Tillämpningar av MRI vid 3T och 7T

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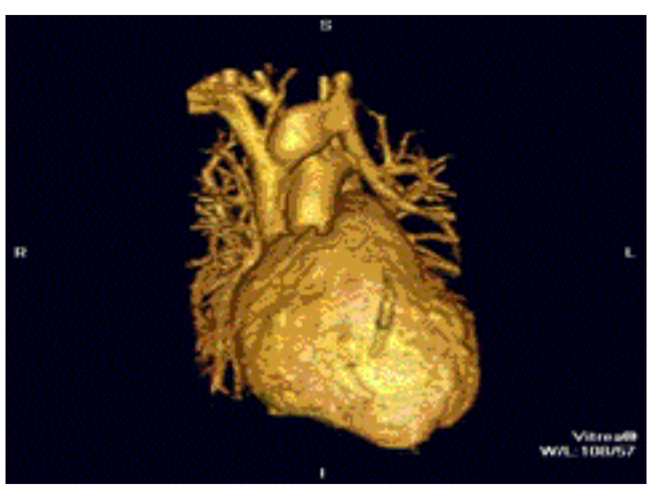
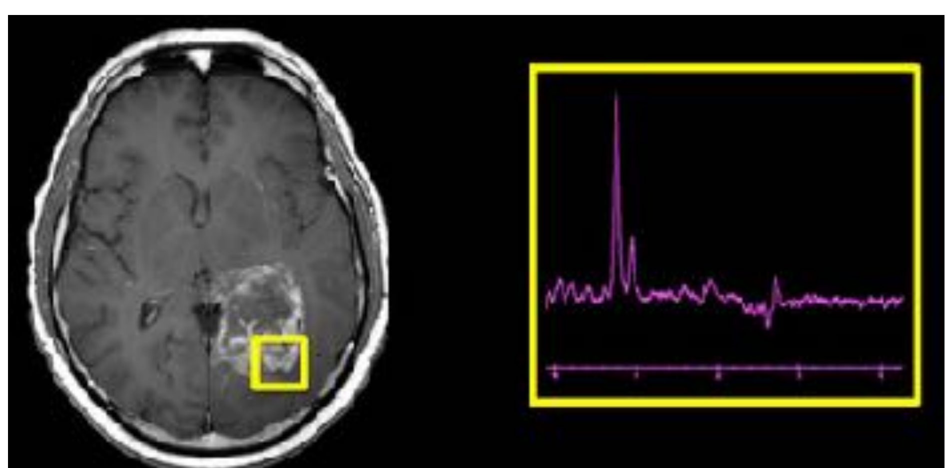
Magnetresonanstomografi

Magnetic Resonance Imaging (aka MRI)

- Det här vet ni redan men; magnetresonanstomografi* eller MRI är en metod där vi använder oss av magnetiska egenskaper hos t.ex. vävnad i kroppen för att skapa en bild utan att behöva öppna folk.
- Det finns flera olika applikationer som kan vara mer eller minde intressanta för oss psykologer men exempel på saker som vi kan mäta är t.ex.:



Vaskulatur



Metaboliter

Eller benvävnad

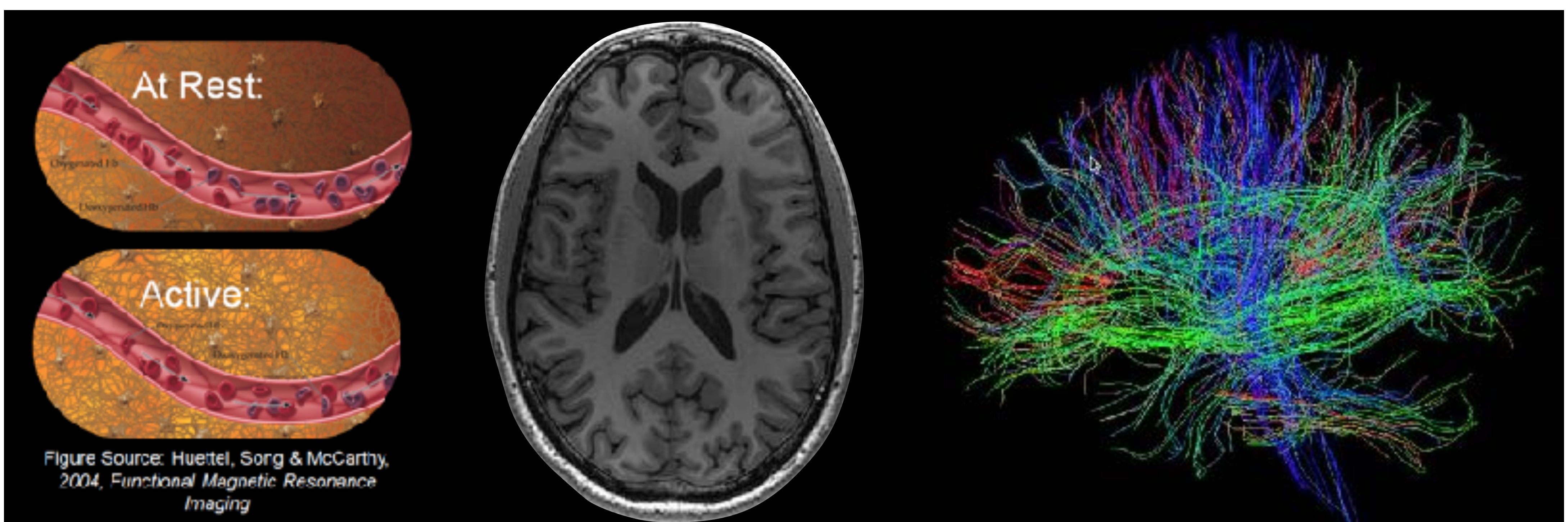
*Inte Sveriges längsta ord: Realisationsvinstbeskattning har 28 bokstäver, vår tävlande har 23.

Magnetresonanstomografi

Magnetic Resonance Imaging (aka MRI)

- I nio fall av tio så är vi intresserade av att mäta hjärnan och nästan uteslutande i relation till beteende eller kliniska variabler.

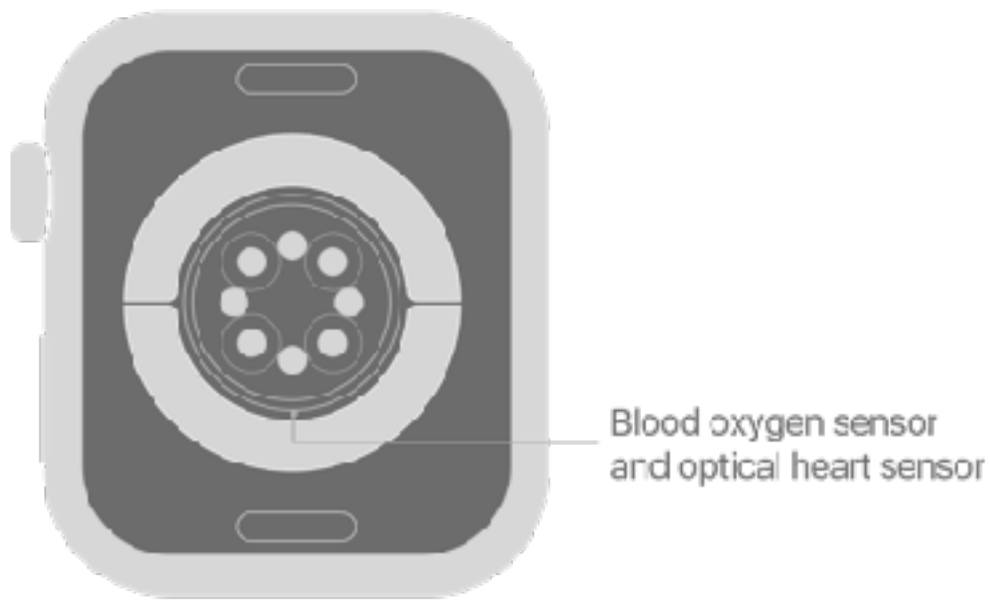
- Detta gör vi primärt via antingen blodflöde (BOLD, eller funktionellt MRI, fMRI), konnektivitet (t.ex. Diffusion Tensor Imaging aka DTI) eller gråsubstans (t1 viktad MRI).



