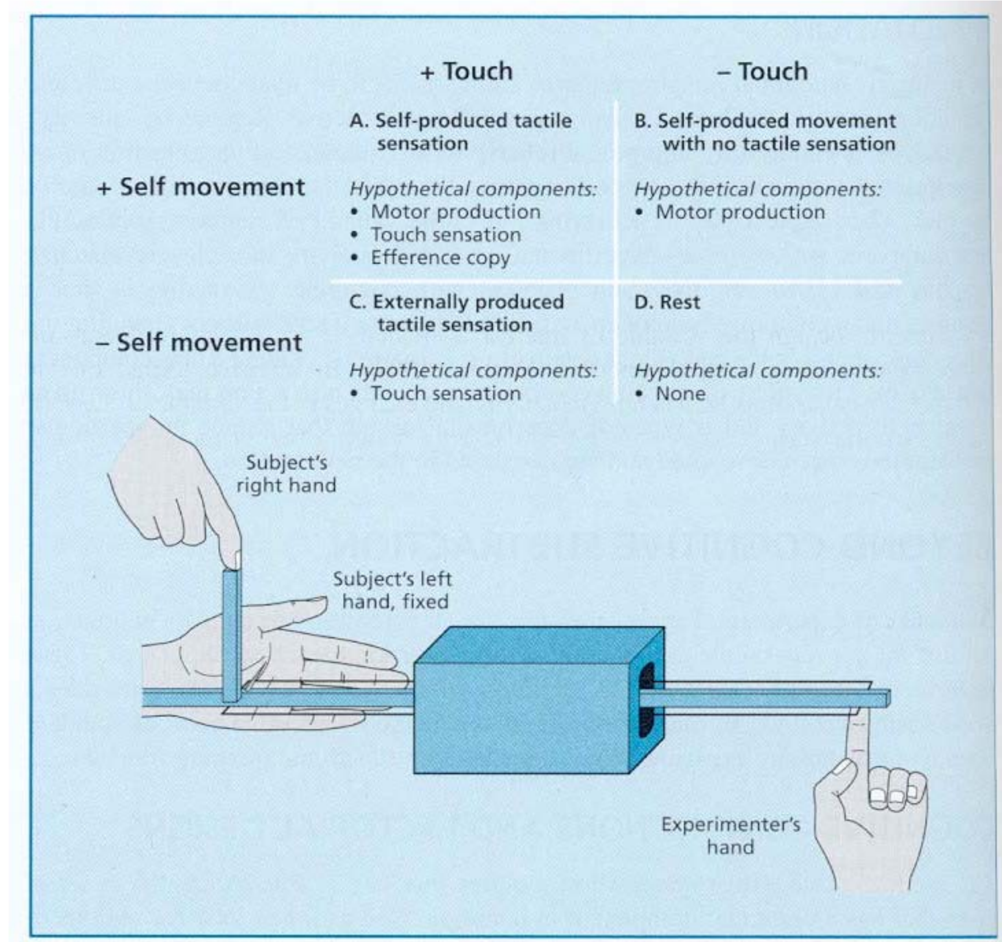
- Kognitive Verknüpfungen
- Faktorielle Designs

Warum kitzelt es nicht, wenn man sich selbst kitzelt?

Warum kitzelt es nicht, wenn man sich selbst kitzelt? (Efferenzkopie)



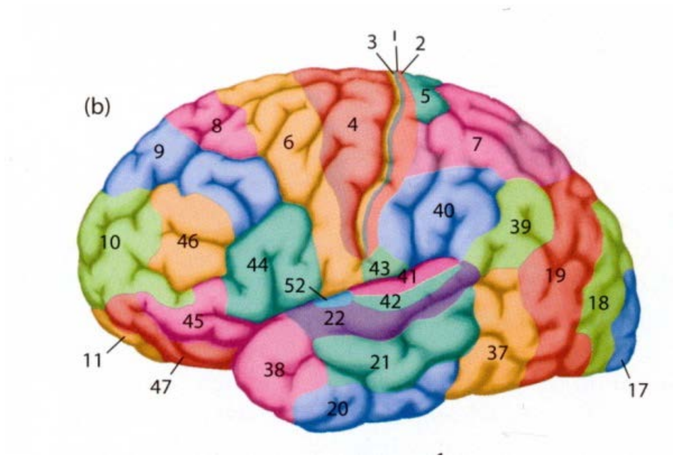


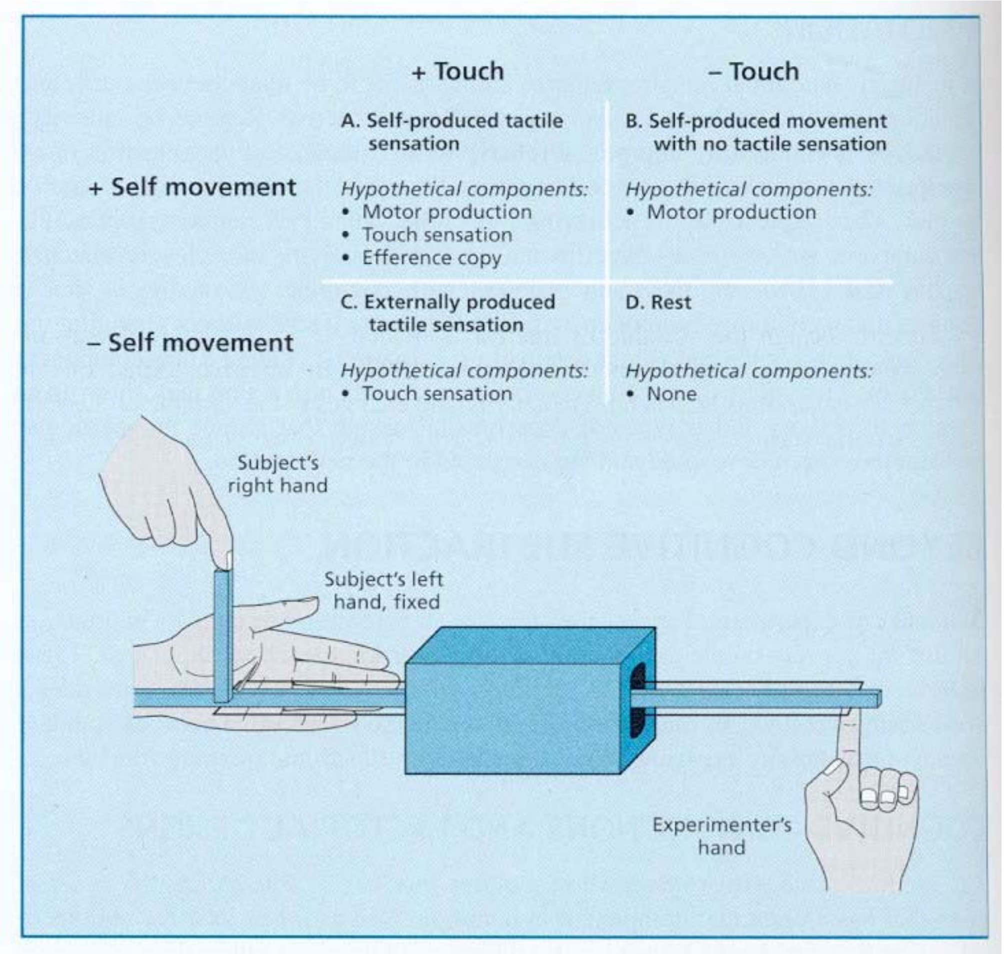


A-B & C-D: Touch sensation
A-C & B-D: Motor production

(A-B) – (C-D): Is touch sensation same or different for self and externally produced sensations?

