



Sensory Processing Disorders and Sensory Integration

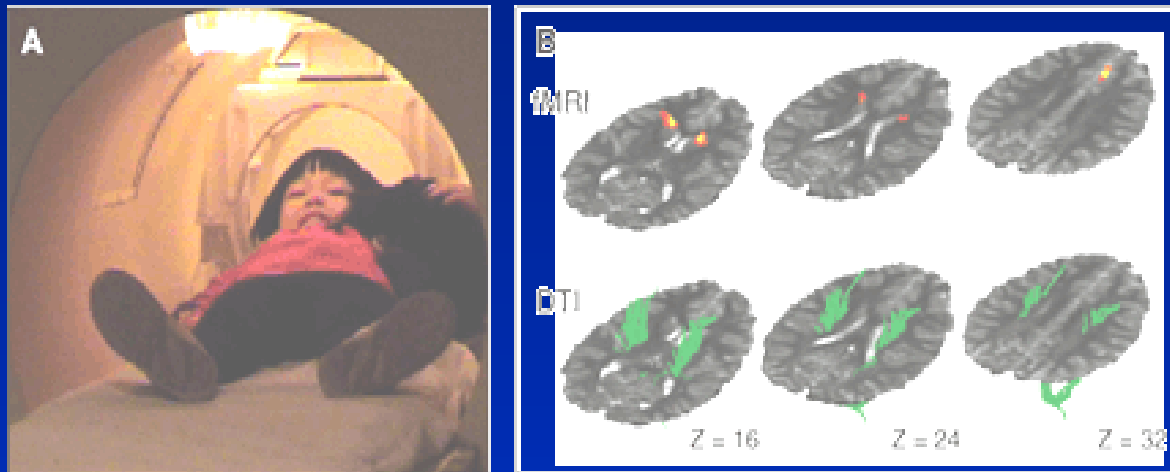
Fernette Eide M.D. and Brock Eide M.D. M.A.

Eide Neurolearning Clinic

www.neurolearning.com

fMRI or functional MRI

fMRI is a rapid method (seconds) of detecting localized changes in blood flow and oxygenation

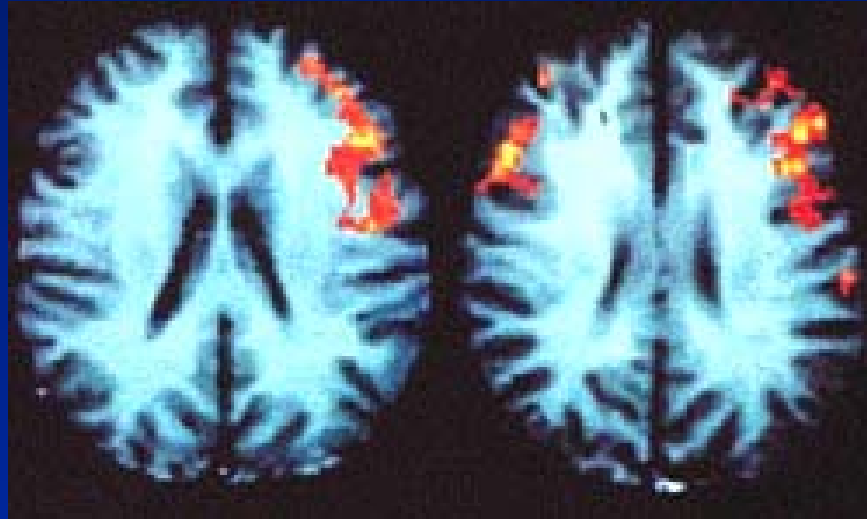


Casey Cornell

We can ‘see’ how the brain responds to sensory input, generates movement, thinks, remembers, and imagines...

Men

Women



Shaywitz Yale

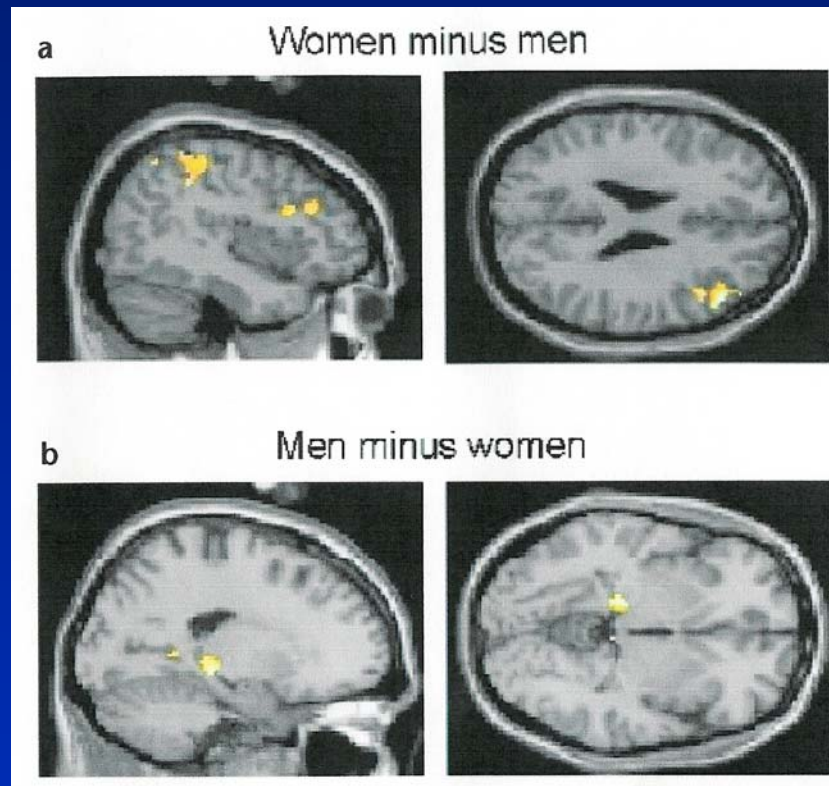
men & women performing a rhyming task

**Men have unilateral activation,
Women have bilateral activation**

Same speed, same accuracy

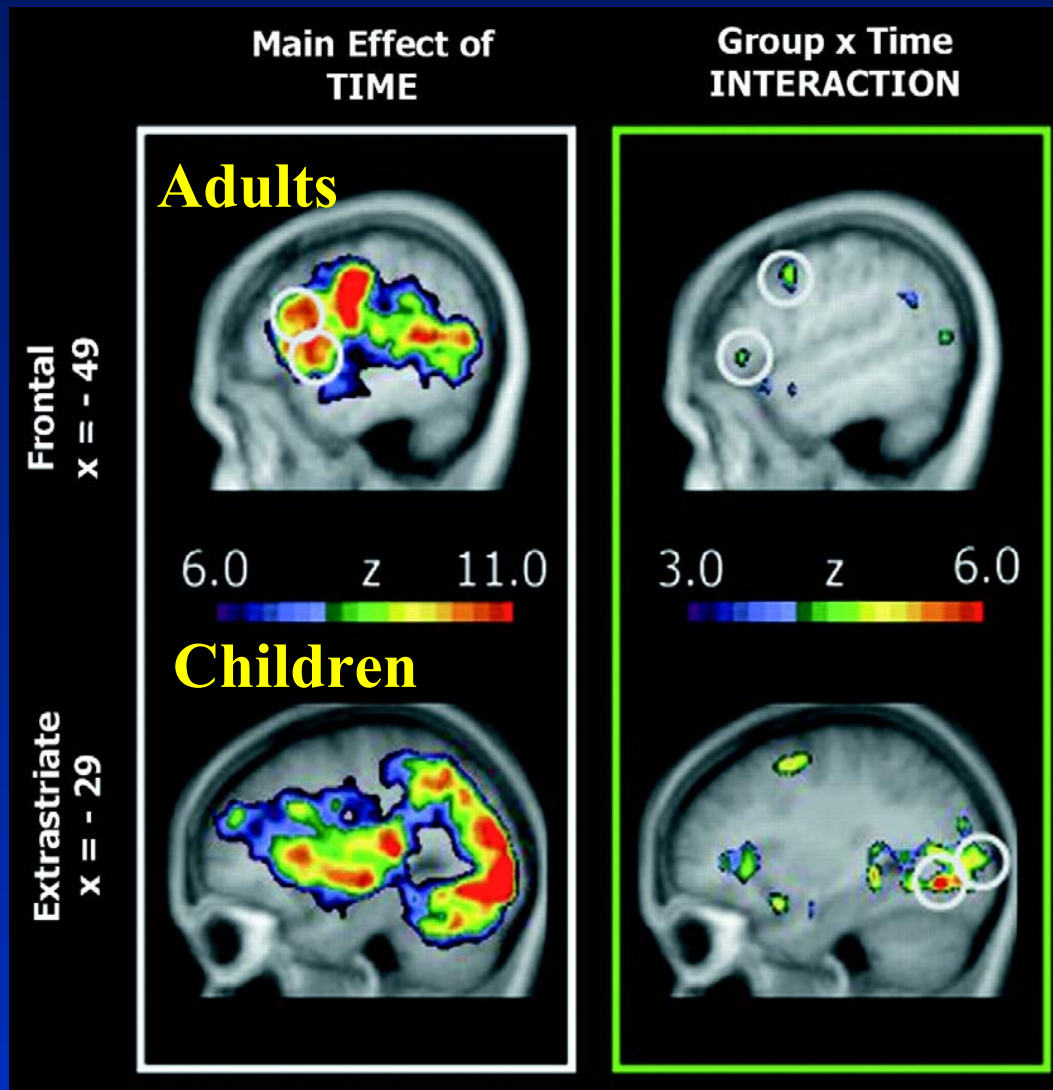
Results show averages of male/female groups