fMRI T1 viktad DTI

BOLD
fMRI


Blood O_2
10:09
Start


Blood oxygen sensor
and optical heart sensor

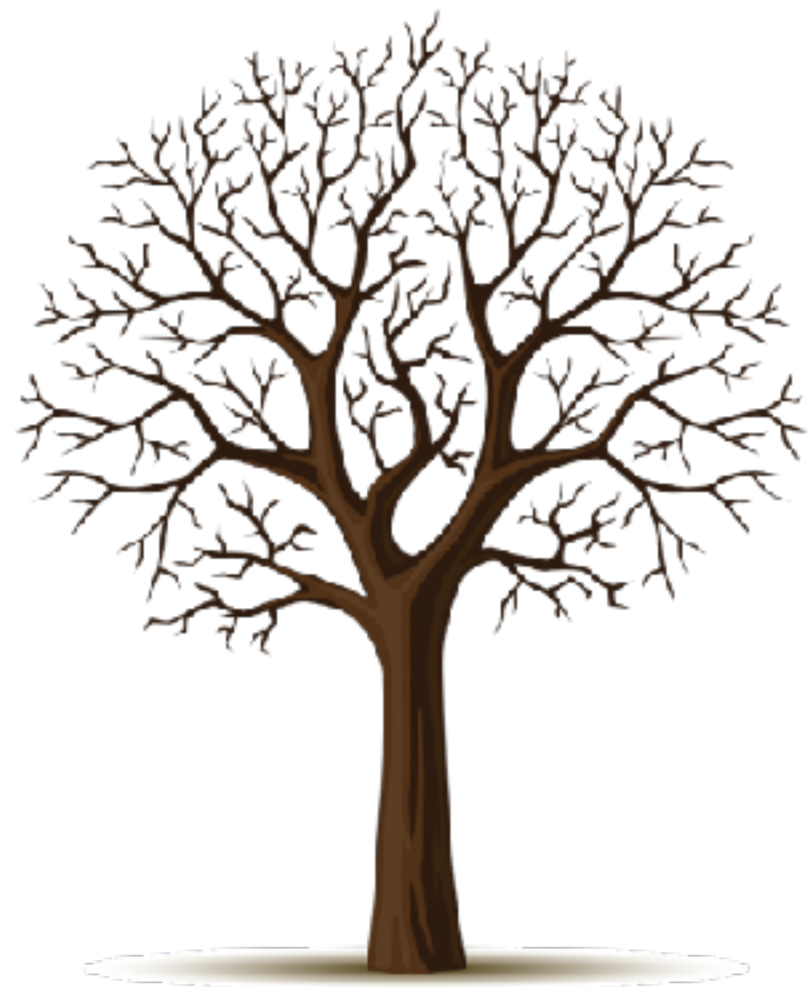
T1-Viktad

Strukturell MRI

DTI

Diffusion Tensor Imaging

T1



DTI

Exempel på tillämpning

Tolkskolan

Exempel på tillämpning

Tolkskolan: steg 1 - kognitiva fynd

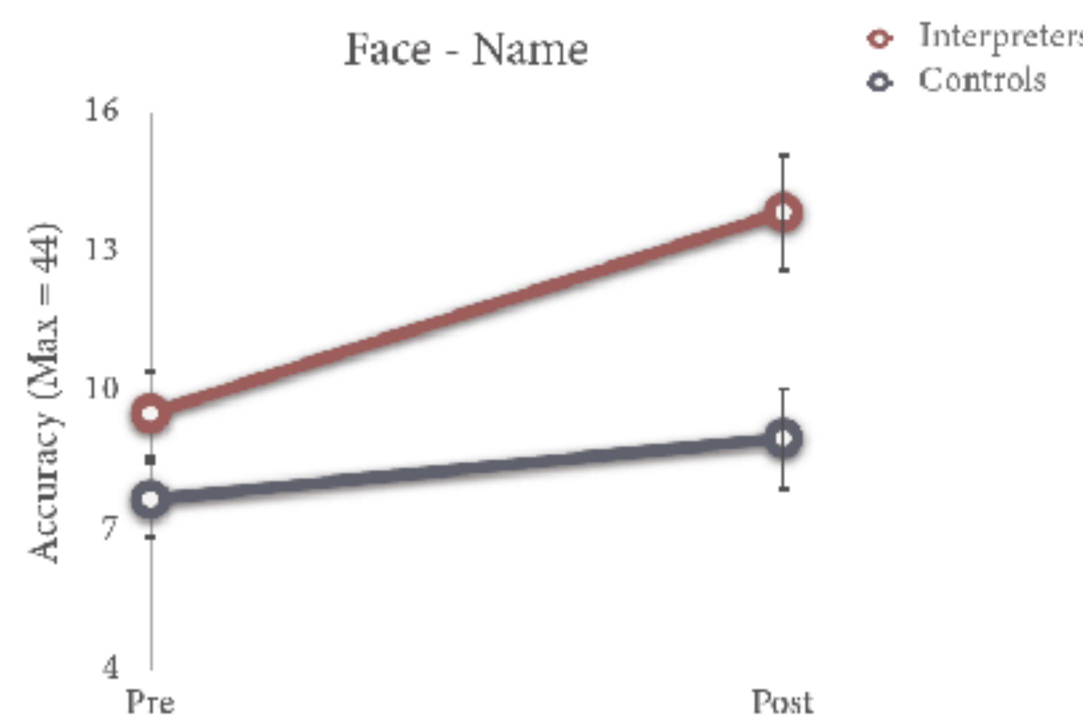


Figure 1. Number of correctly recalled names for interpreters and controls before and after 3 months of training. The group by time interaction is significant: $F(1,32)$ 5.16, p 0.03, $\eta 2$ 0.14. Error bars represent SEM.

Mårtensson & Lövdén, 2011

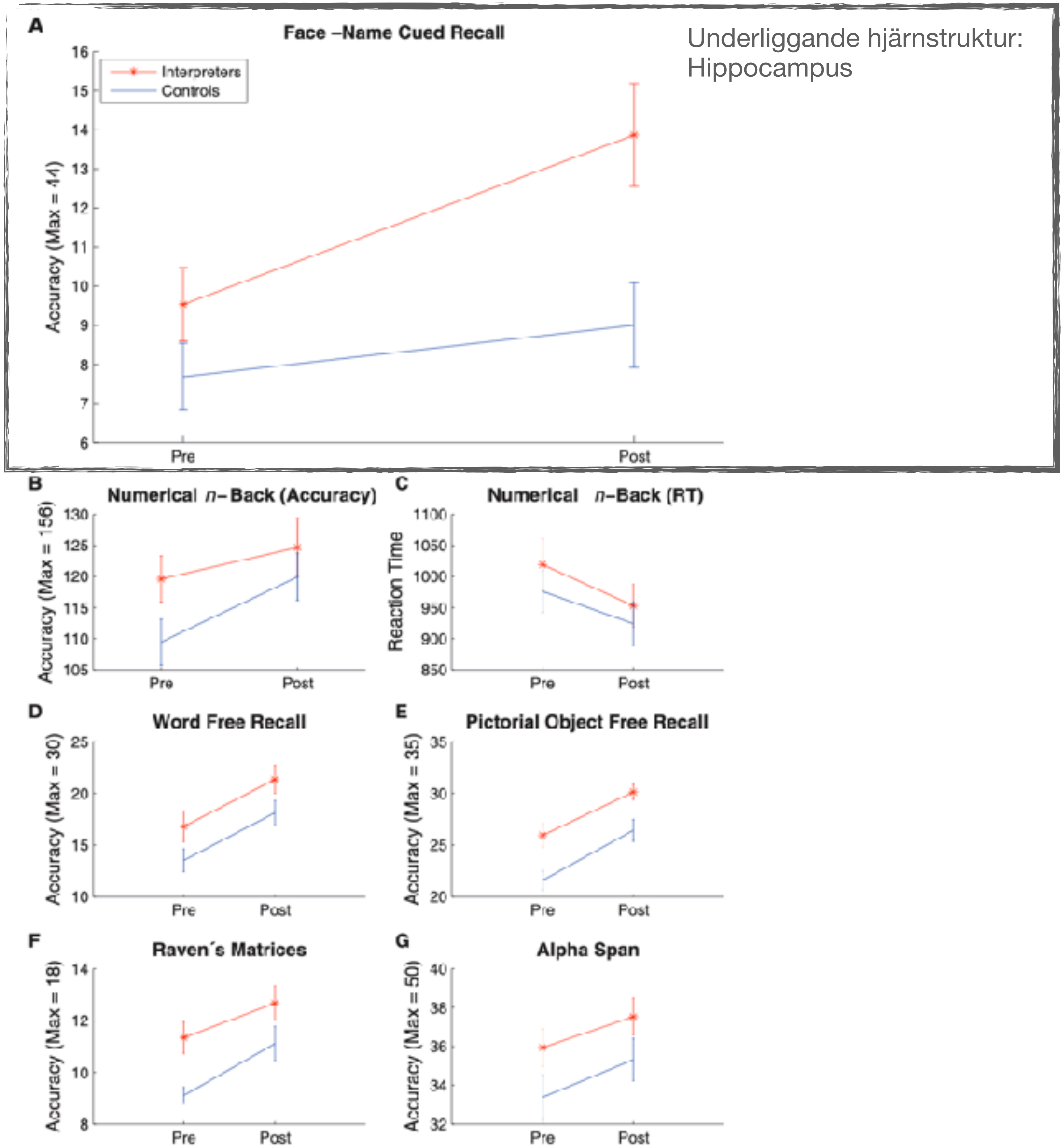
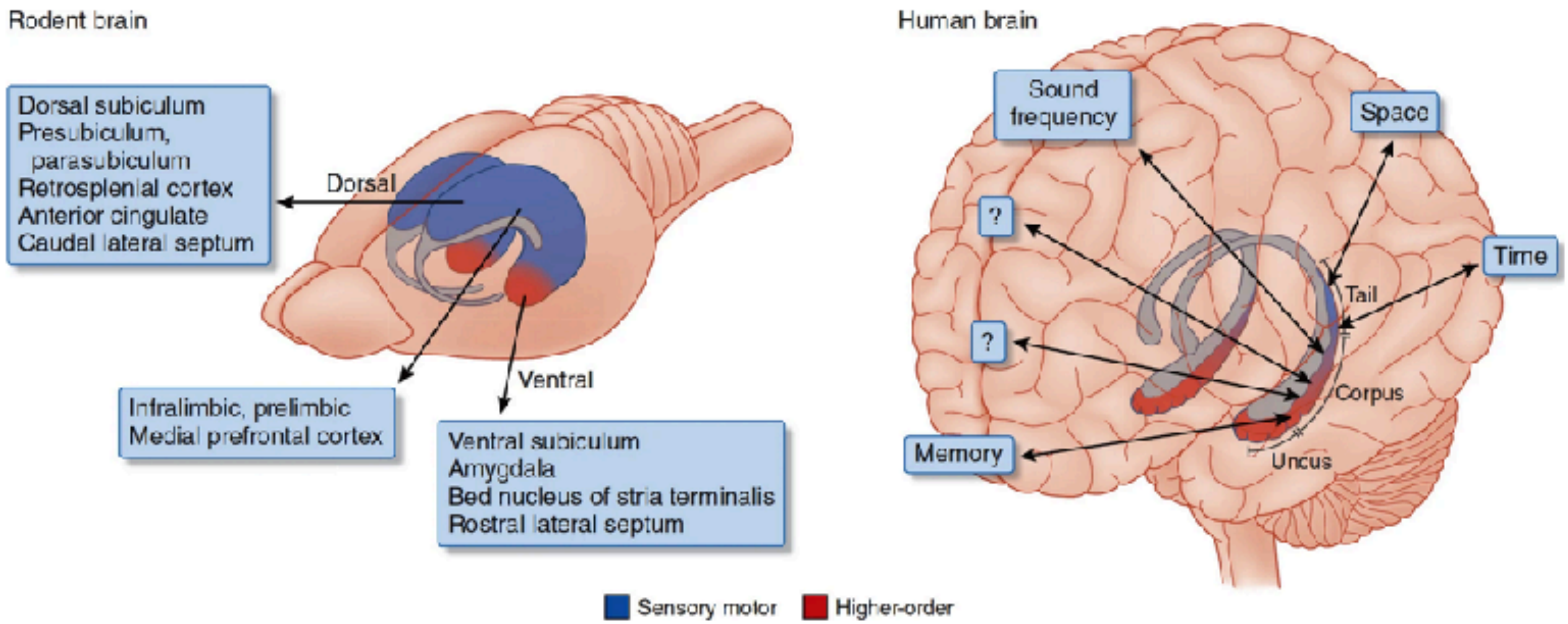


FIGURE 1 | Face–name paired-associates performance increase more for interpreters than for university students (A). There were no group-differences in change for working memory (**B, C, and G**), strategic episodic memory (**D and E**), or fluid intelligence (**F**). Error bars represent SEM.

Figure 1: Homologous regions of the hippocampus in the human and rat brains.

From: Viewpoints: how the hippocampus contributes to memory, navigation and cognition



Debbie Maizels/Springer Nature

The ventral quadrant of the rodent hippocampus became disproportionally enlarged in primates to keep up with the increasingly larger share of higher-order neocortex and formed the uncus and body. Only the relatively small tail part of the primate hippocampus communicates with visuospatial areas. This tail is the part that is homologous with the rodent dorsal-intermediate hippocampus. Differential connections to and from the different segments of the septotemporal axis are shown. Most recordings and manipulations in the rodent brain have been performed in the dorsal hippocampus. Adapted with permission from ref. 145, "Distinct representations and theta dynamics in dorsal and ventral hippocampus", Royer, S., Sirota, A., Patel, J. & Buzsáki, G., 2010, in *Journal of Neuroscience*, **30** (5), 1777–1787.