Warum kitzelt es nicht, wenn man sich selbst kitzelt? (Efferenzkopie)





A-B & C-D: Touch sensation
A-C & B-D: Motor production

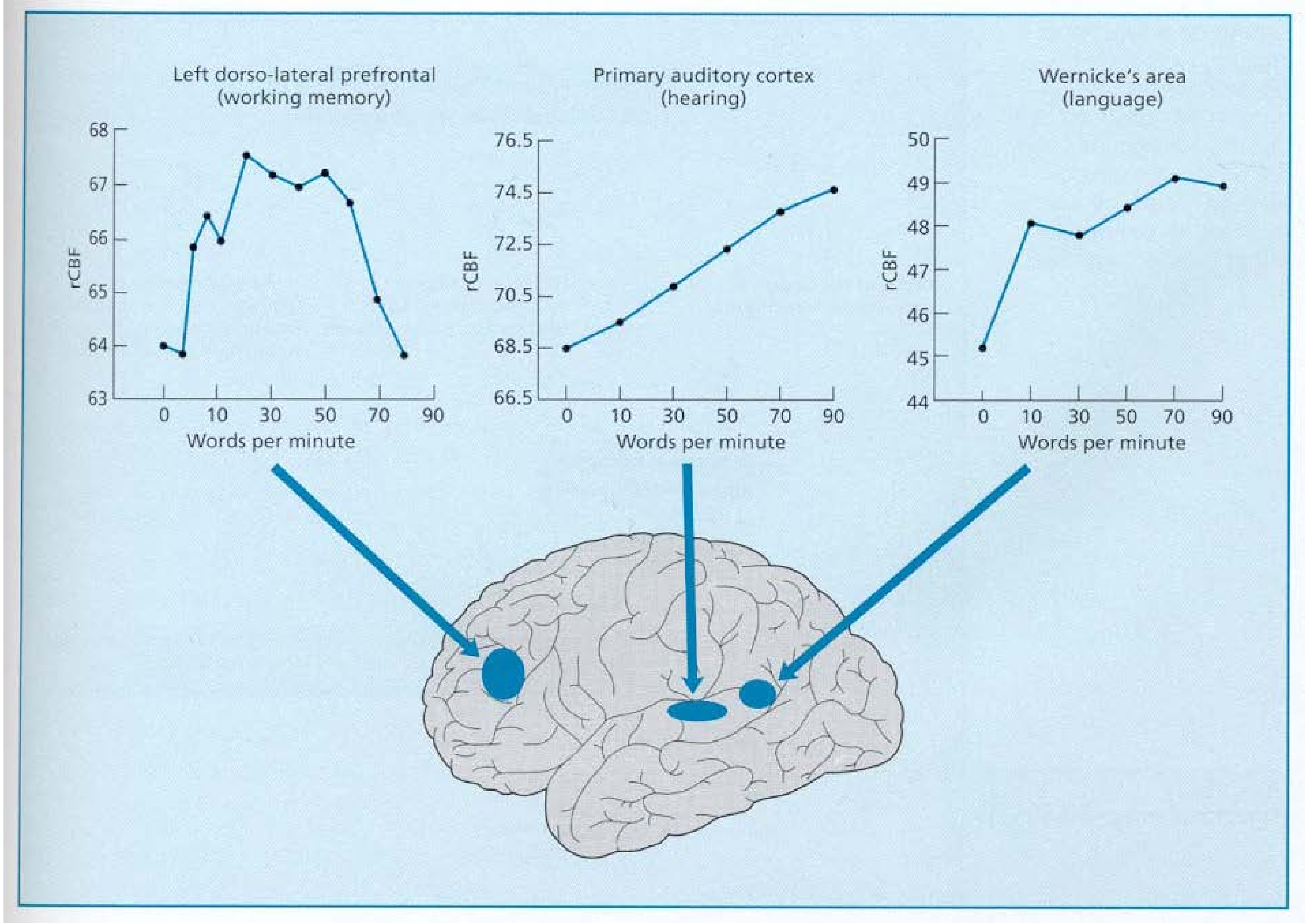
(A-B) – (C-D): Is touch sensation same or different for self and externally produced sensations?

(A-B)-(C-D): Deactivation in somatosenory cortext & activation in cerebellum

Kognitive Konjunktionen und faktorielle Designs

- ☺ minimieren das Problem der „pure insertion“
- ☺ ermöglichen Interaktionsanalysen (Differenzen von Differenzen)

Parametrische Designs



Der BOLD Effekt:
Scaling & Superposition

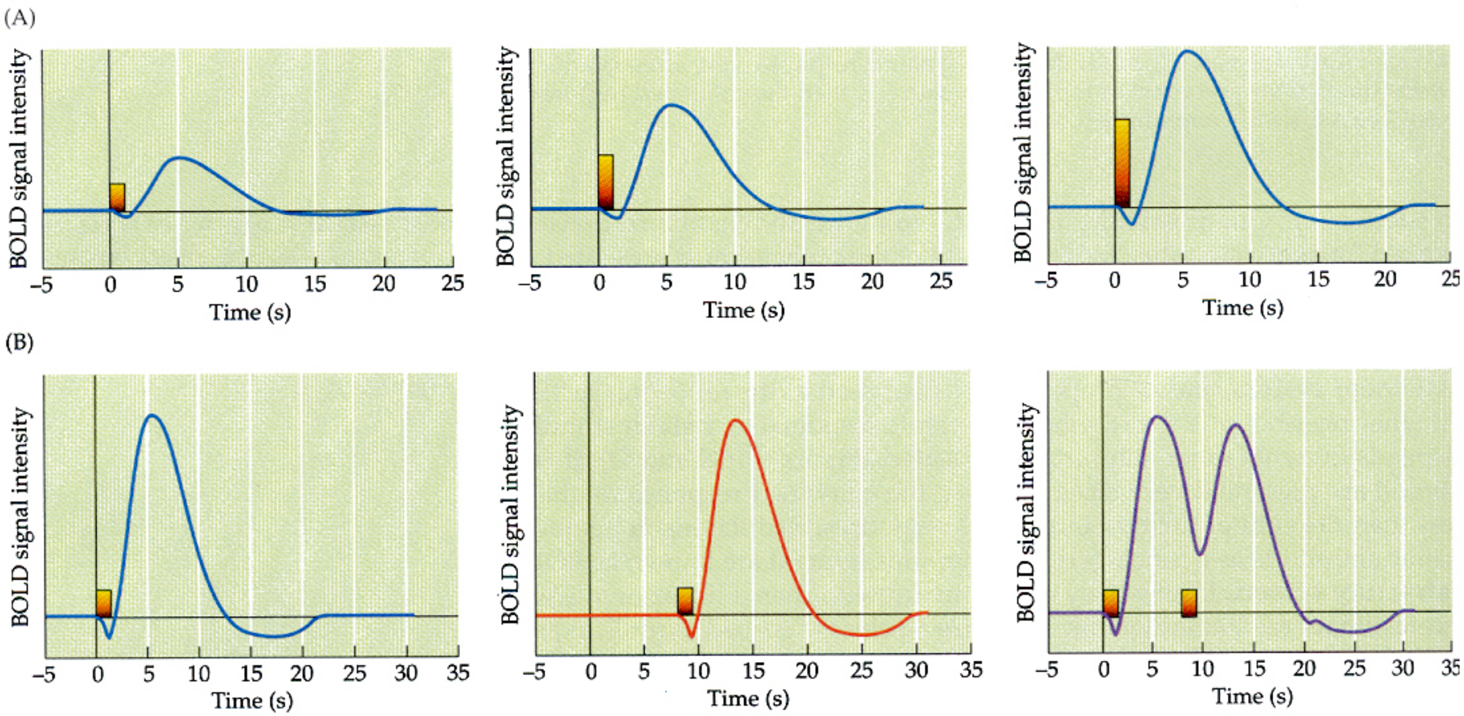


Figure 8.18 Scaling and superposition. (A) The principle of scaling states that the output of a linear system is proportional to the magnitude of the input. For fMRI, this implies that the amplitude of the hemodynamic response reflects the amount of underlying neuronal activity. (B) The principle of superposition states that the output of a linear system with more than one input is the sum of the responses to the individual inputs.