Men & Women Differ in Spatial Navigation

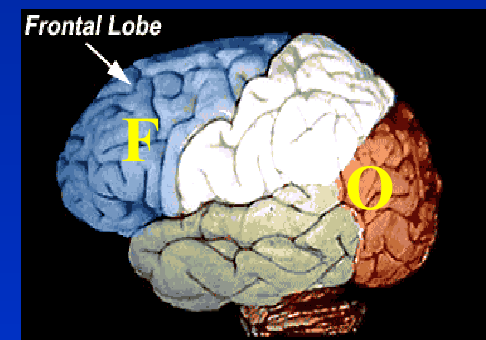


Riepe U of Ulm

**Differences in fMRI patterns reflect different strategies
Using landmarks vs. geometry ('it's over there somewhere')**

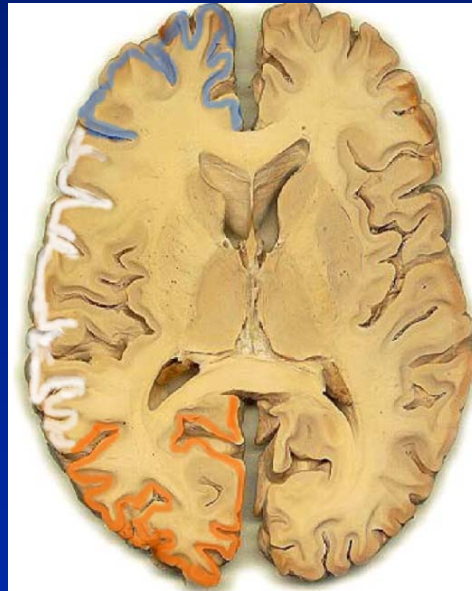
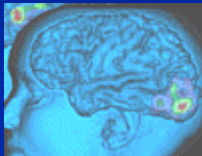
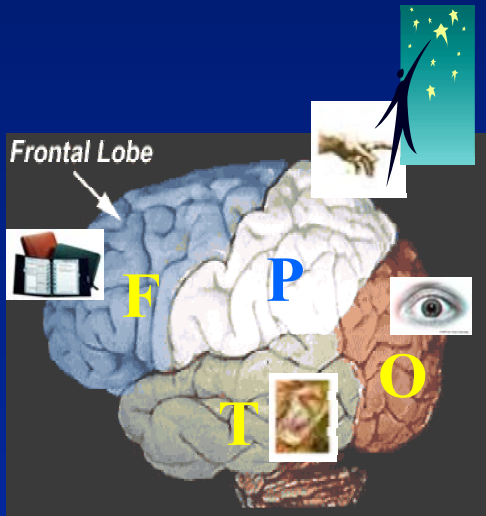


**fMRI also shows
how adults & children
have different brain
mechanisms for
learning a single task**



Schlaggar Wash Univ St Louis

Quick Neuroanatomy



Axial Views

Frontal

Parietal

Occipital



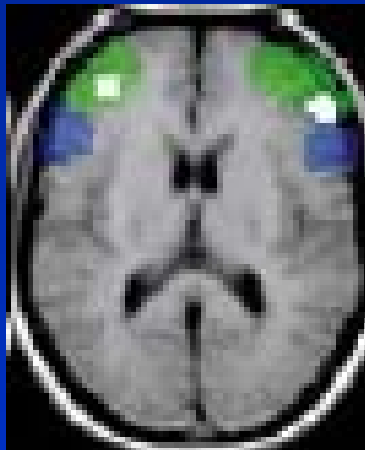
Temporal



Frontal Cortex & Working Memory



**fMRI activation for remembering
5 random letters presented
simultaneously**



**fMRI activation for remembering
& then alphabetizing the 5 random
letters presented simultaneously**



Frontal-Sequential Learning

- ◆ motor planning
- ◆ fact mastery
- ◆ rule-based learning
- ◆ long division, geometrical proofs
- ◆ logic