BOLD

fMRI

ELSEVIER

NeuroImage

www.elsevier.com/locate/ynimg
NeuroImage 25 (2005) 958–968

Hippocampus activity differentiates good from poor learners of a novel lexicon

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BOLD

fMRI

C. Breitenstein et al. / NeuroImage 25 (2005) 958–968

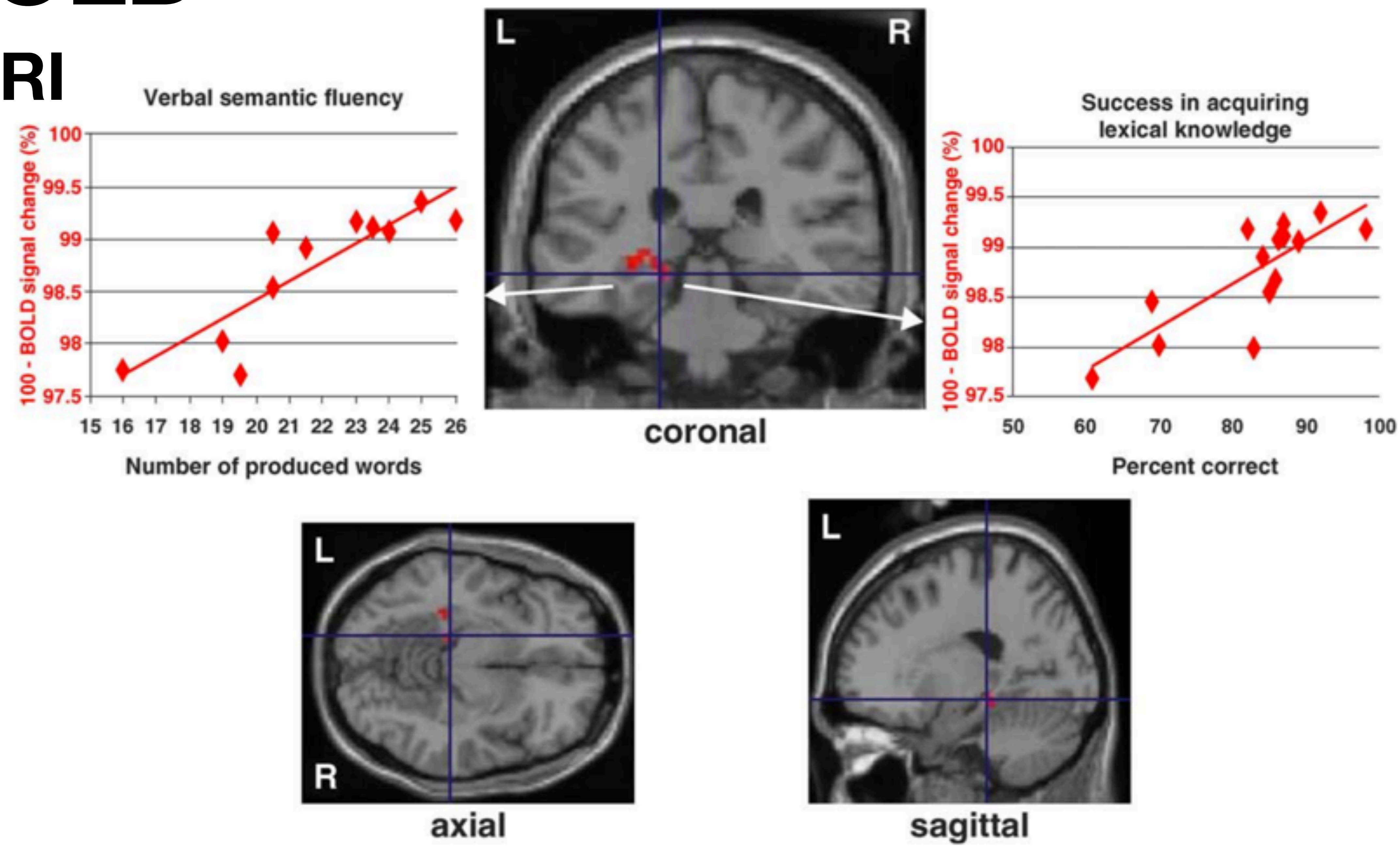


Fig. 5. Less suppression of activity within the left hippocampus across learning compared to baseline (displayed on the canonical SPM99 T1-template for the three dimensions) predicted both verbal semantic fluency in subjects' native language (left: mean number of words produced per min) and success in acquiring lexical knowledge in the novel vocabulary (right). Please note that only 11 of the 14 subjects were available for neuropsychological testing, including assessment of verbal semantic fluency. For clarity of presentation, values for percent BOLD signal change are presented as 100 minus percent BOLD signal change across learning. Percent BOLD signal change refers to the degree of activity change across the five training blocks (individual beta weights for the contrast modeling a linear decrease across training blocks). The mean distance was 11 ± 3 mm (range: 6.7–17.2 mm) from the standard hippocampus MNI coordinates. Inspection of the individual activation patterns on subject's structural scans confirmed that the activity modulation was truly within the hippocampus for all subjects.

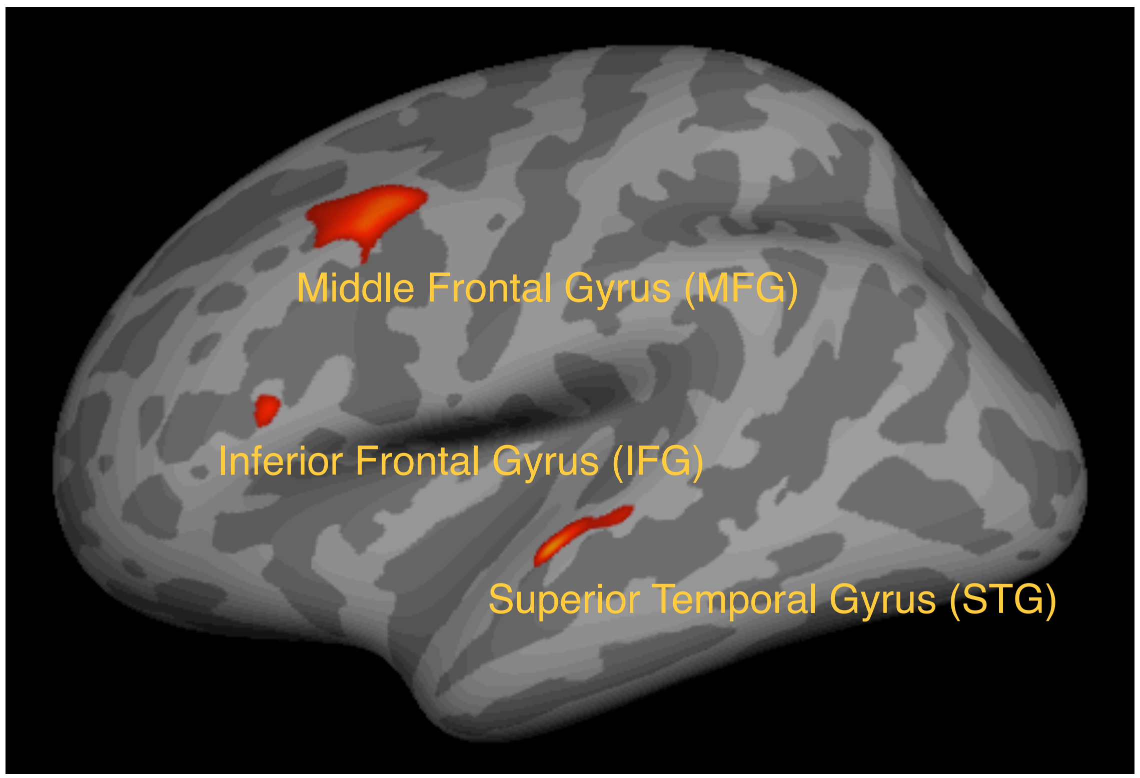
Exempel på tillämpning

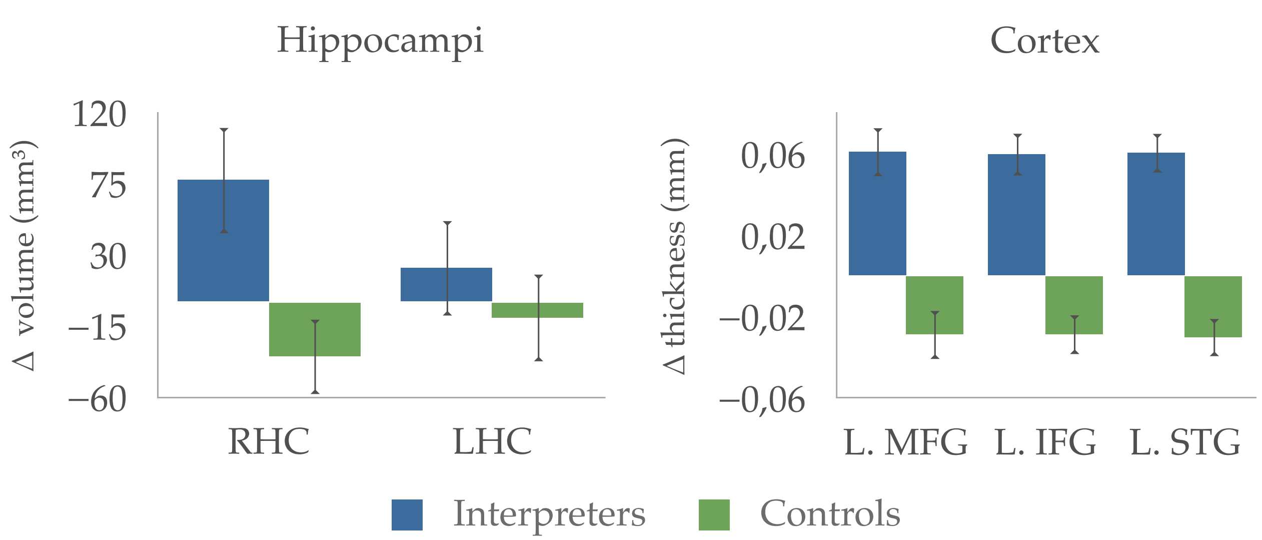
Tolkskolan: steg 2 - buss upp till Lars (Nyberg) från FMUndSäkC

- 14 tolkar jämfördes med 17 kontroller från Umeå universitet. Kontrollerna utgjordes av studenter från läkarprogrammet och kognitionsvetenskap
- Språk: Arabiska (1/4), Dari (2/4), Ryska (1/4)
- Varje individ testades i 3 timmar. Hälften av tiden i en MR Scanner, den andra hälften vid datoriserade tester
- Deltagarna bussades 575km från Uppsala till Umeå universitet, där en ny MR Scanner precis köpts in till Umeå centre for Functional Brain Imaging (UFBI)

Exempel på tillämpning

Tolkskolan: steg 3 - hjärndata (3T MRI)





Vi fann selektiva ökningar för tolkarna. Inga minskningar för någondera grupp

Left dorsal MFG (premotor cortex, BA6) = -39 10 47: In speech perception: Involved in mapping phonological representations to articulatory motor representations, learning to speak is essentially a sensorimotor task, learning new vocabulary, higher order motor planning

Left posterior IFG (Broca, BA45) = -48 24 17: Classically phonological motor processing