Der BOLD Effekt: Lineare Additivität

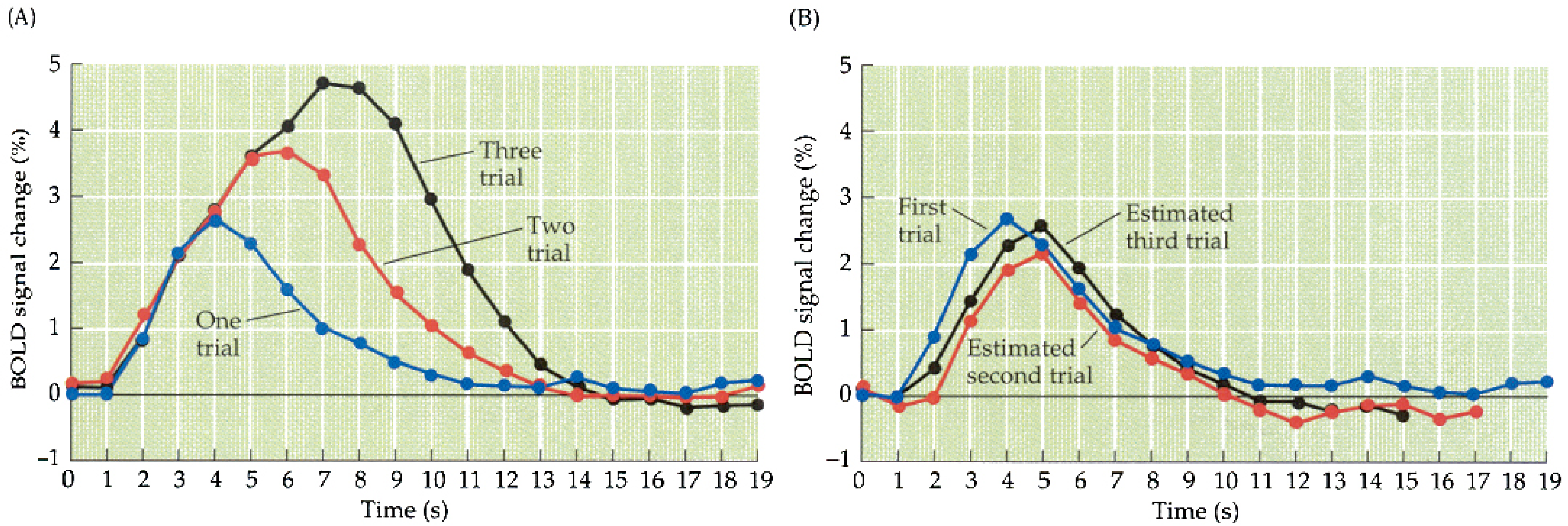
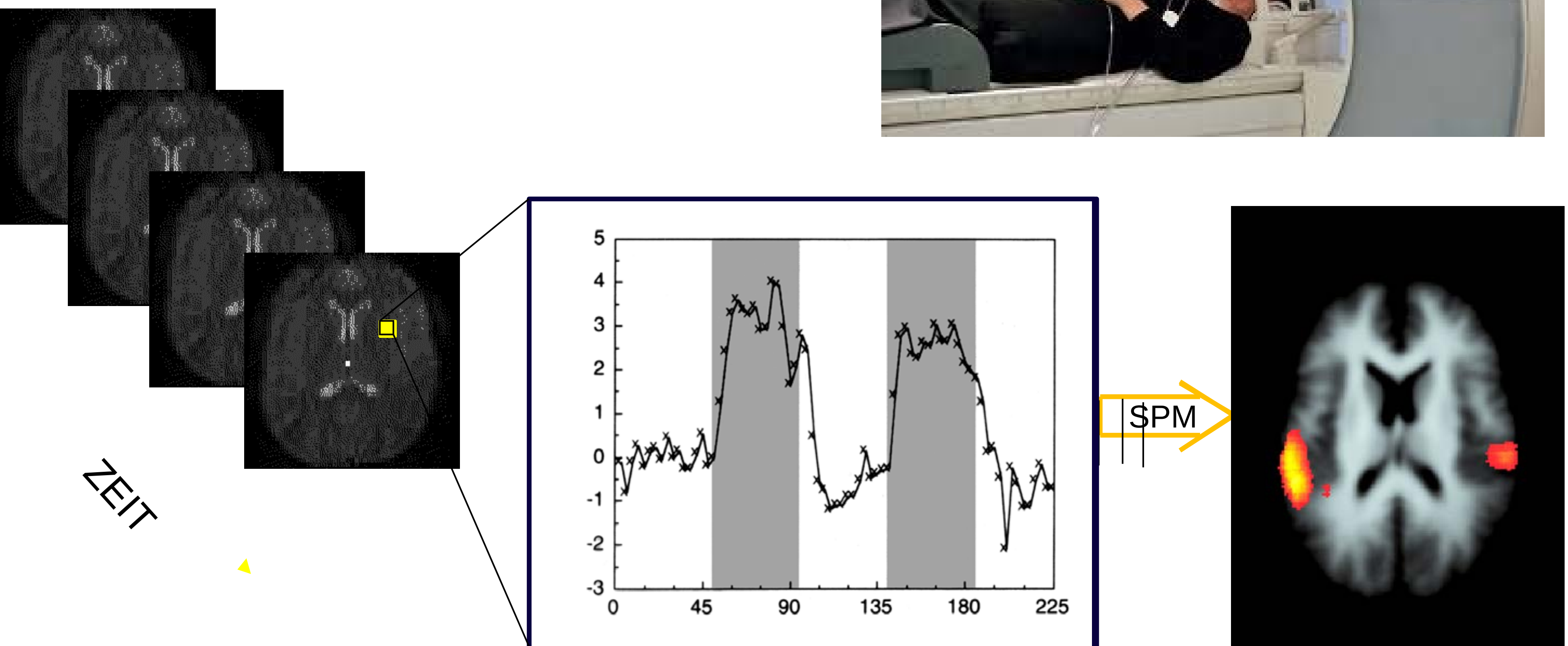
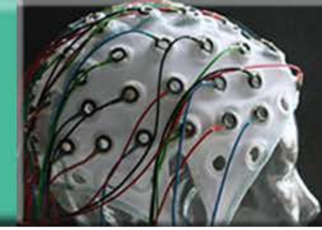


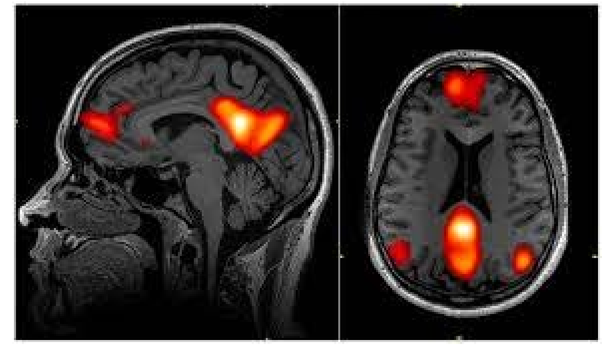
Figure 8.20 Linear addition of hemodynamic responses to individual stimulus events. (A) The hemodynamic responses evoked by presentation of one, two, or three identical stimuli (short-duration visual flashes) at short interstimulus intervals were measured. Shown here are data from a 2-s interval. The total hemodynamic response increased in a regular fashion as the number of stimuli in a trial increased. (B) By subtracting the one-stimulus trial from the two-stimulus trial, and the two-stimulus from the three-stimulus, the contributions of the second and third stimuli in a trial were estimated. To a first approximation, the responses to the second and third stimuli were similar to that to the first, suggesting that the BOLD response scales in a roughly linear fashion. (From Dale and Buckner, 1997.)

Funktionele Magnetresonanz-tomographie



Funktionelle Integration





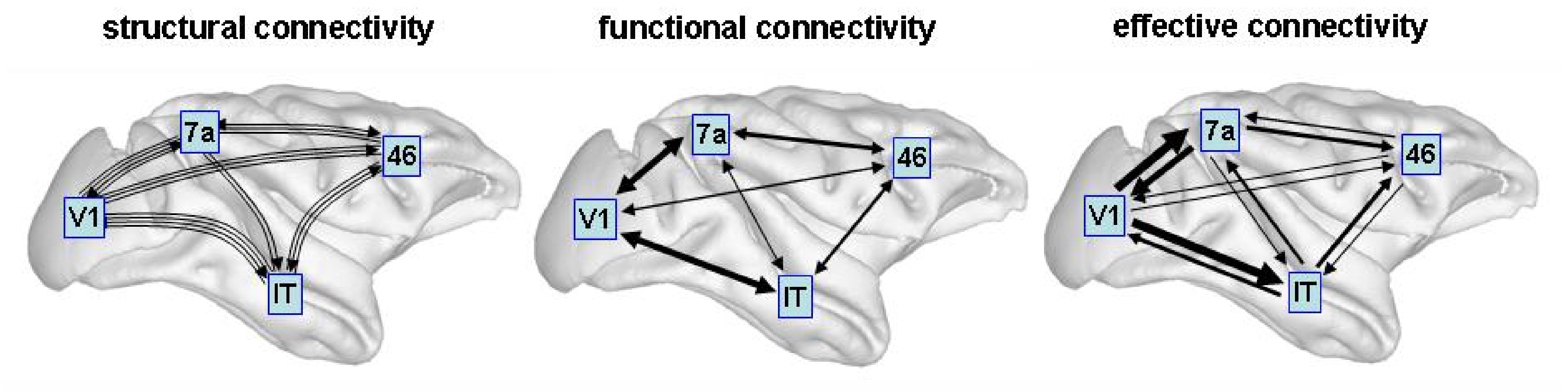
- Funktionelle Integration
- Funktionelle vs. effektive Konnektivität

  Funk. Kon: Wie hängen Aktivitäten in verschiedenen Regionen voneinander ab?