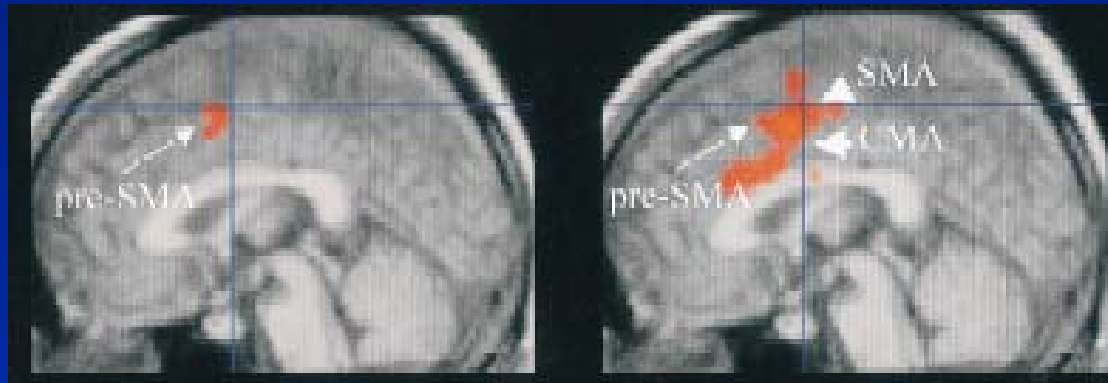


111,111.11
9)1,000,000.00
900,000.00
100,000.00
90,000.00
⋮
.10
.09
.01

Less is Better for Motor Tasks

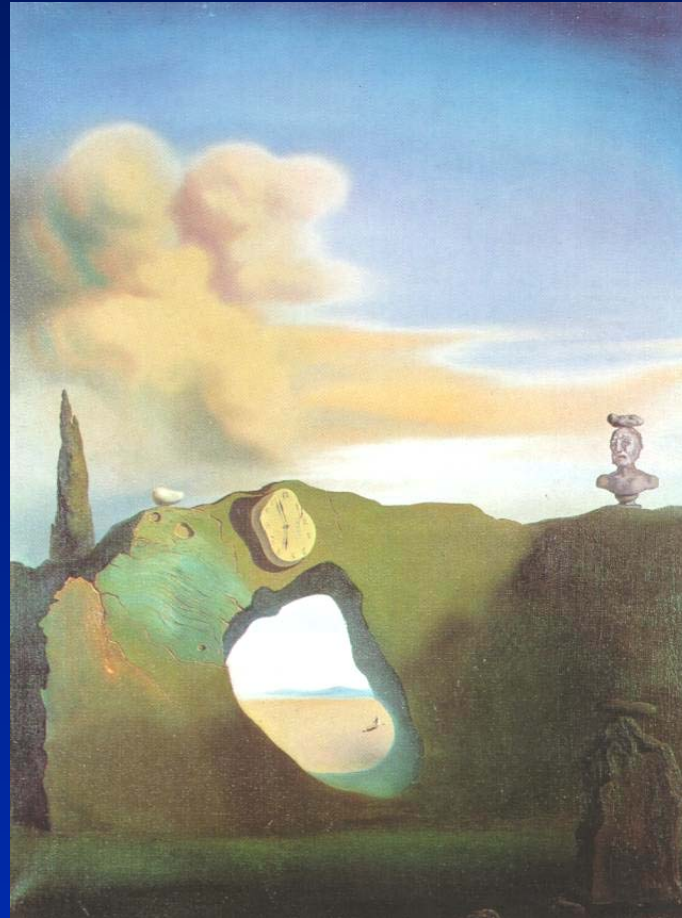
Pianists

Non-Musicians



Jancke U Guelph

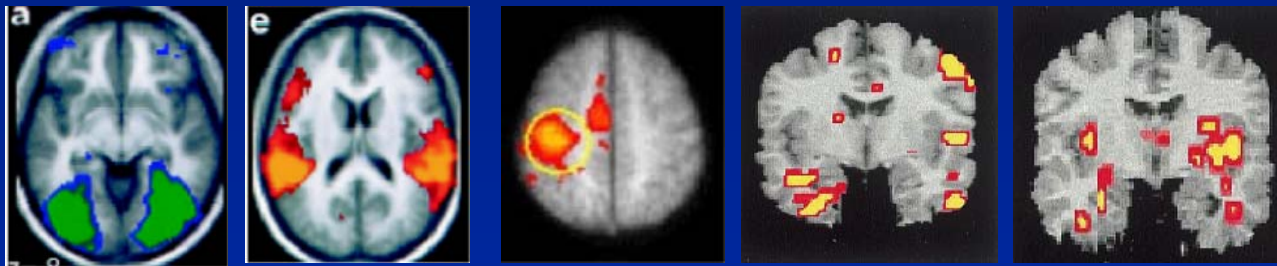
Bilateral Hand Movements

$$\begin{array}{r}
 111,111.11 \\
 \hline
 9 \overline{) 1,000,000.00} \\
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 100,000.00 \\
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 \vdots \\
 .10 \\
 \underline{.09} \\
 .01
 \end{array}$$