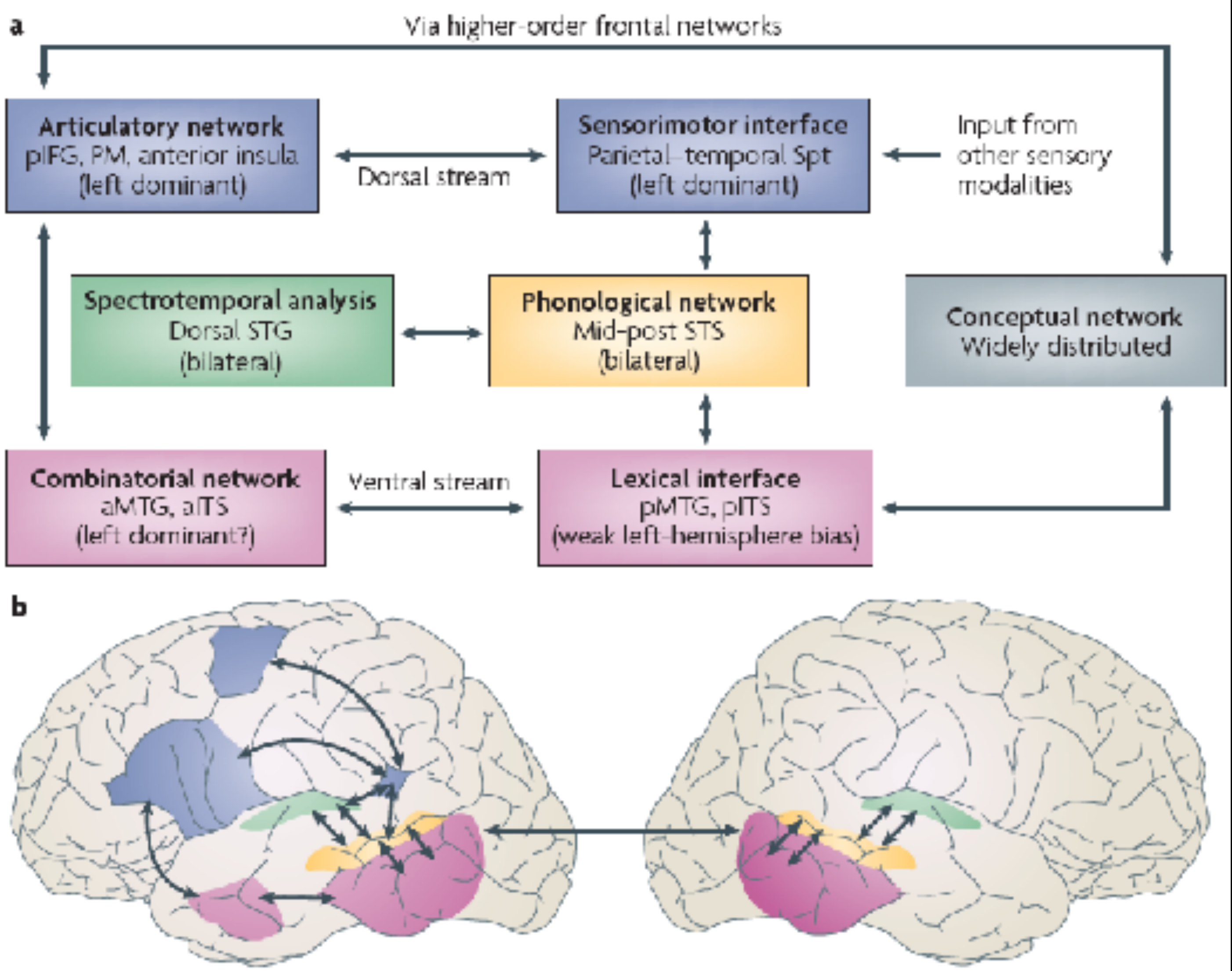
Left mid-posterior STG (Wernicke, mainly BA22, a few in BA21) = -60 -11 -3: Phonological level processing and representation, is classically STS though (yellow in Hickok & Poeppels model), but coordinates in literature very close to ours

T1-Viktad

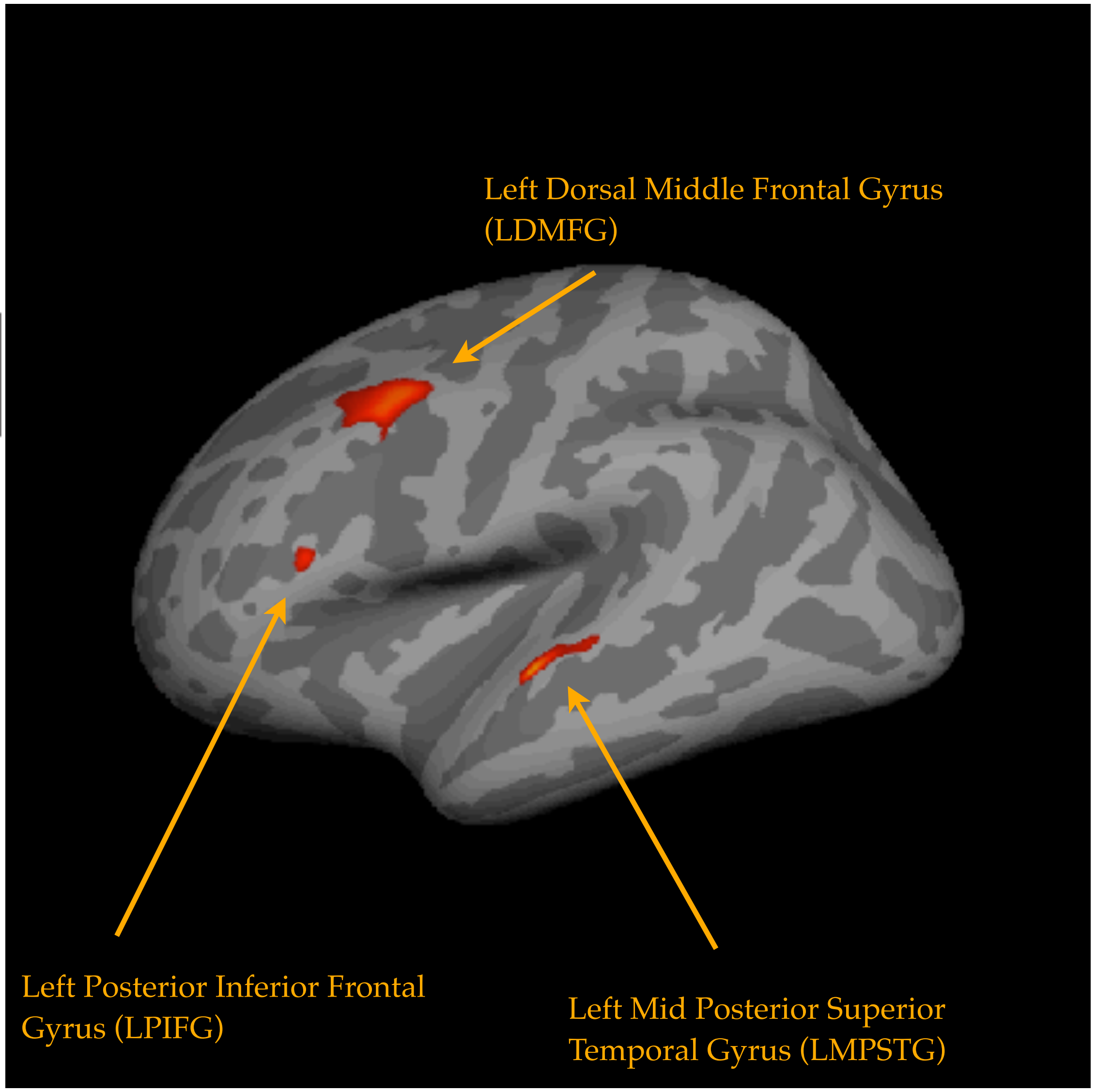
Strukturell MRI

Exempel på tillämpning

Tolkskolan: steg 4 - jmf med teori



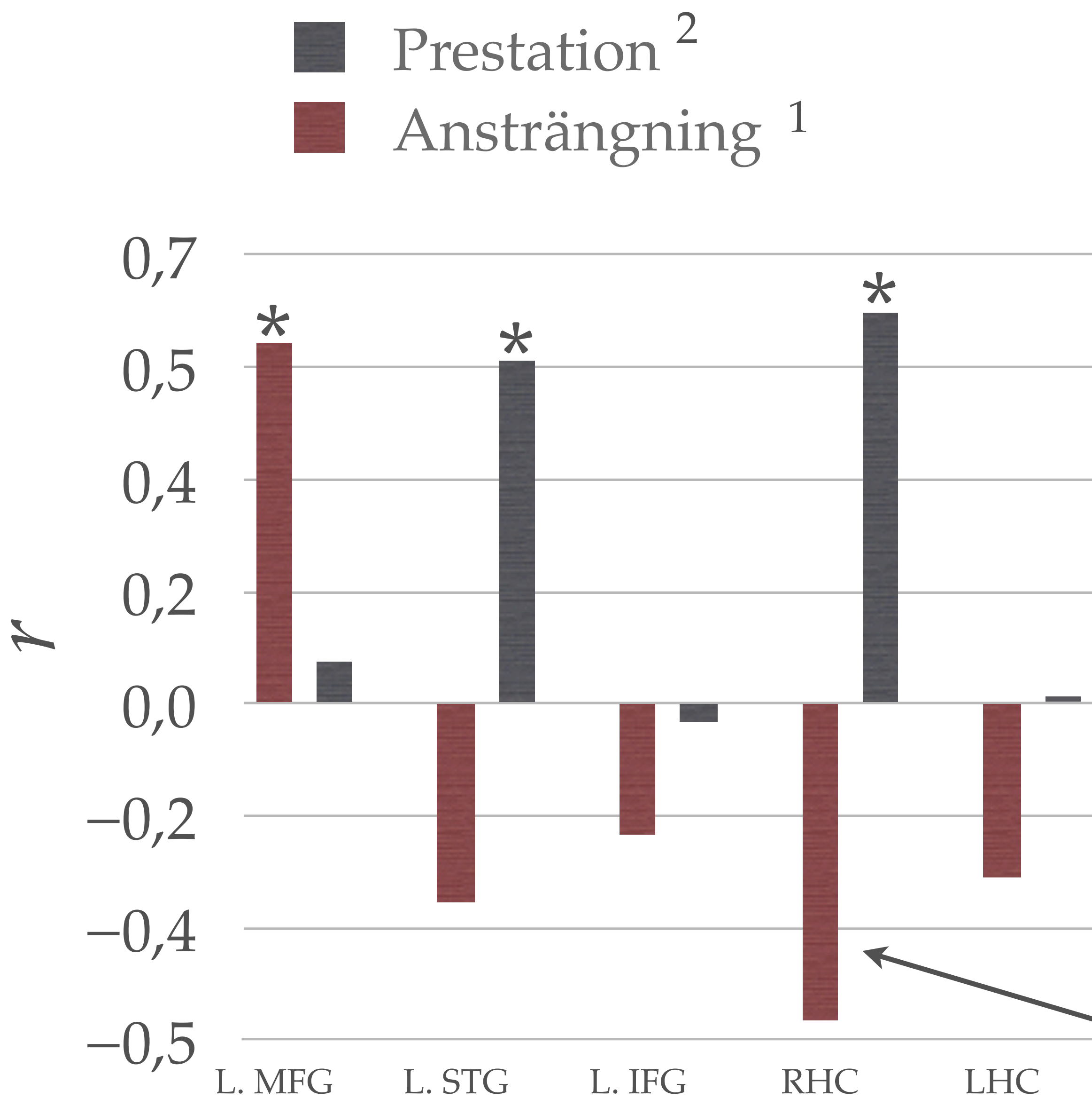
Hickok & Poeppel, 2007



Mårtensson et al., 2012

Exempel på tillämpning

Tolkskolan: steg 5 - återkoppling till beteende



1

Lärarskattning: ”Bedöm hur stor ansträngning som krävts av varje elev för att uppnå Tolkskolans mål för att få vara kvar vid utbildningen”