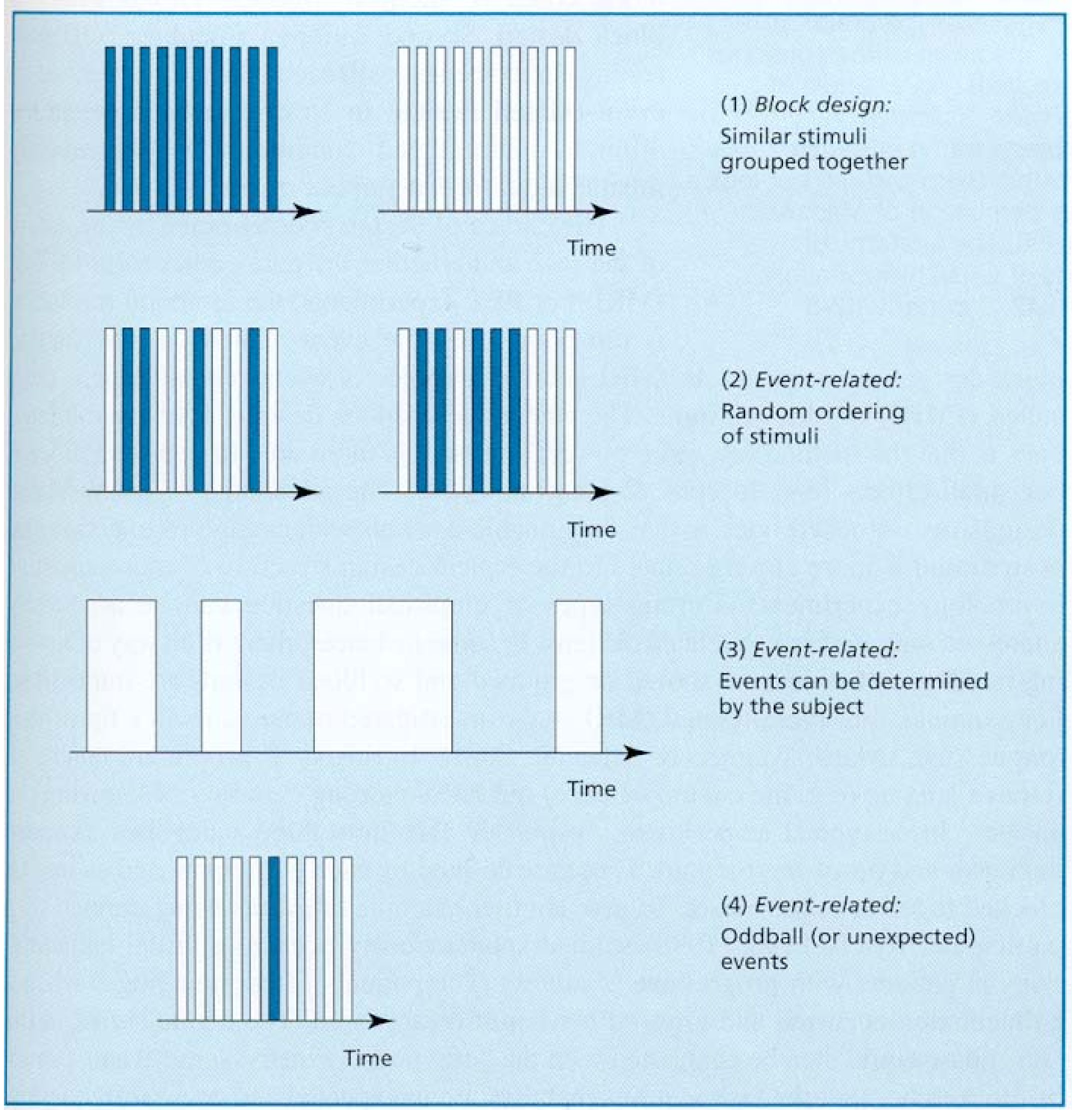
  Eff. Kon: Welchen Einfluss hat ein Effekt in Region A auf einen Effekt in Region B

- Konnektivitäten und Diskonnektivität
- Friston & Frith (1995)