**Frontal-Sequential
Thought & Processing**

**Visual/Sensory/Associative
Thought & Processing**

The Sensory Brain



Seeing

Hearing

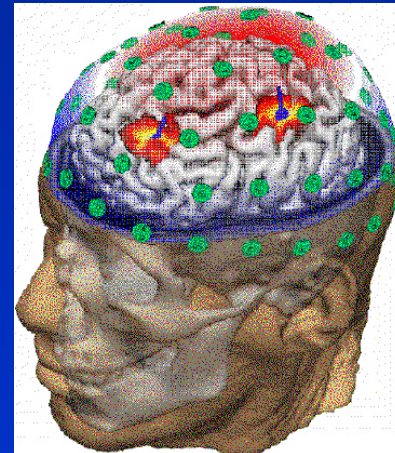
Touch

Taste

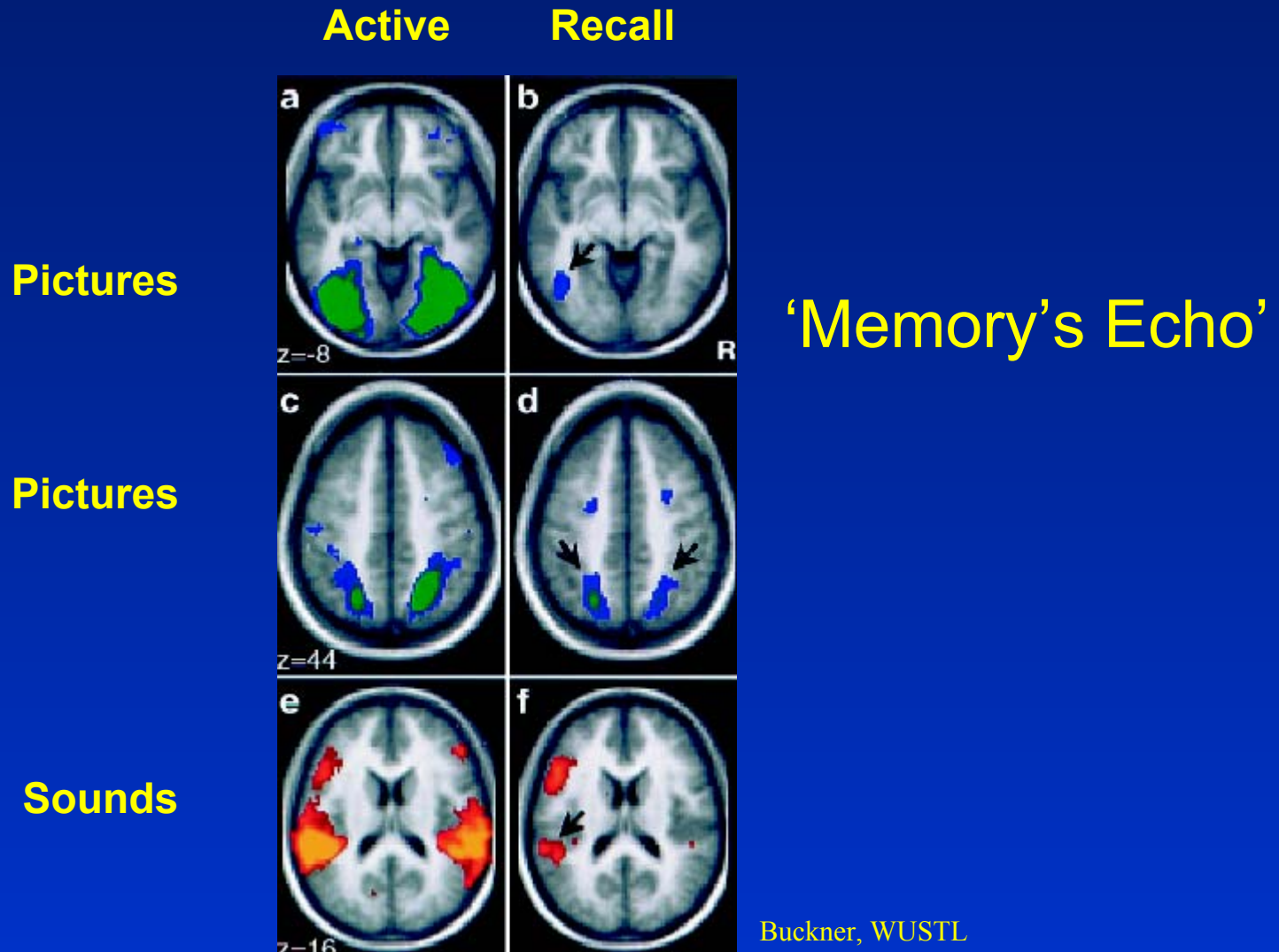
Smell

The Sensory Cortices are Multimodal

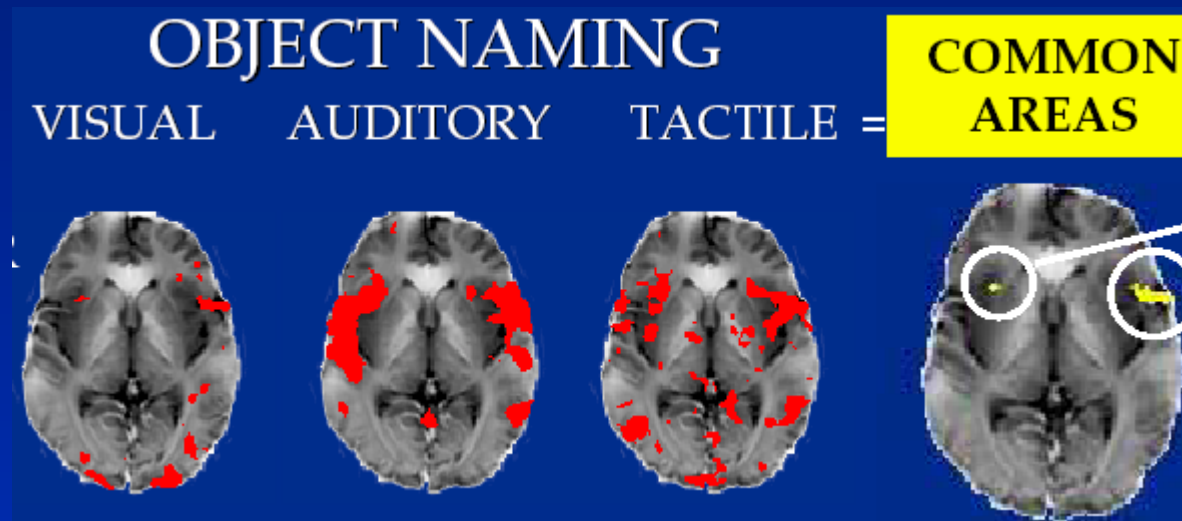
- ◆ various 'sensory' cortices are connected in widely dispersed 'systems'
- ◆ the senses are connected in parallel, not serial neural networks
- ◆ we perceive something by sight, hearing, touch, taste, and smell
- ◆ many perceptions are 'unconscious'
- ◆ the data acquired by are senses are complex



More is Better for the 'Sensing Brain'



When we identify an object, we are simultaneously identifying & localizing it through sight, hearing,& touch

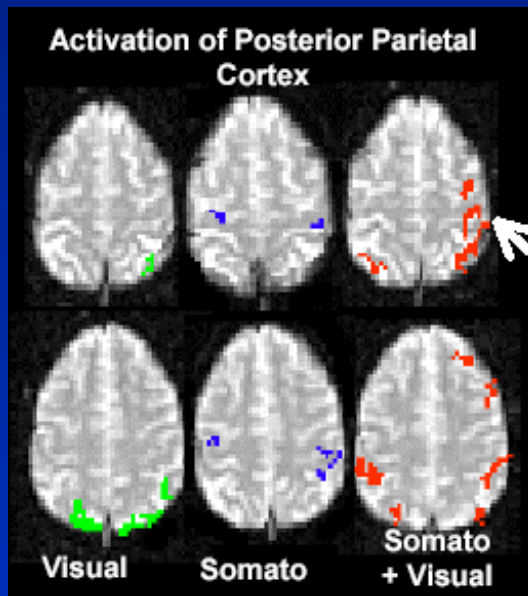


Hirsch Sloan-Kettering

Sensory Systems Critical for Perceiving External World

The Sensory Brain & Multimodality

When $2 + 2 = 5$



Roberts, UCSF

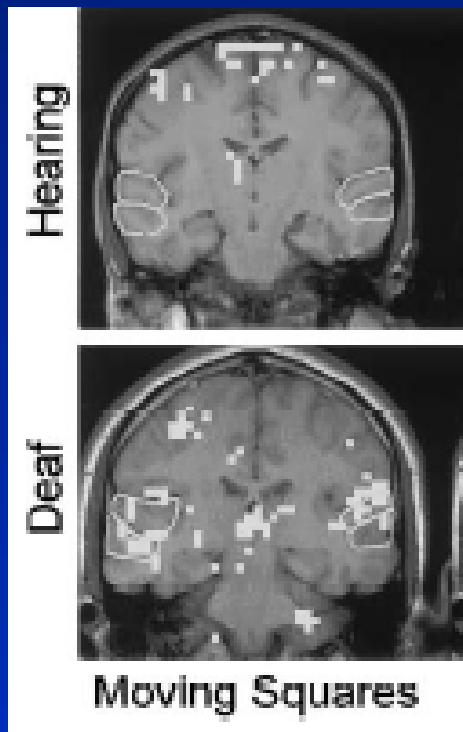
**Different Modalities
Are Supra-Additive**

Sight & Touch

'Gestalt'
perception

Senses Compensate for Deficiencies...

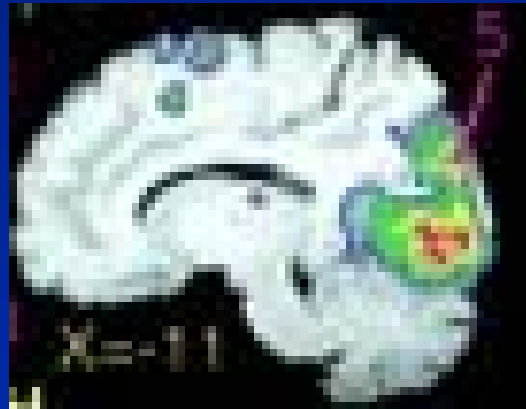
The Infrastructure for Hypersensitivity



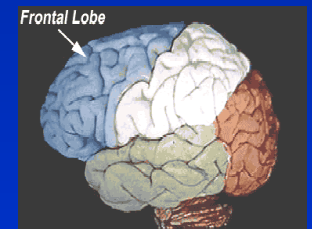
**More Visual Sensitivity with Deafness-
Deaf 'See' with Auditory Cortex
as well as Visual Cortex**

**In other studies,
Blind Hear with Visual Cortex**

Blind 'Touch' with Visual Cortex



Burton, WUSTL

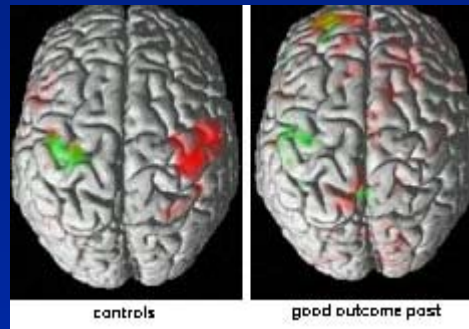


Dysfunction of Sensory Integration

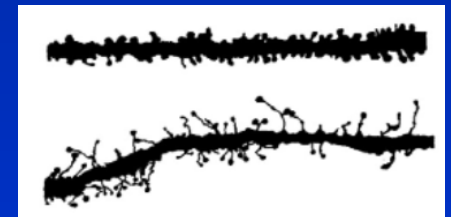
Aberrant CNS Recovery

Stroke Recovery & Changed Body Map

- CAPD
- Autism
- Brain injury
- Premies
- Sensory-deprived
- ‘Cerebral Palsy’
- Tourettes
- Highly Gifted