2

Resultat från deras halvtidsprov

p = .07

* *indikterar p < .05*

Proficiency and brain structure during intense language learning

Johan Mårtensson[1*], Johan Eriksson[2], Timothy Brick[3], Nils Bodammer[3], Magnus Lindgren[1], Mikael Johansson[1], Lars Nyberg[1] and Martin Lövdén[4]

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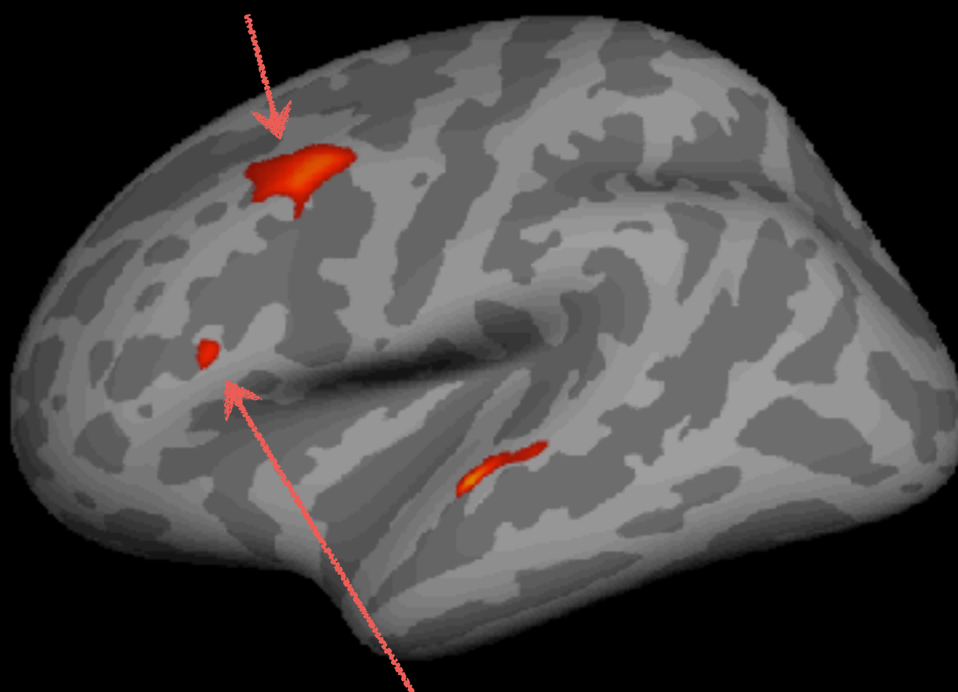
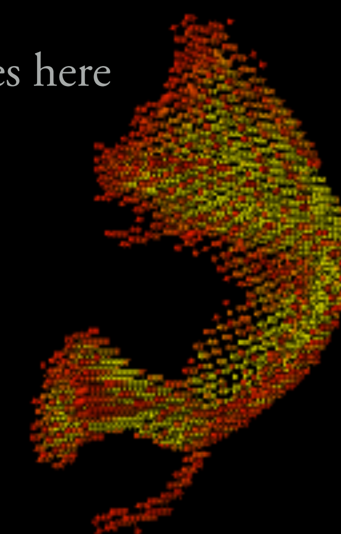
Foreign language acquisition can lead to changes in brain structure in young adults. Conscripts at the Swedish Armed Forces Interpreter Academy undergo highly intense foreign language training and approach near fluency over the course of a year.
Structural MRI before and after 3 months of training revealed grey matter increases in the left dorsal middle frontal gyrus, left inferior posterior frontal gyrus, left superior temporal gyrus and the right hippocampus. Grey matter increases were related to language performance, with higher increases in the right hippocampus and left superior temporal gyrus for interpreters with better performance at the end of the semester. In contrast, participants who had to work relatively harder to achieve the goals of the interpreter program exhibited the most widespread cortical change in the middle frontal gyrus.
A possible explanation is that participants with larger increases in the middle frontal gyrus put more strain on the articulatory network during acquisition. Preliminary findings from probabilistic tractography between the inferior frontal gyrus and middle frontal gyrus indicate higher increases in fractional anisotropy for individuals who had to work more intensively to achieve the goals of the academy. Change scores were at least partially dependent on starting values with larger increases and more work required for individuals with lower fractional anisotropy scores in part of the articulatory network prior to admission to the academy.