Funktionelle Integration

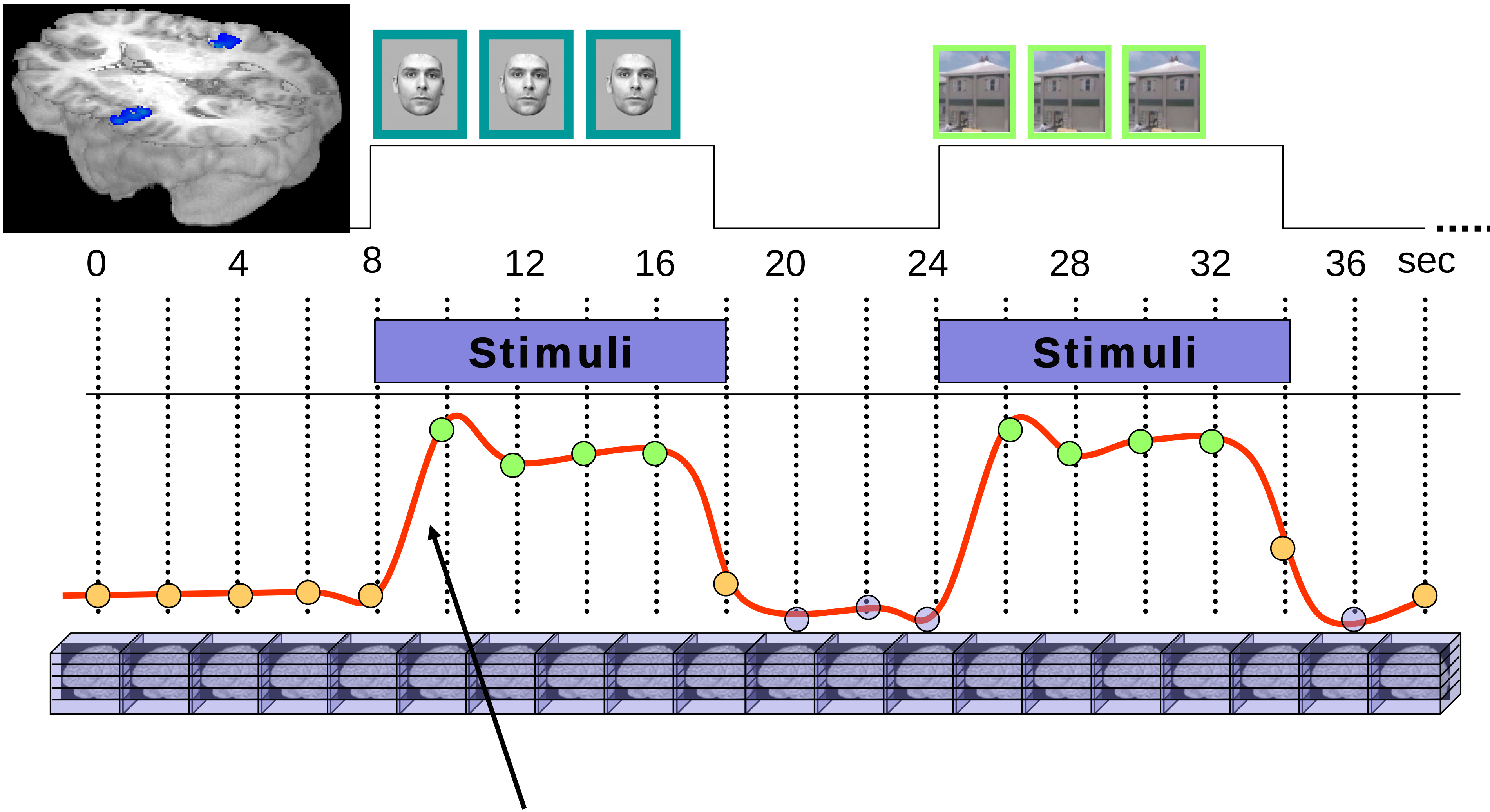


Funktionelle Bildgebung: Ereignisbezogene vs. geblockte Designs



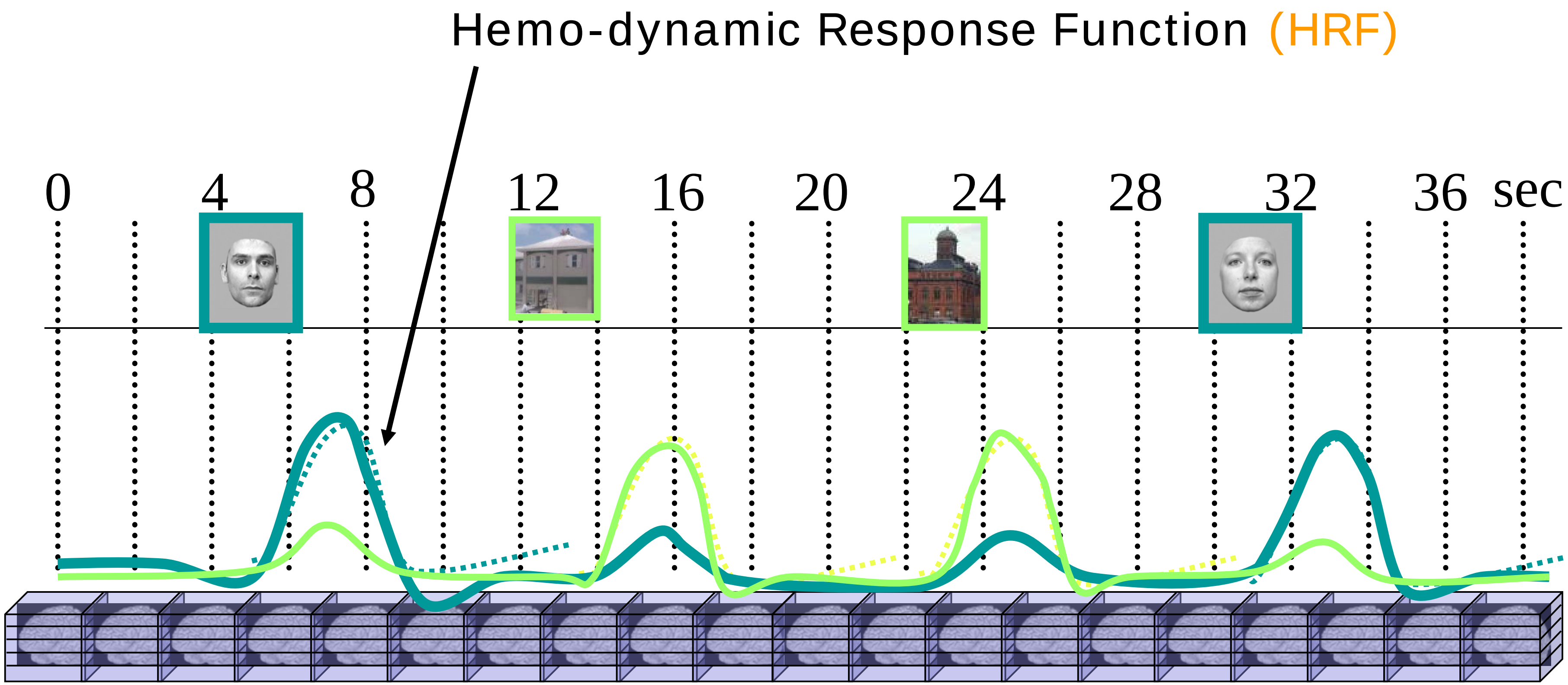
A comparison of block designs versus event-related designs. The blue and white bars could represent different types of stimuli, conditions or task.

Block Design

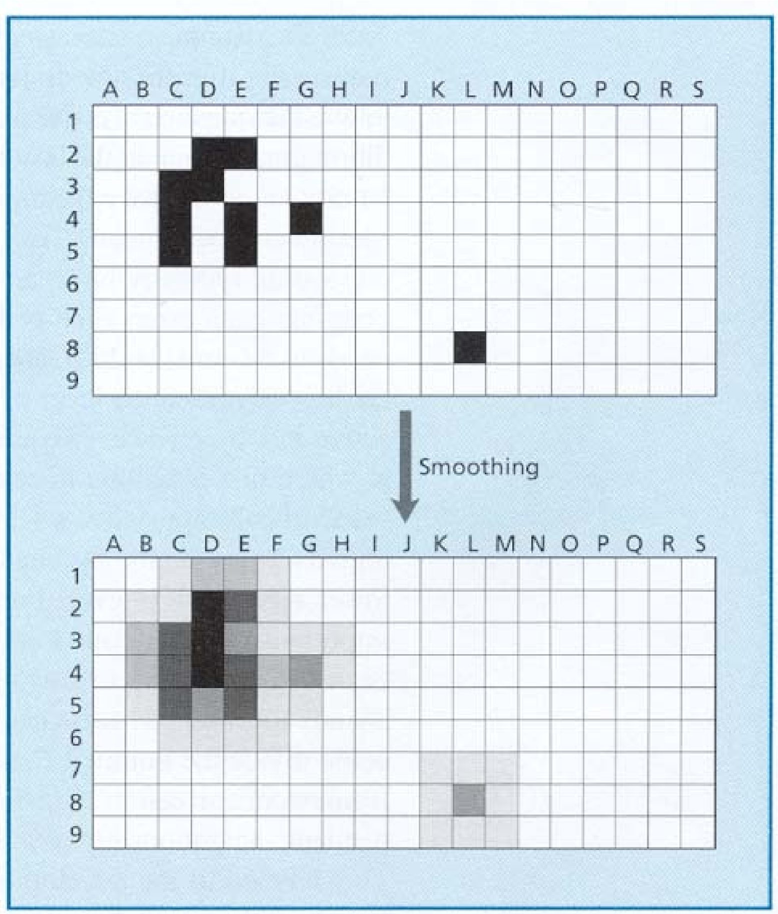


Hemo-dynamic Response Function (HRF)