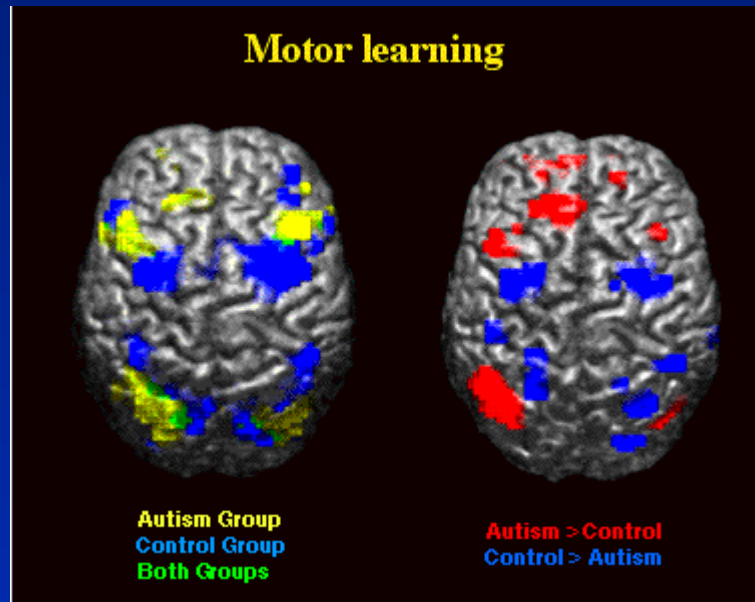


U Tuebingen



Raisman & Field, 1973

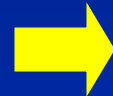
Altered Cortical Maps in Autism Motor Learning



More Activation Prefrontal & Inferior Parietal

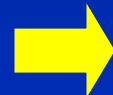
‘What would life be like if you were unable to ignore sensations as minor as the hum of a fluorescent light, the glint of sunlight on a window, or the rub of clothing against your skin? Making sense out of the torrent of stimuli that continually bombards us...’-- Matthew Belmonte

Hyperinnervation



Hypersensitivity

Sensory-Sensory Mismatches
Sensory-Motor Mismatches



Incoordination

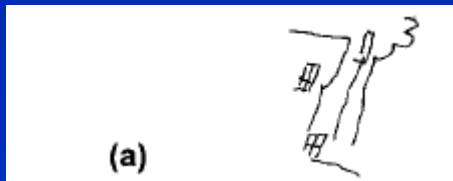
Hyposensitivity

Hypotonia

Mistarget/Overshoot

Multimodality & Implications for Therapy

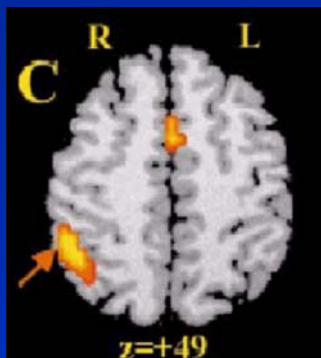
- improvement in one modality can affect others
- examples: correction of vision with prisms improves auditory neglect, touch improves visual attention...
- multimodal assessment & therapy- vision, motor planning, balance, touch, auditory....



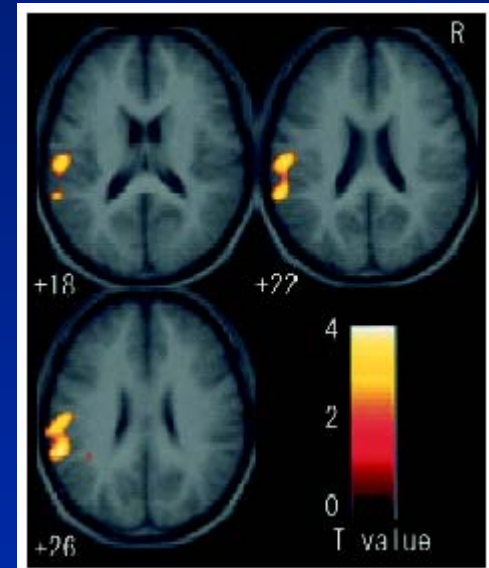
Correction Visual & Sensory (Haptic) neglect

Sensorimotor Integration

Sensation & Spatial Pathways
Essential for Motor Imagery...



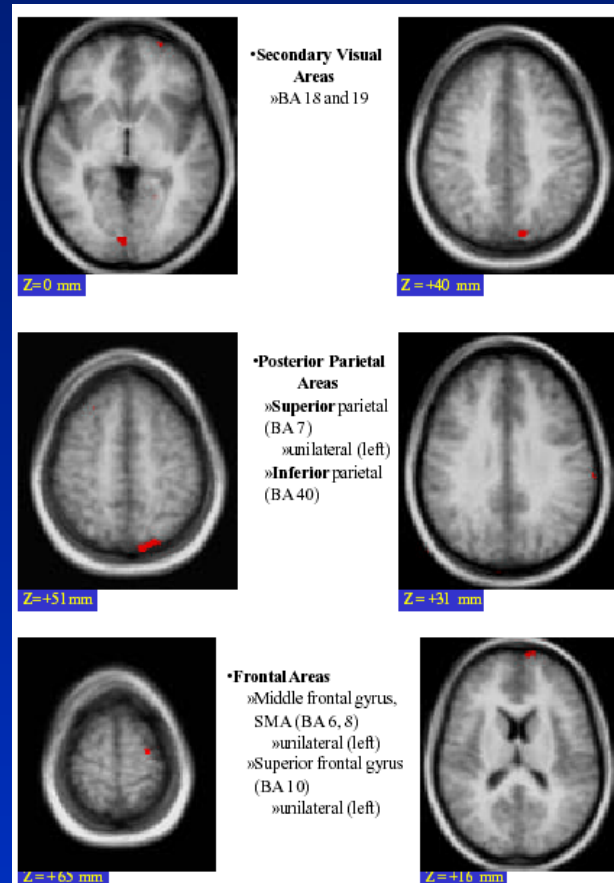
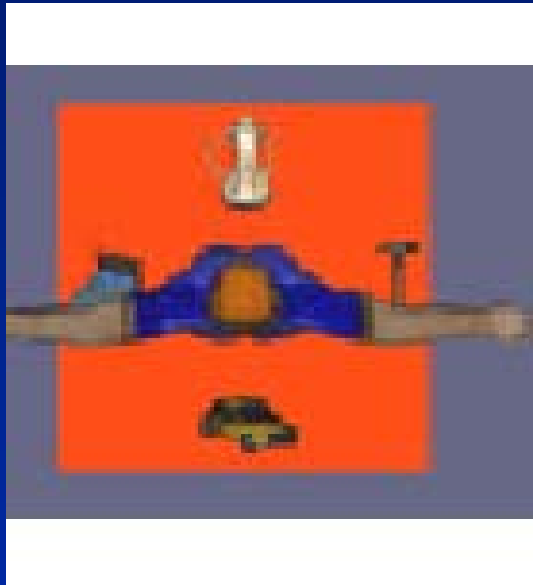
Ehrsson et al., Karolinska



Naito et al., Kyoto Univ

...and Fine Motor Feedback
(adjustments, scaling, handwriting...)

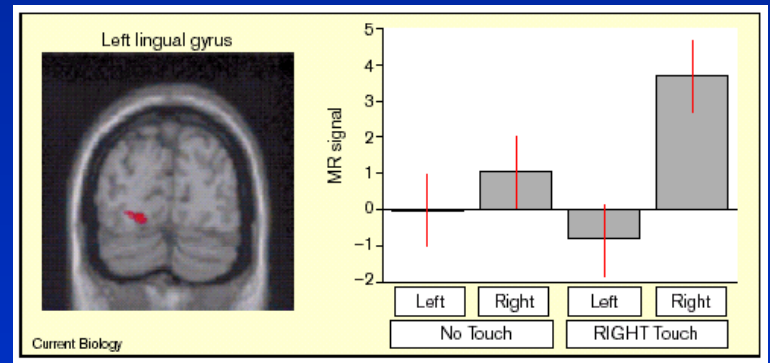
Imagined Rotation Activates Visual, Parietal & Prefrontal Cortex



The Senses & Attention

- the Senses & Attention are integrally related
- the Senses Sharpen or Dull Attention
- Attention affects the perception of sensory stimuli