DTI

Diffusion Tensor Imaging

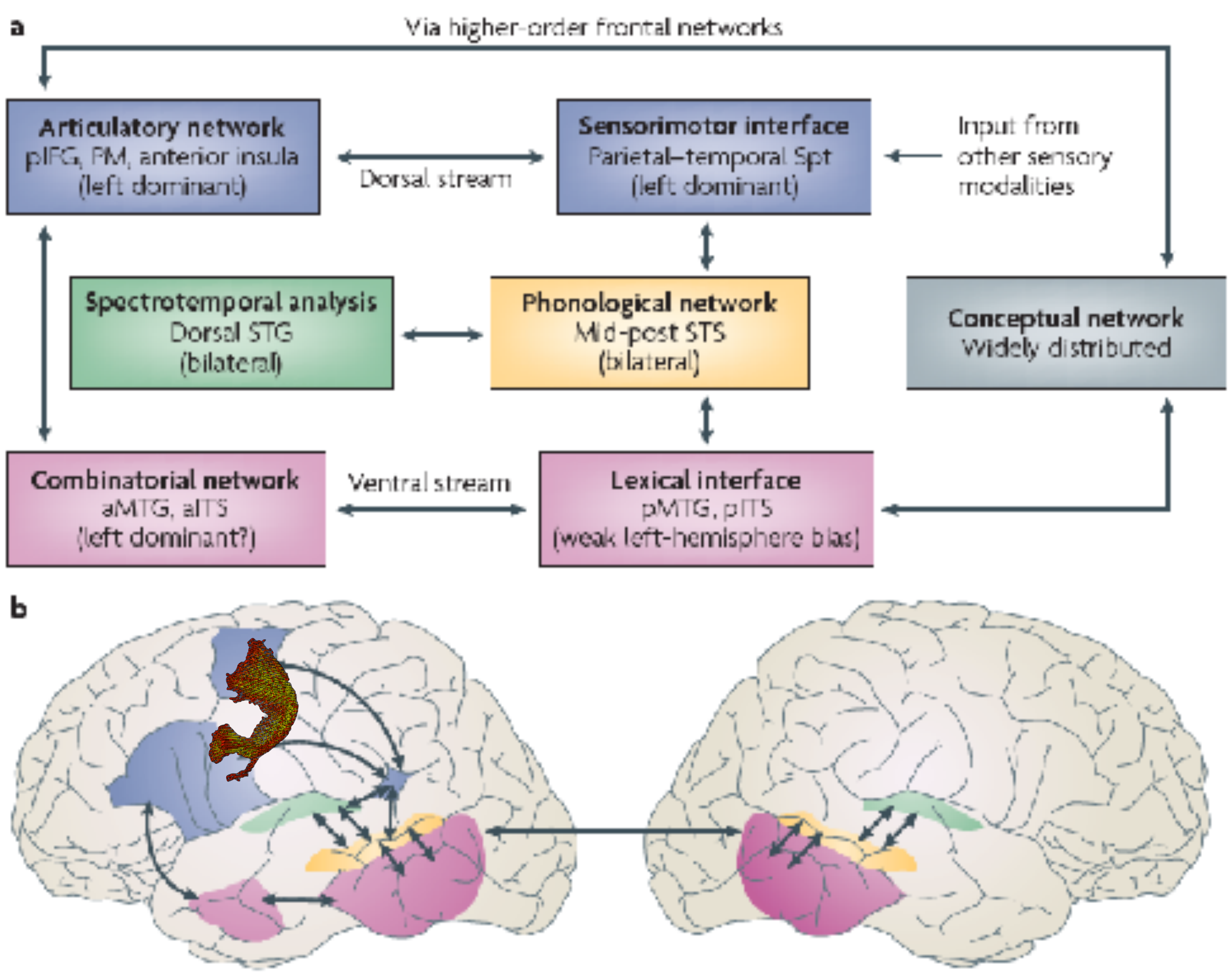




Mårtensson et al., 2014

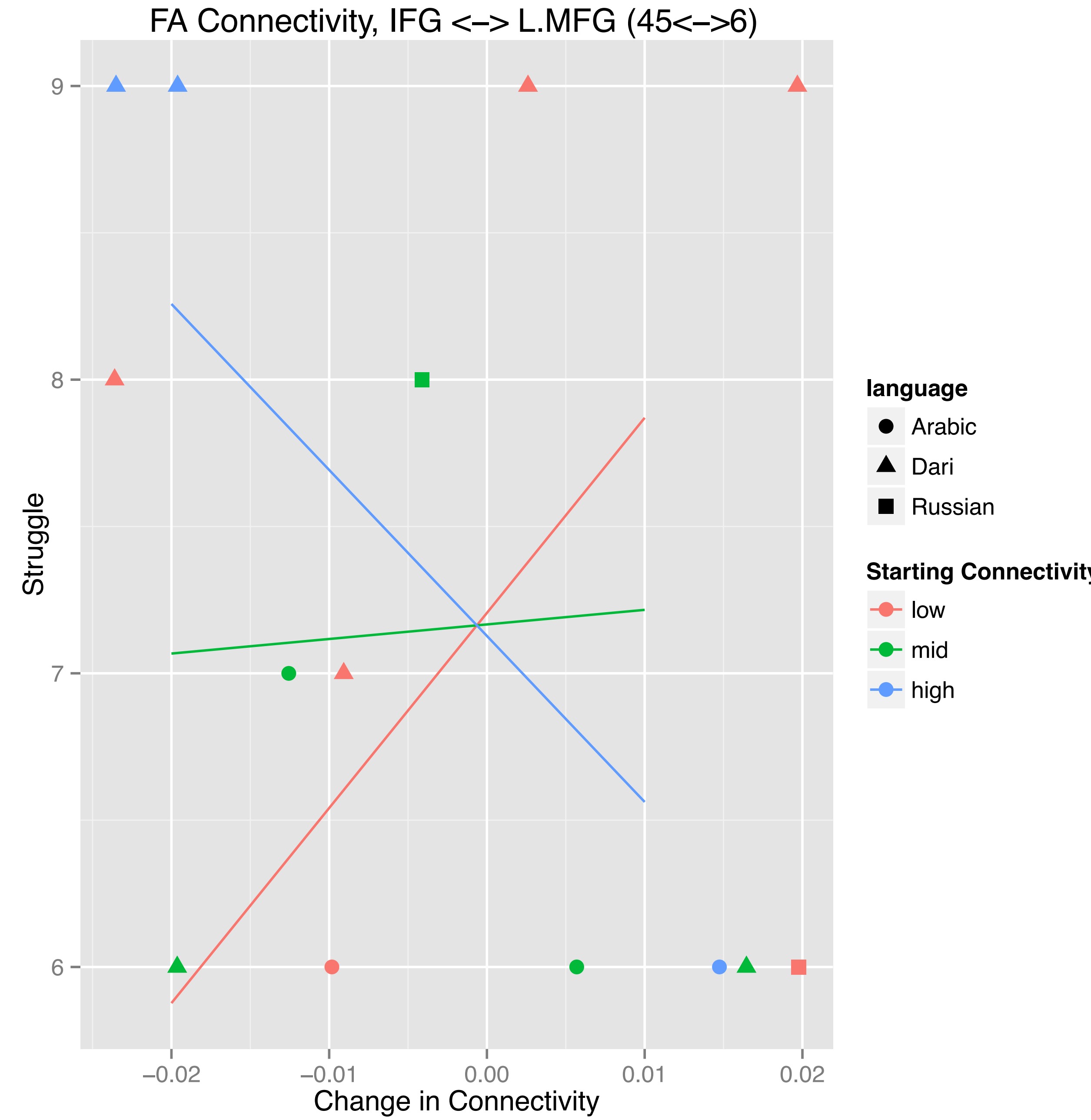
DTI

Diffusion Tensor Imaging



Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-3.93e+00	1.23e+01	-0.32	0.759	
diff_ba45_ba6_FA	7.43e+02	3.00e+02	2.48	0.042	*
pre_ba45_ba6_FA	-1.31e+00	1.52e+01	-0.09	0.934	
diff_ba45_ba6_MD	-3.80e+04	1.45e+05	-0.26	0.801	
pre_ba45_ba6_MD	1.24e+04	9.02e+03	1.37	0.212	
diff_ba45_ba6_FA:pre_ba45_ba6_FA	-2.05e+03	8.11e+02	-2.53	0.039	*
diff_ba45_ba6_MD:pre_ba45_ba6_MD	7.76e+07	1.63e+08	0.47	0.649	



Exempel på tillämpning

Tolkskolan

- Beteende: minnesökning i ett kognitivt testbatteri till följd av språkstudier

- Hjärnan: förändringar på macronivå på t1-viktad MRI (hjärnstruktur) och i nätverksegenskaper (DTI)

- Tillsammans: Studenterna utvecklas olika beroende på studiesituation och ev. pga förutsättningar

Exempel på tillämpning

Kan vi i framtiden använda oss av MRI i klinik för att välja intervention?

Denna sida på svenska

ASG Rapid brain change and long-term outcomes

We continue to learn new skills and develop our abilities throughout our life. Modern neuroimaging methods let us look inside the brain and observe how and where changes occur as an effect of experience. In the recent past, researchers have come to realize that learning a new skill, such as juggling or academic studies can lead to changes in brain structure in areas related to visuo-motor coordination or learning. It is also known that other academic studies such as language learning can lead to the same type of changes but in language areas and importantly, that these increases are relevant for academic performance. Additionally, we can make use of brain measures to help predict the outcome of an intervention or a study program.

The brain's capacity for change has proven much larger than earlier believed. Experience can shape the structure of our brains on an observable level within seconds to minutes rather than weeks or months as it was previously assumed. We know much less about the cellular mechanisms underlying these plasticity processes and how these rapid effects relate to long-term changes and learning ability. Predicting outcomes is important if we are to understand why we respond to education differently, or if we want to know why some patients respond to a particular intervention in a clinical setting whilst others do not.

This Theme consists of member from the faculties of Medicine, Humanities, Social Sciences and Faculty of Engineering. Our common denominator is a keen interest in brain plasticity and a knowledge that combines work on both animals and humans, using novel imaging techniques.

Members

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Med flera

Exempel på tillämpning

Kan vi i framtiden använda oss av MRI i klinik för att välja intervention?
Mycket tyder på det - men! effekter är än så länge på gruppnivå

REVIEW

Predispositions and Plasticity in Music and Speech Learning: Neural Correlates and Implications

Robert J. Zatorre*

Speech and music are remarkable aspects of human cognition and sensory-motor processing. Cognitive neuroscience has focused on them to understand how brain function and structure are modified by learning. Recent evidence indicates that individual differences in anatomical and functional properties of the neural architecture also affect learning and performance in these domains. Here, neuroimaging findings are reviewed that reiterate evidence of experience-dependent brain plasticity, but also point to the predictive validity of such data in relation to new learning in speech and music domains. Indices of neural sensitivity to certain stimulus features have been shown to predict individual rates of learning; individual network properties of brain activity are especially relevant in this regard, as they may reflect anatomical connectivity. Similarly, numerous studies have shown that anatomical features of auditory cortex and other structures, and their anatomical connectivity, are predictive of new sensory-motor learning ability. Implications of this growing body of literature are discussed.

The nervous system's remarkable capacity to learn has been a central concern of neuroscience since its origins. Manifestations of change, plasticity, or adaptation to environmental signals can be discerned at every level of analysis, from molecular to synaptic, to systems, to cognitive. What makes the problem intriguing is that changes in the nervous system must occur for an organism to optimize its behavior in relation to its environment; but the initial state of the nervous system when it is exposed to the learning situation is not identical for all individuals.

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Exempel på tillämpning

Kan vi i framtiden använda oss av MRI i klinik för att välja intervention?
Mycket tyder på det

Bilingualism: Language and Cognition

cambridge.org/bil

White matter microstructure predicts foreign language learning in army interpreters

Johan Mårtensson[1], Johan Eriksson[2], Nils Christian Bodammer[3], Magnus Lindgren[4], Mikael Johansson[5], Lars Nyberg[6] and Martin Lövdén[7]

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Research Article

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Keywords:
diffusion tensor imaging; language acquisition; interpreting

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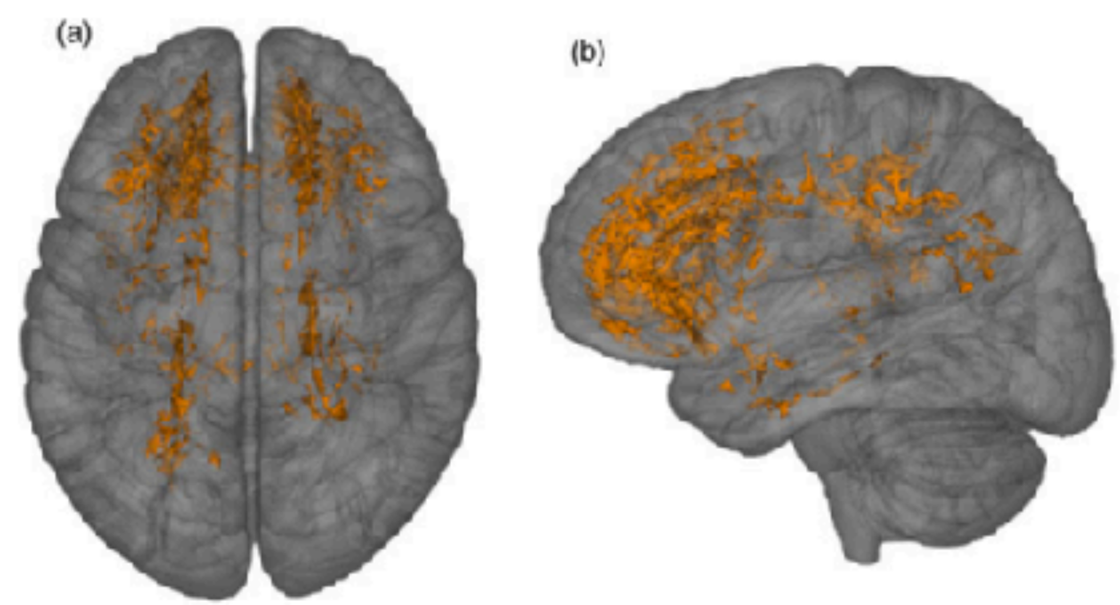

Exempel på tillämpning

Physical neglect

Physical neglect during childhood alters white matter connectivity in healthy young males

Indira Tendolkar[1,2] | Johan Mårtensson[3] | Simone Kühn[4,5] | Floris Klumpers[2,6] | Guillén Fernández[2]

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Abstract

Background: Childhood adversity (CA) leads to greater vulnerability for psychopathology by causing structural as well as functional brain abnormalities. Recent findings on gray matter effects point towards the importance of identifying CA outcome as a function of different CA types, varying in the dimensions of threat and deprivation. Using diffusion tensor imaging, we investigate whether different forms of CA impact differently on white matter connectivity in a healthy cohort not confounded by other aspects of disease.

Methods: In 120 healthy young males, we assessed different forms of maltreatment during childhood with the Childhood Trauma Questionnaire (CTQ). Fractional anisotropy (FA) and mean diffusivity (MD) images were generated and projected onto a white matter skeleton using tract-based spatial statistics. Correlational analysis between FA, MD, and CTQ subscores was then performed using voxelwise statistics.

Results: Of all CTQ-subscores, only physical neglect (PN) predicted a decrease of FA but not MD in the bilateral anterior thalamic radiation around the middle frontal gyrus and the right inferior fronto-occipital fasciculus, the inferior longitudinal fasciculus, the cingulum and precuneus. Reduced FA in the posterior cingulum was related to the effects of PN during childhood on anxiety levels at trend level.

Conclusions: PN may have severe consequences and should be considered equally important to more active forms of abuse. FA changes, particularly in the cingulum, actually appear to a functional consequence and are linked to trait anxiety, a personality dimension that is suggested to be a transdiagnostic risk factor of affective disorders. Potentially this reveals a mechanistic chain that forms one pathway from CA to disease.