Event-related Design

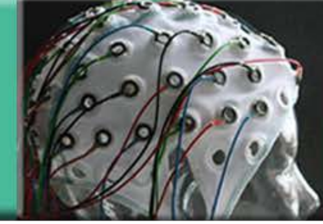


Funktionelle Bildgebung: Datenanalyse

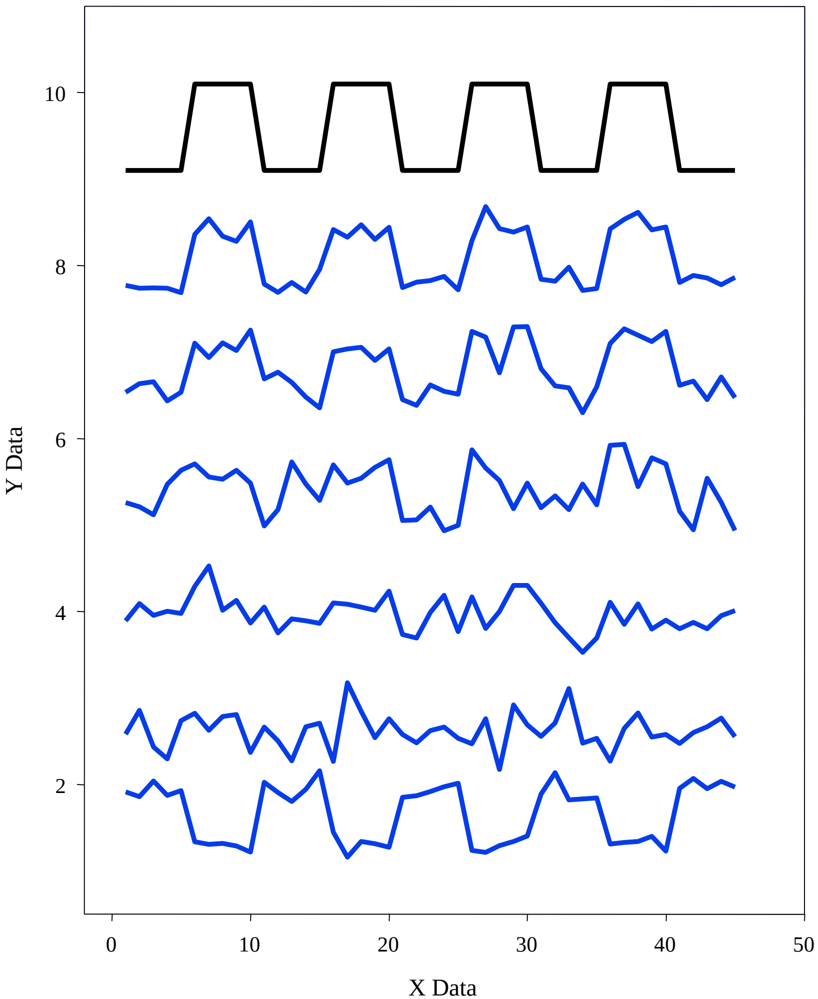


Smoothing spreads the activity across voxels – some voxels (e.g. D4) may be enhanced whereas others (e.g. L8) may be reduced.

Korrelations-Analyse (BOLD – Signal vs HRF)



P. A. Bandettini et al., *Magn. Reson. Med.*, 30, 161 (1993)



stimulus

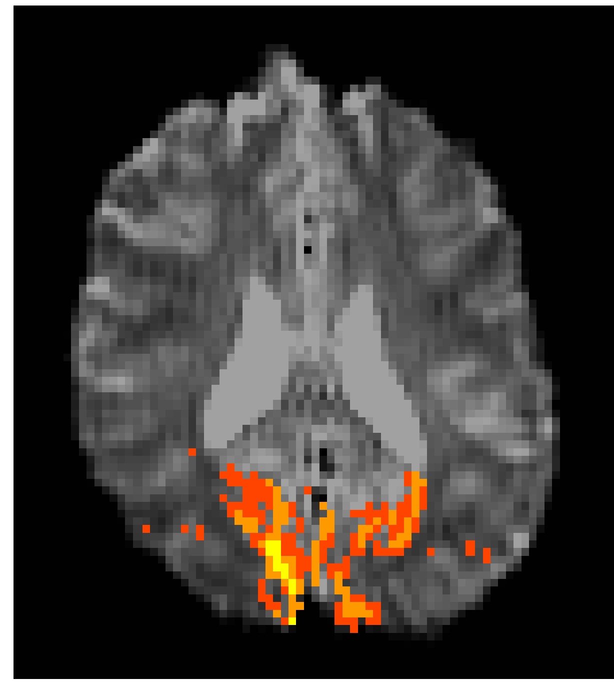
r = 0.95

r = 0.90

r = 0.70

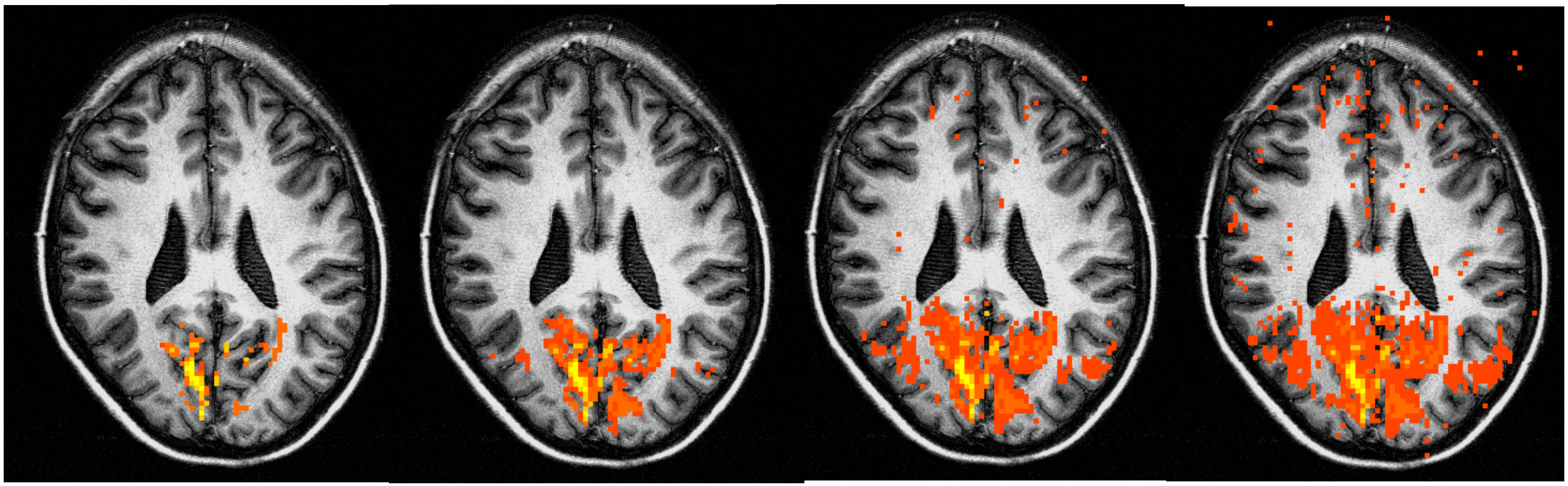
r = 0.50

r = 0.30



correlation map

Datenanalyse
Wahl der Korrelationsschwelle

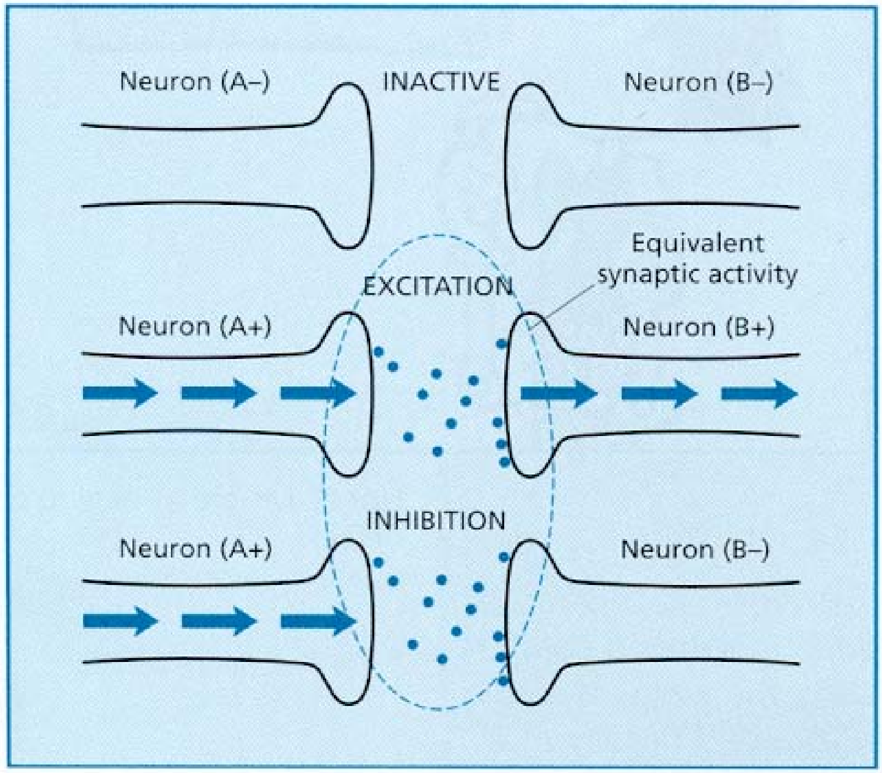


r = 0.9 | r = 0.7 | r = 0.5 | r = 0.3

Typ 1 vs Typ 2 Fehlerminimierung

Fälschliches Finden von Effekten (Typ 1) vs fälschliches Übersehen von Effekten (Typ 2)

Funktionelle Bildgebung: Dateninterpretation



Excitatory and inhibitory synaptic connections both involve metabolic activity and thus an inhibited region could be mistakenly interpreted as a region of activity.