Touch Sharpens Visual Attention



Deaf More Sensitive in Peripheral Vision

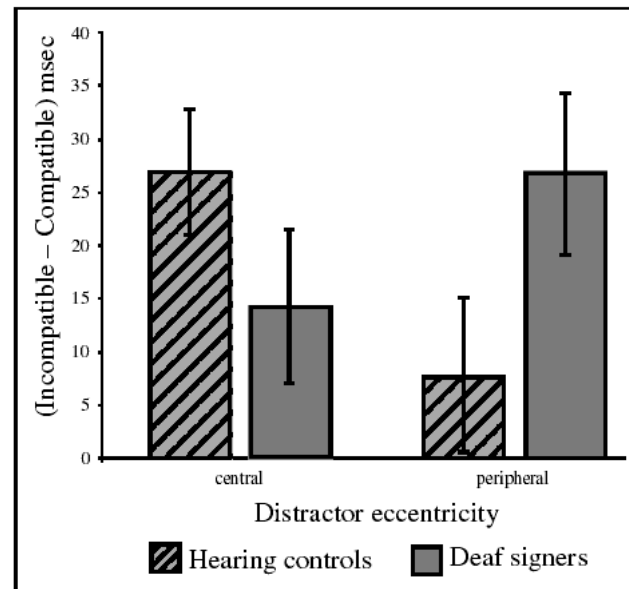
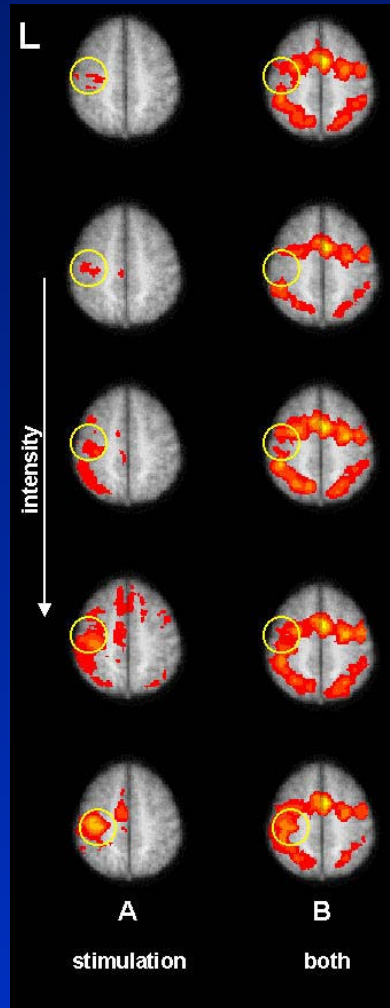


Figure 2. Compatibility effects (msec) for hearing controls and deaf individuals as a function of the distractor eccentricity in Experiment 1. The compatibility effect was measured by the RT difference between displays in which target and distractor were incompatible and those in which they were compatible. For central distractors, hearing displayed a trend for larger compatibility effects than deaf individuals, whereas the opposite effect was observed for peripheral distractors.

Less Perception of Sensory Stimulation When Counting...

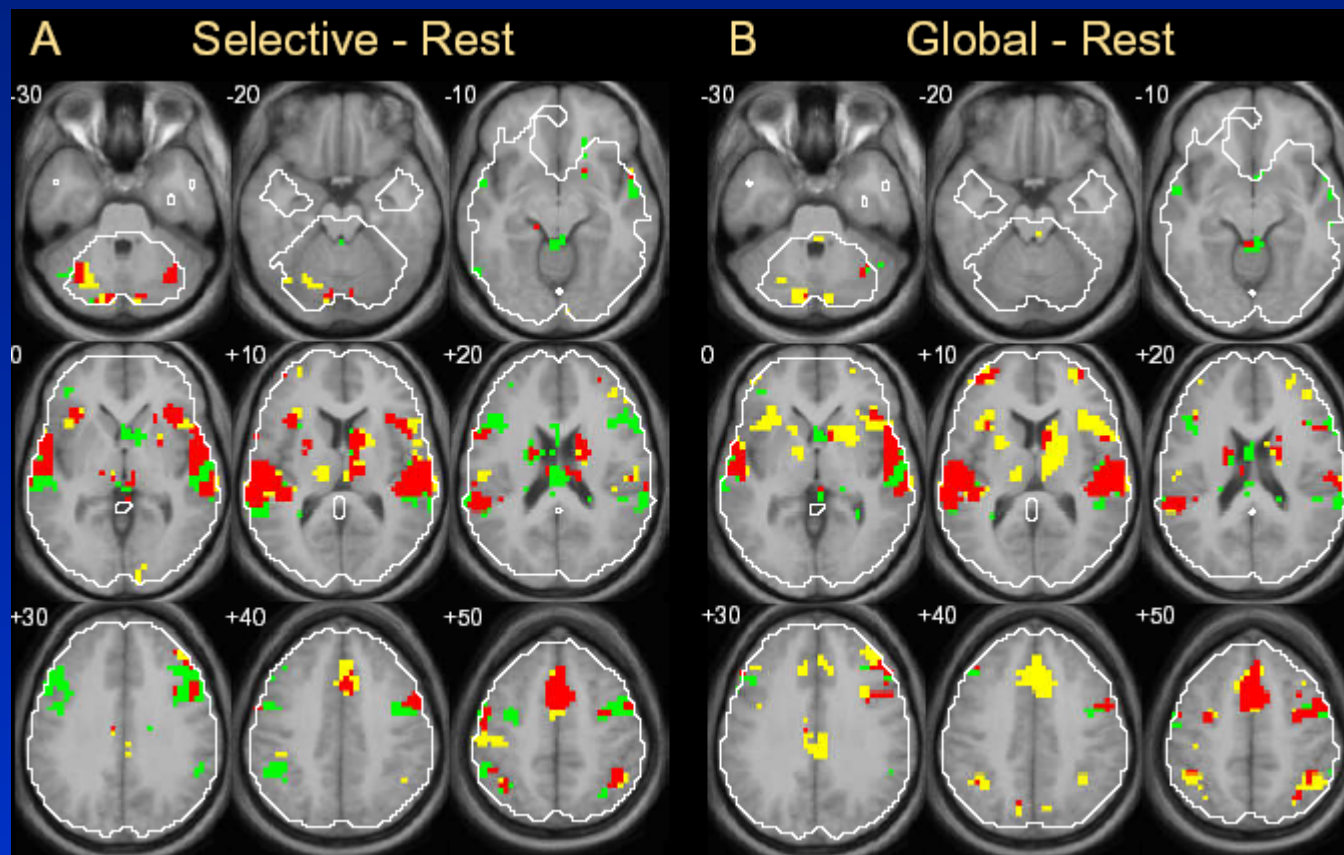
Primary Somatosensory Cortex
In Circle



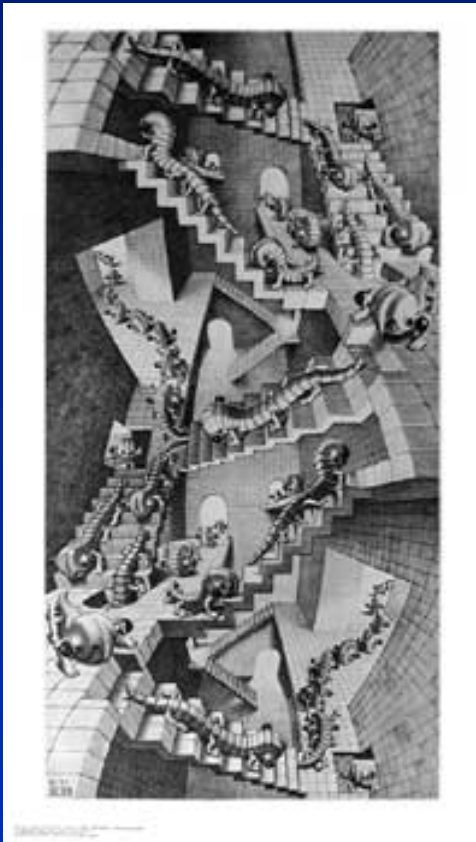
Matthews, Oxford

The Complex 'Dance' of Auditory Attention Listening to Music

**During 'Selective' Trials, Subjects were told to Selectively Listen
To One Melody Line within the Composition**



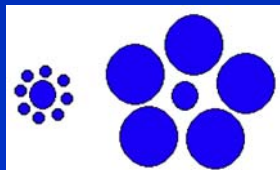
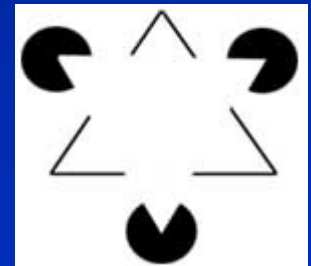
Visual Perception & SI