KEYWORDS
childhood adversity, diffusion tensor imaging (DTI), fractional anisotropy, healthy controls, tract-based spatial statistics (TBSS)

Exempel på tillämpning

Physical neglect

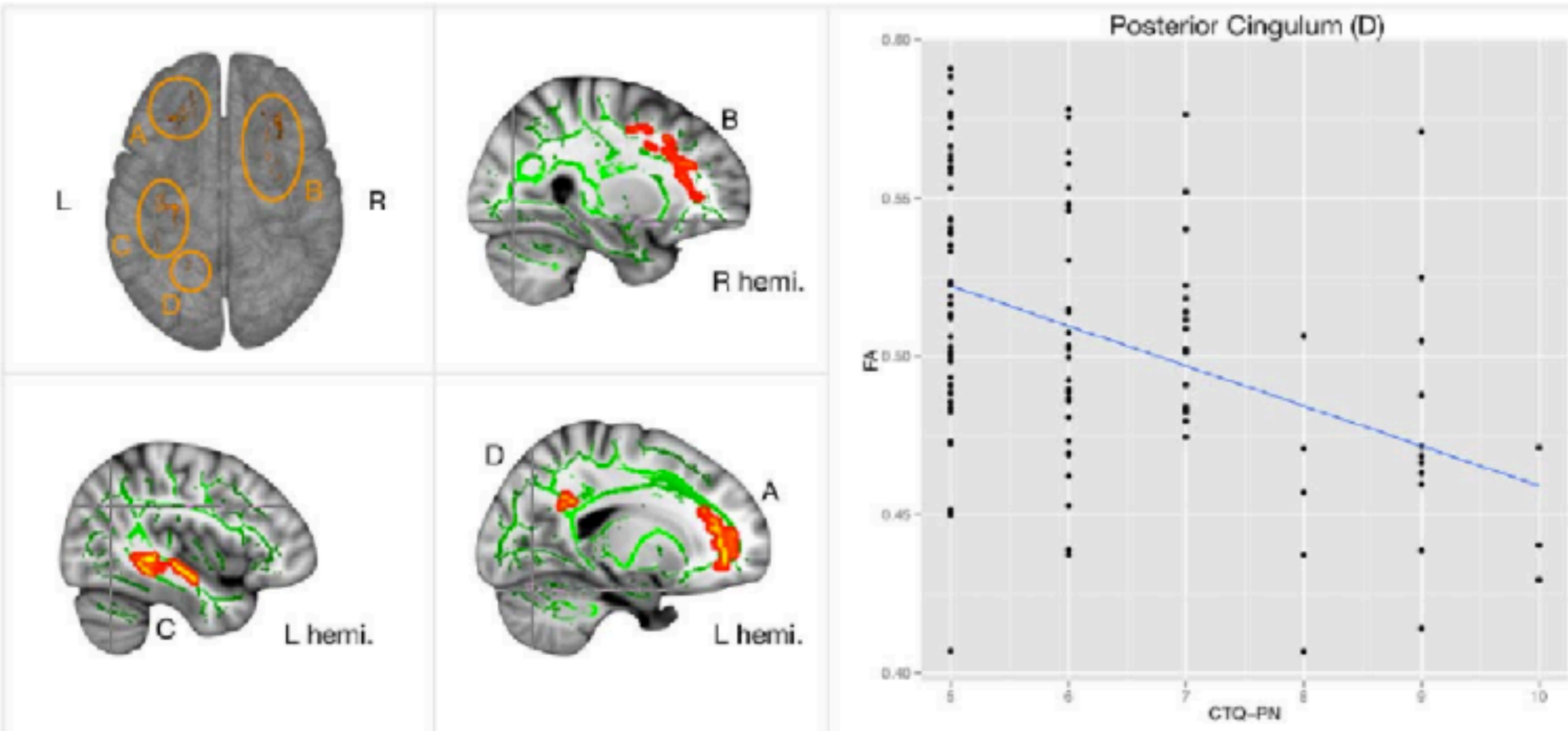
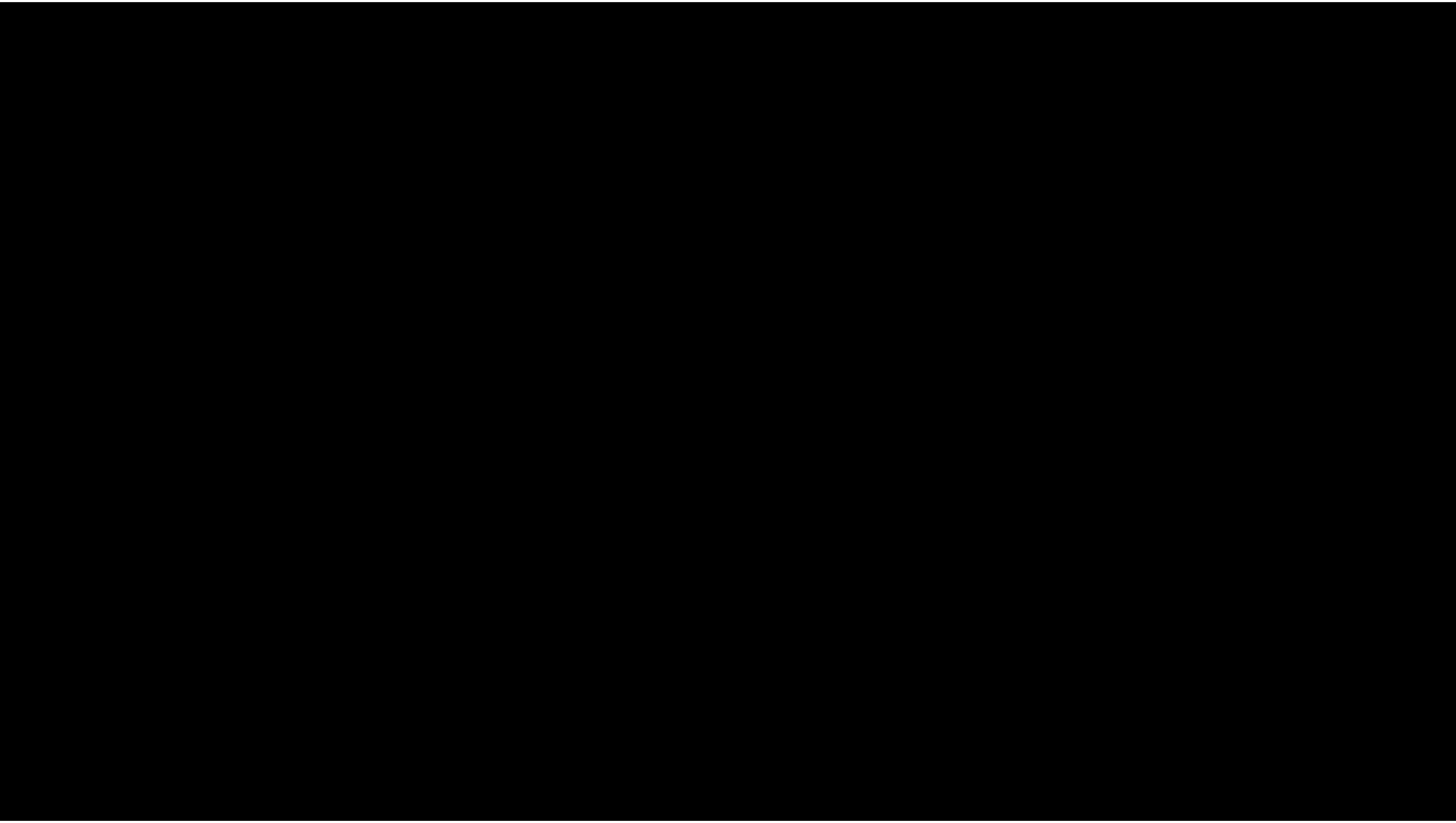


FIGURE 2 Displayed are fractional anisotropy images of all subjects ($n = 114$), which are projected onto a skeletonised image representing the centres of all tracts common to the group. Images are fully corrected for multiple comparisons using threshold-free cluster enhancement at $p < .05$. The color-coded areas (subfigure 1–4) depict the negative correlation between the physical neglect subscale of the CTQ in the bilateral anterior thalamic radiation around the middle frontal gyrus, which included the forceps minor and unciate fasciculus (area A) on the left side and the inferior fronto-occipital fasciculus on the right side (area B). The regions also include the left inferior fronto-occipital fasciculus and inferior longitudinal fasciculus (area C), and the posterior cingulum near the precuneus (area D). All regions were voxelwise correlated to CTQ-PN, but only FA in the posterior cingulum mediated trait anxiety (subfigure 5, also see Figure 3) [Color figure can be viewed at wileyonlinelibrary.com]

Vilka möjligheter har vi i Lund?

I Lund har vi god tillgång till MRI som metod via Lund university Bioimaging Center (LBIC)

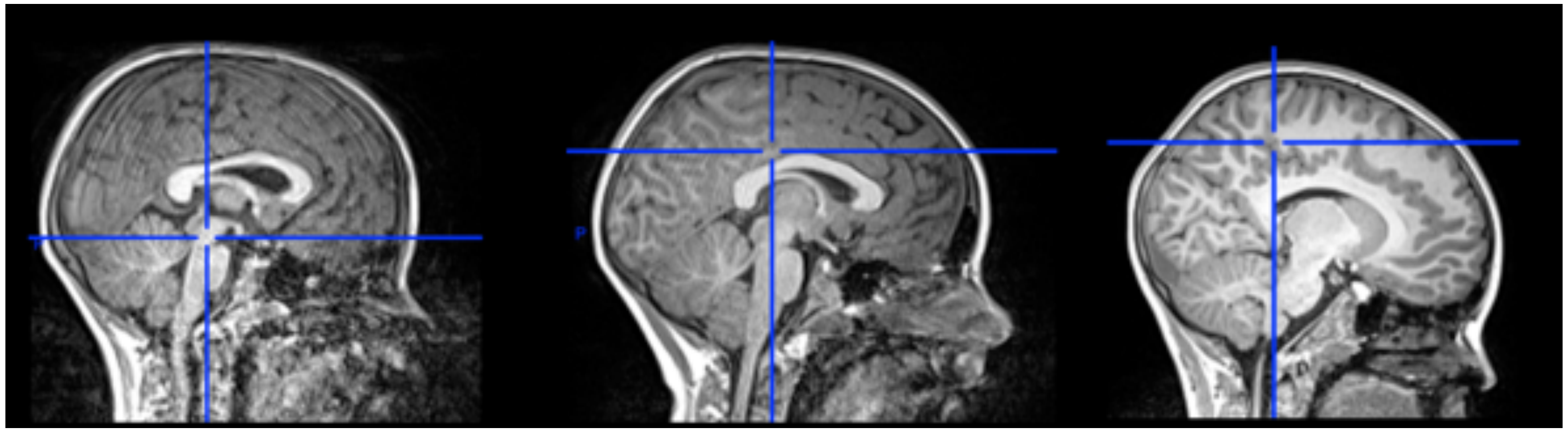
- Vi har dels tillgång till klinska 1,5T och 3T maskiner, t.ex. vår Siemens PRISMA
- Och sen har vi även tillgång till Nationella 7T enheten, som är belägen på samma våningsplan



7T vs 3T

Det finns för och nackdelar med båda fältstyrkorna

- I vår PRISMA har deltagaren betydligt bättre utrymme, t.ex. i en studie där vi jagar myelinisering i relation till utbildning och inlärning i barn som är så små som 6-7 år gamla. Vid repeterade mätningar kan detta vara skillnaden mellan att komma åter eller ej.



7T vs 3T

Det finns för och nackdelar med båda fältstyrkorna

- Det är även lättare med sekvensutveckling vid 3T som är mer av en standardmaskin, och gradientstyrkan är fördelaktig vid t.ex. DTI, samtidigt som 3T leder till mindre distortion.

- Kruxet är att vi har relativt dålig tillgång till dessa maskiner pga att de används inom vården.