Die Baseline Problematik: Aktivierungsabnahmen bei Beanspruchung

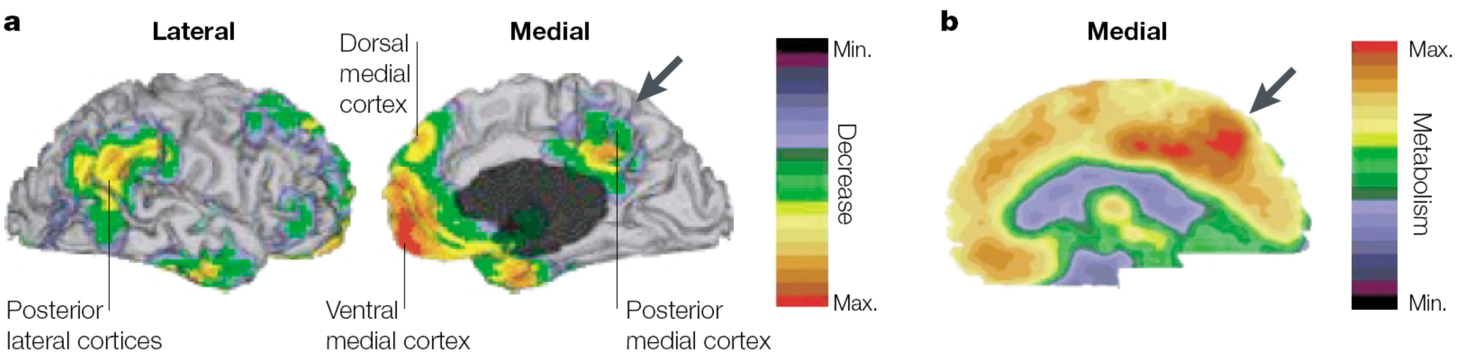


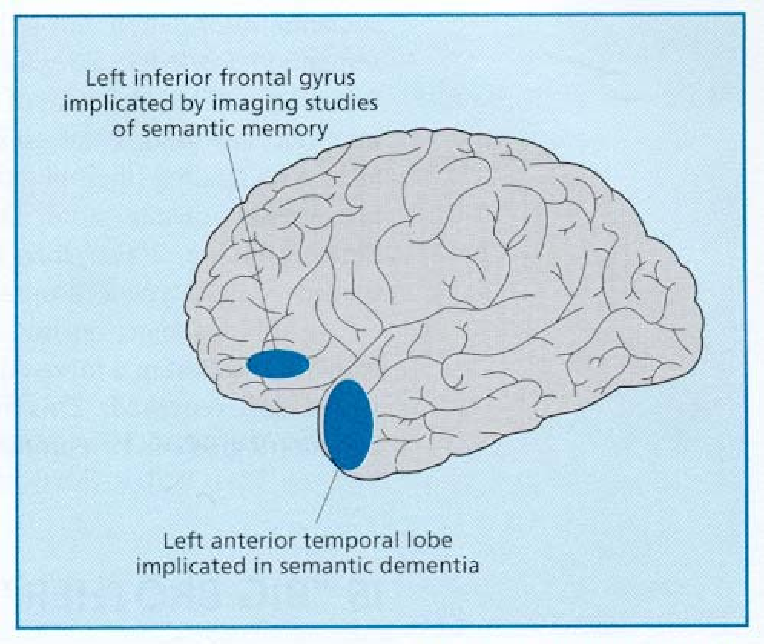
Figure 1 | **Task-independent decreases observed in functional imaging experiments. a** | The coloured areas on the lateral and medial surfaces of the cerebral cortex[80] summarize the decreases observed in nine functional brain-imaging studies that were carried out using positron emission tomography (PET)[13]. In these studies, which involved 132 normal adults, subjects had to process various visual stimuli in the tasks of interest, such as detecting targets, setting up sequencing task operations, establishing an intention and performing language-related tasks; in the control state, they passively viewed the same visual stimuli. The results were similar when a simple visual-fixation task was used. These decreases are remarkable for their task independence. The only common feature among the tasks, beyond the fact that they involved visual stimuli, was that they required active goal-directed behaviour. **b** | Areas showing task-independent decreases along the midline of the brain, particularly posteriorly in medial parietal cortex and the posterior cingulate cortex (arrows), are associated with the highest resting metabolic rates in the human cerebral cortex. This is illustrated in this PET image of resting glucose metabolism in 22 normal individuals[81], which was measured with ^{18}F-fluorodeoxyglucose[82]. Images in **a** courtesy of D. Van Essen and A. Z. Snyder, Washington University, USA.


REVIEWS

SEARCHING FOR A BASELINE: FUNCTIONAL IMAGING AND THE RESTING HUMAN BRAIN

Disagreements and solutions….

- Läsions-Defizit-Analyse:
  - Semantische Demenz nach Läsionen des anterioren Temporallappens
- Funktionelle Bildgebung:
  - Aktivierung im linken IFG bei semantischer Aufgabe (Verbgenerierung)



Disagreements and solutions....

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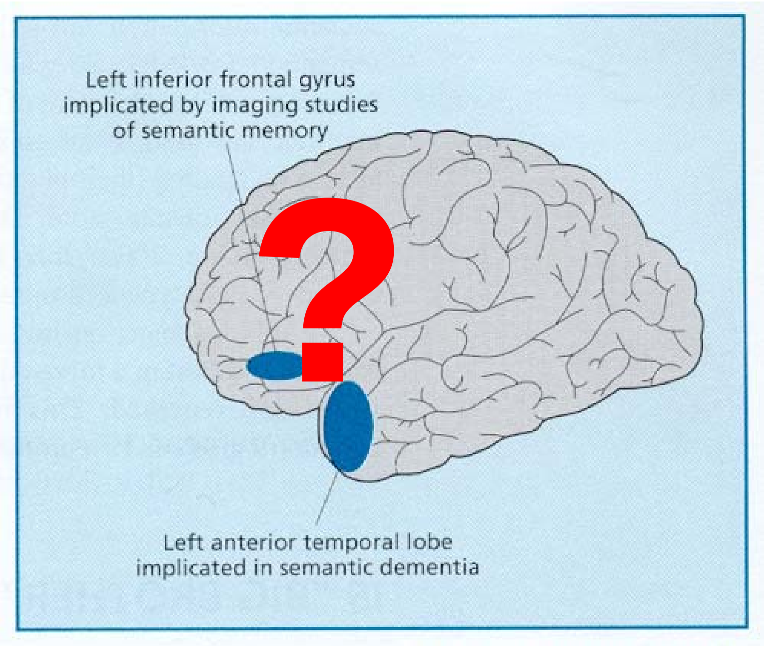