Visual perception is as complex as auditory perception

We attend to certain visual stimuli within the context of a whole

We only 'see' what relationships our brain shows us



Visual Motion & SI



- R & L Visual Fields are Coordinated & Balanced
- Brain Sorts out Self- & Environmental-Motion
- Brain Stabilizes our Perception of the External World although Eyes and Head are in motion (visual-vestibular sensory integration)



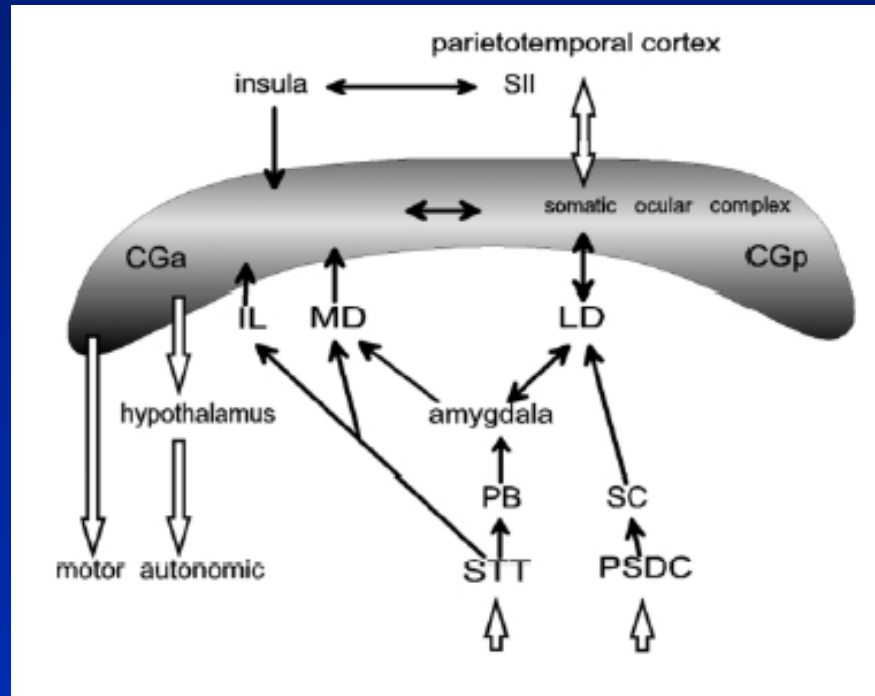
The Senses & Arousal

- Senses critical for self-protection, detecting danger
- Senses direct attention
- Arousal system gets body ready for 'fight' or 'flight'
- Behavioral problems relevant to DSI most often due to activation hyperarousal— fear, sympathetic activation, anxiety...