7T vs 3T

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- Det är även lättare med sekvensutveckling vid 3T som är mer av en standardmaskin, och gradientstyrkan är fördelaktig vid t.ex. DTI, samtidigt som 3T leder till mindre distortion.

- Kruxet är att vi har relativt dålig tillgång till dessa maskiner pga att de används inom vården.

7T vs 3T

Det finns för och nackdelar med båda fältstyrkorna

- Vi har betydligt bättre tillgång till 7T, som är en ren forskningsmaskin och som utgör nationell infrastruktur
- Det finns dock högre risk för distortion i bilderna
- Maskinen och datan som samlas in kräver betydligt mer av t.ex. nya användare
- Det finns ytterligare komplikationer för deltagarna i form av yrsel eller för den delen den trånga tunneln

7T vs 3T

Men sen kan vi göra helt andra grejor i 7T

Whole-body somatotopic maps in the cerebellum revealed with 7T fMRI

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A B S T R A C T

The cerebellum is known to contain a double somatotopic body representation. While the anterior lobe body map has shown a robust somatotopic organization in previous fMRI studies, the representations in the posterior lobe have been more difficult to observe and are less precisely characterized. In this study, participants went through a simple motor task asking them to move either the eyes (left-right guided saccades), tongue (left-right movement), thumbs, little fingers or toes (flexion). Using high spatial resolution fMRI data acquired at ultra-high field (7T), with special care taken to obtain sufficient B_1 over the entire cerebellum and a cerebellar surface reconstruction facilitating visual inspection of the results, we were able to precisely map the somatotopic representations of these five distal body parts on both subject- and group-specific cerebellar surfaces. The anterior lobe (including lobule VI) showed a consistent and robust somatotopic gradient. Although less robust, the presence of such a gradient in the posterior lobe, from Crus II to lobule VIIIb, was also observed. Additionally, the eyes were also strongly represented in Crus I and the oculomotor vermis. Overall, crosstalk between the different body part representations was negligible. Taken together, these results show that multiple representations of distal body parts are present in the cerebellum, across many lobules, and they are organized in an orderly manner.

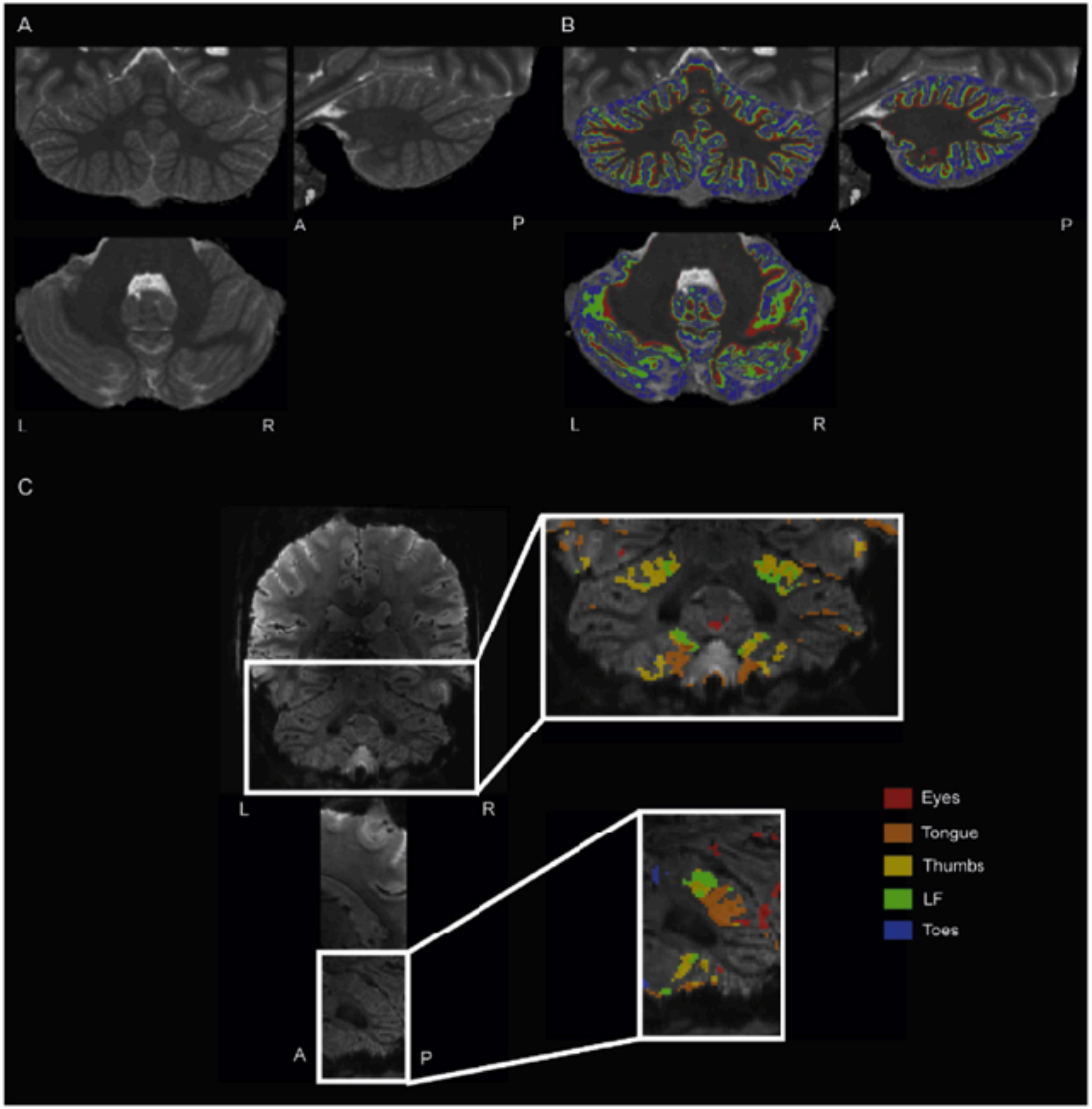

Fig. 1. A) T_1 image acquired at 0.6 mm isotropic resolution providing sufficient resolution to delineate the different folia and arbor vitae. B) Layering of the cerebellar grey matter at three different cortical depths: inner (red), middle (green) and outer (blue). C) Functional EPI image of 1 mm resolution with the somatotopic label map of a single subject. L/R stands for left/right orientations and A/P for anterior/posterior orientations.

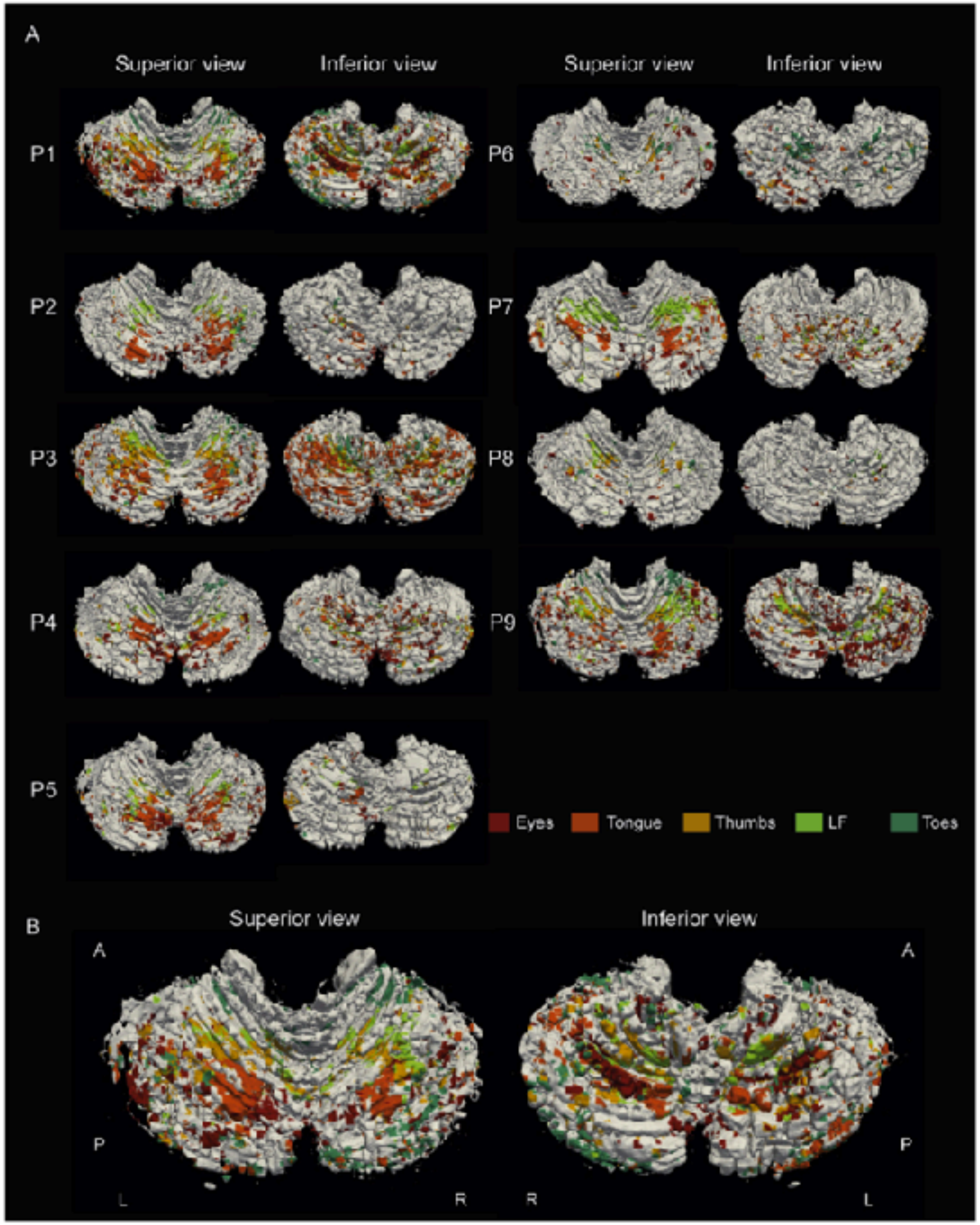

Fig. 2. A) Subject-specific cerebellar surfaces (top and bottom views) of the nine participants on which the somatotopic labels are mapped. The label maps were generated by using the F-test results ($p < .001$ uncorrected) as a mask where each voxel was attributed to the body part showing the highest T-value. B) Enlarged surface of participant P1. L/R stands for left/right orientations and A/P for anterior/posterior orientations.

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Brain classification reveals the right cerebellum as the best biomarker of dyslexia

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Slutkläm

MRI är användbart för att förstå beteende, utan beteende blir MRI ej förståbart

- MRI mätningar kan hjälpa oss att få en djupare förståelse för psykologiska fenomen och patologi
- Genom kombinerade mätningar av både MRI och beteende får vi en betydligt bättre förståelse av ett förlopp, t.ex. inlärning eller sjukdom, än vi hade fått av endera mätmetoden
- I Lund har vi mycket god tillgång på MRI mätningar, ffa genom Nationella 7T Enheten som är belägen inne på SUS men tillhör LU

Tack!

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