Verb Generation Task: Generating vs reading

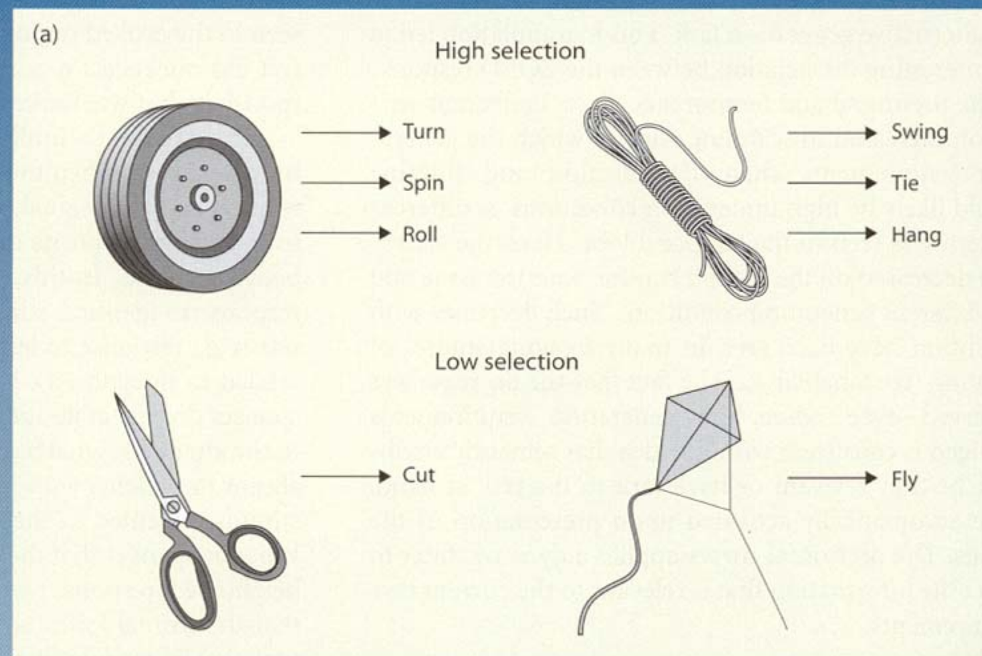
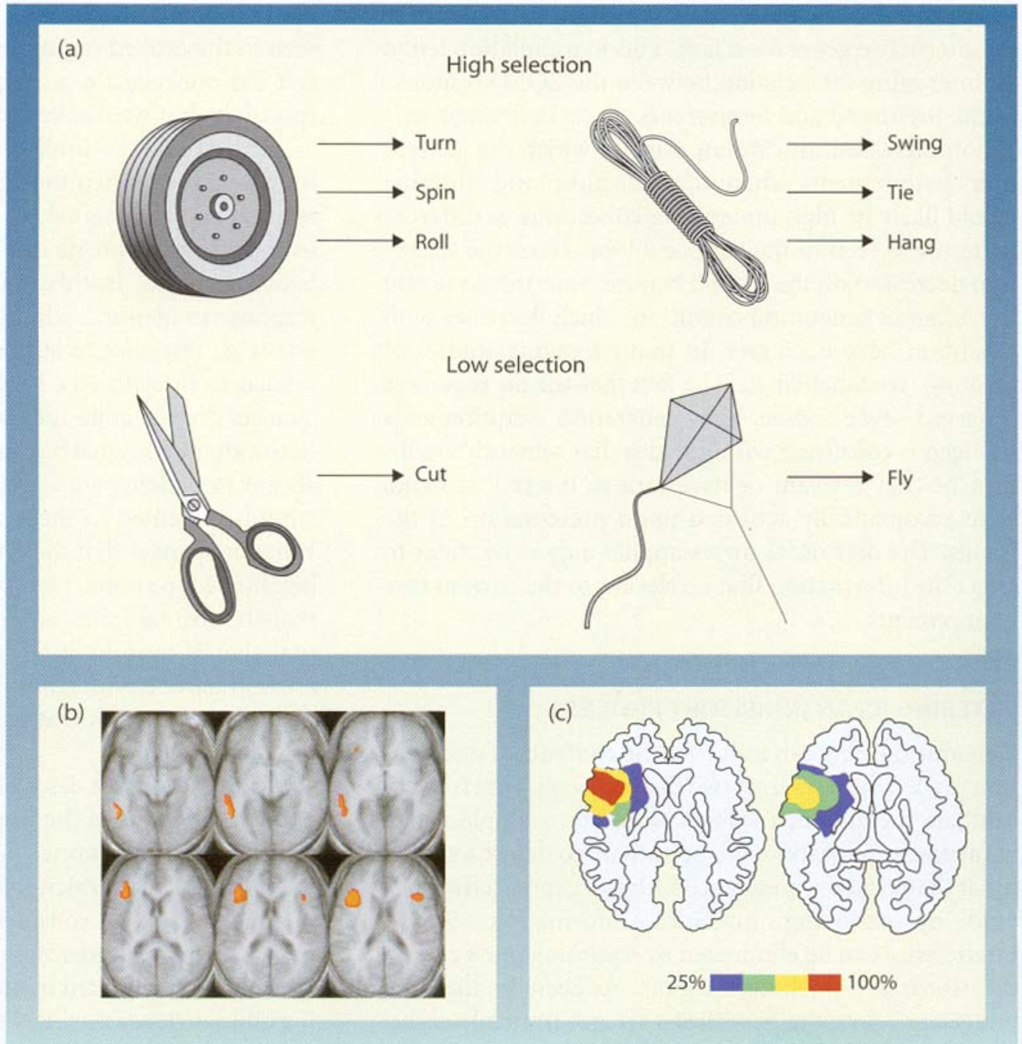


Figure 12.17 Involvement of inferior frontal cortex in response selection. **(a)** The verb generation task can be performed with nouns that are associated with many actions (high selection) or few actions (low selection). **(b)** Areas showing higher activity in the high-selection condition are shown in yellow. **(c)** Overlap in lesion location for patients who had difficulty in the high-selection condition. (b) From Thompson-Schill et al. (1997). (c) From Thompson-Schill et al. (1998).

Können Patienten mit IFG Läsionen diese Aufgabe? Warum zeigt sich bei Verbgenerierung keine anteriore Temporallappenaktivierung?



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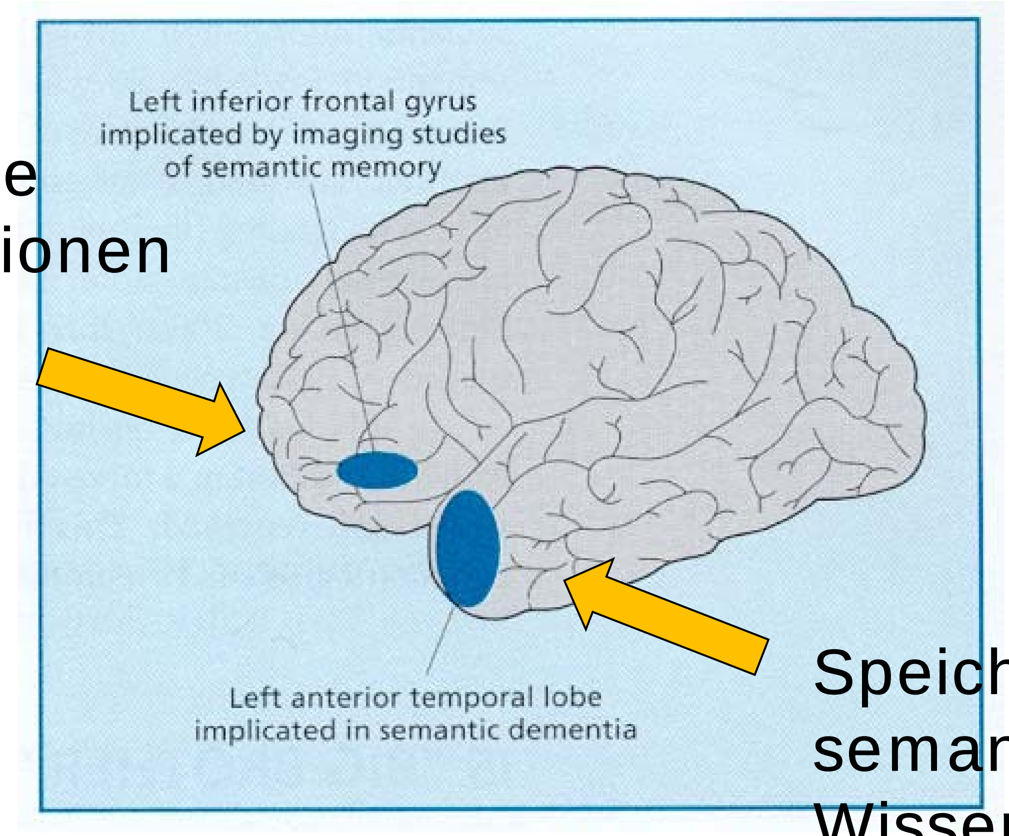
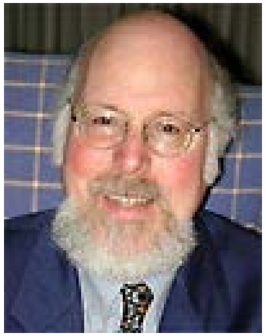
Semantic Memory Revisited

Strategische Abrufoperationen



Speicher für semantisches Wissen

Interpretation



“When brain imaging is the answer, what is the question?“

Big Brother ?


Danke für Ihre Aufmerksamkeit!