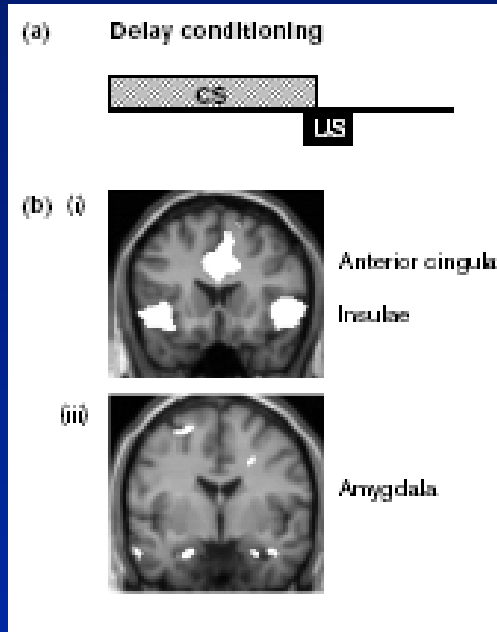


Cingulate Cortex

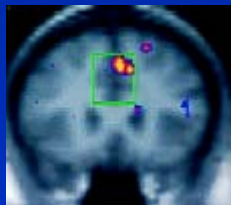
Sensation, Arousal, Emotion, Attention



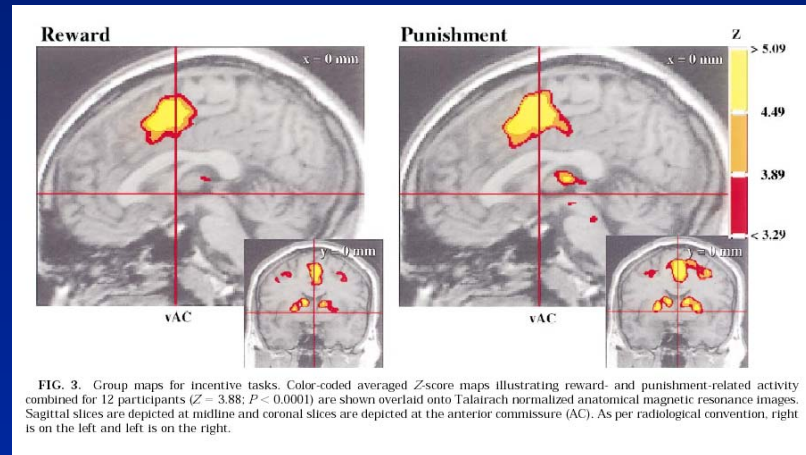
Cingulate Cortex



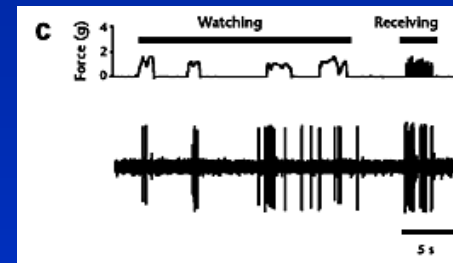
Aversive Conditioning



Response
Conflict/Stroop



Reward & Punishment

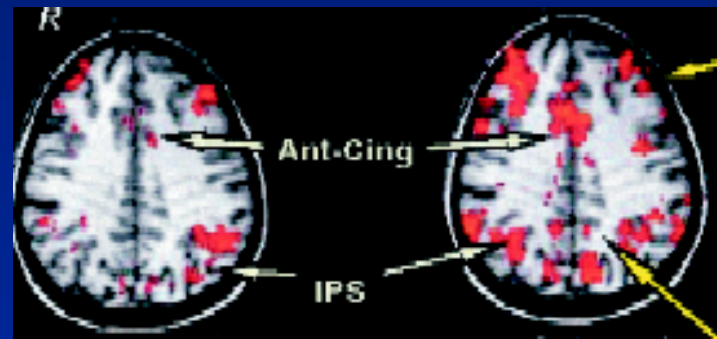


Anticipating Pain

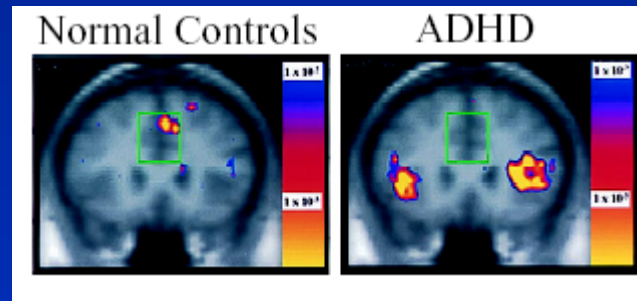
Differences in Cingulate Activation

Autism

Controls



Following Visual Target

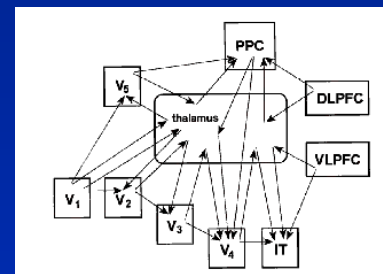
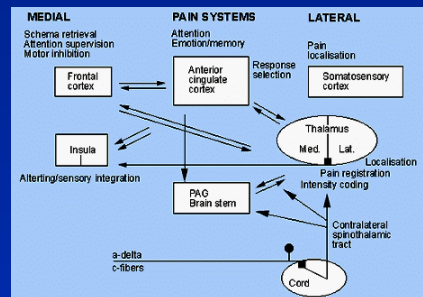
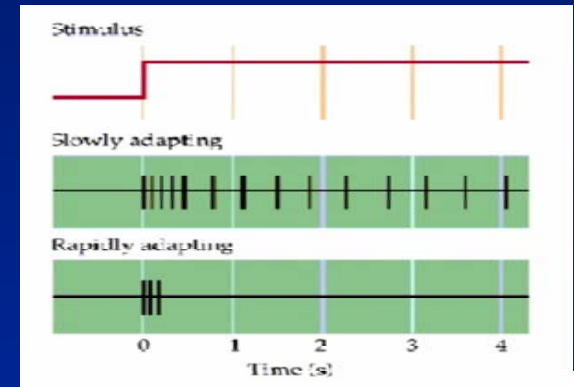
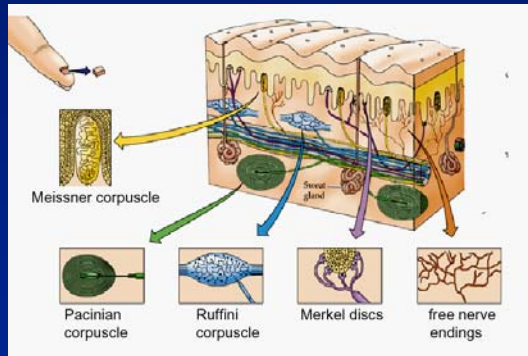


Stroop

BLUE	GREEN	YELLOW
PINK	RED	ORANGE
GREY	BLACK	PURPLE
TAN	WHITE	BROWN

(Sweeney, U Pittsburgh; Biederman, Harvard)

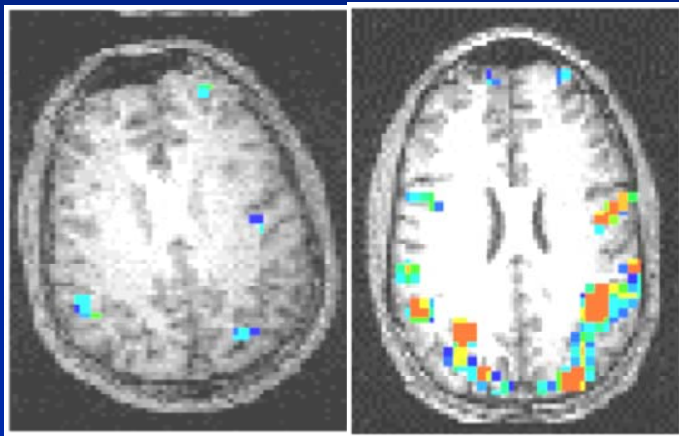
Complex Regulation of Sensory Perception



Or why DSI is good one day, but bad another...

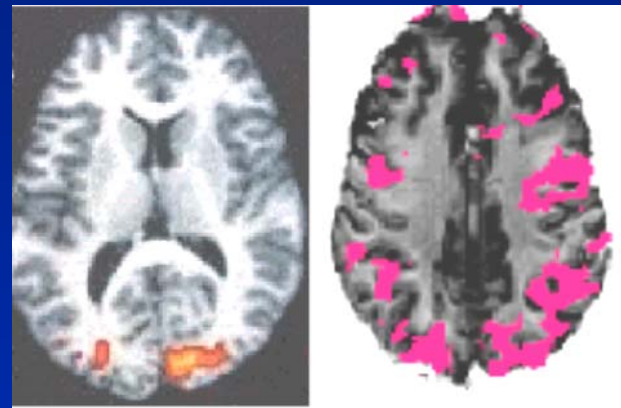
stimulus processing all levels, bottom-up, top-down,
intrinsic activity, location, feedback, emotion, attention

Sensing Extensively Activates Brain



Non-Musician

Musician

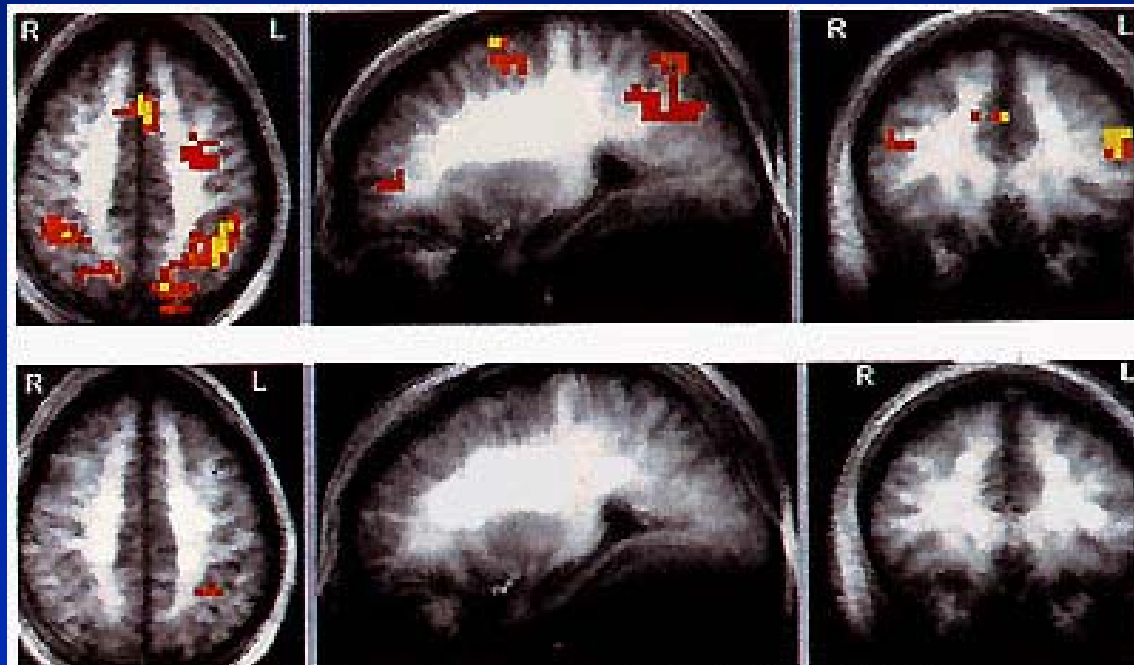


Seeing
a Word

Visual
Imagination

(U Cincinnati; Berninger, UW; Hirsch, Sloan-Kettering)

The Exhausted Brain



Control

Sleep
Deprived

Drummond, UCSD

Math Test without a Good Night's Sleep

Calming & Organizing Strategies For Sensory-Related Hyperarousal

- deep pressure (proprioceptive)
- rhythmic rocking, swinging...

Tactile Situation Awareness System
For 'Out-of-Sync' Pilots



Proprioceptive Stimulus for Spatial Disorientation



Solutions for Sensory Integration

teachers occupational therapists

parents

psychologists

speech therapists

neuroscientists

audiologists pediatricians

children

neurologists

physical therapists

neuropsychologists

vision therapists



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