Functional MRI: Future at NIH

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Section on Functional Imaging Methods

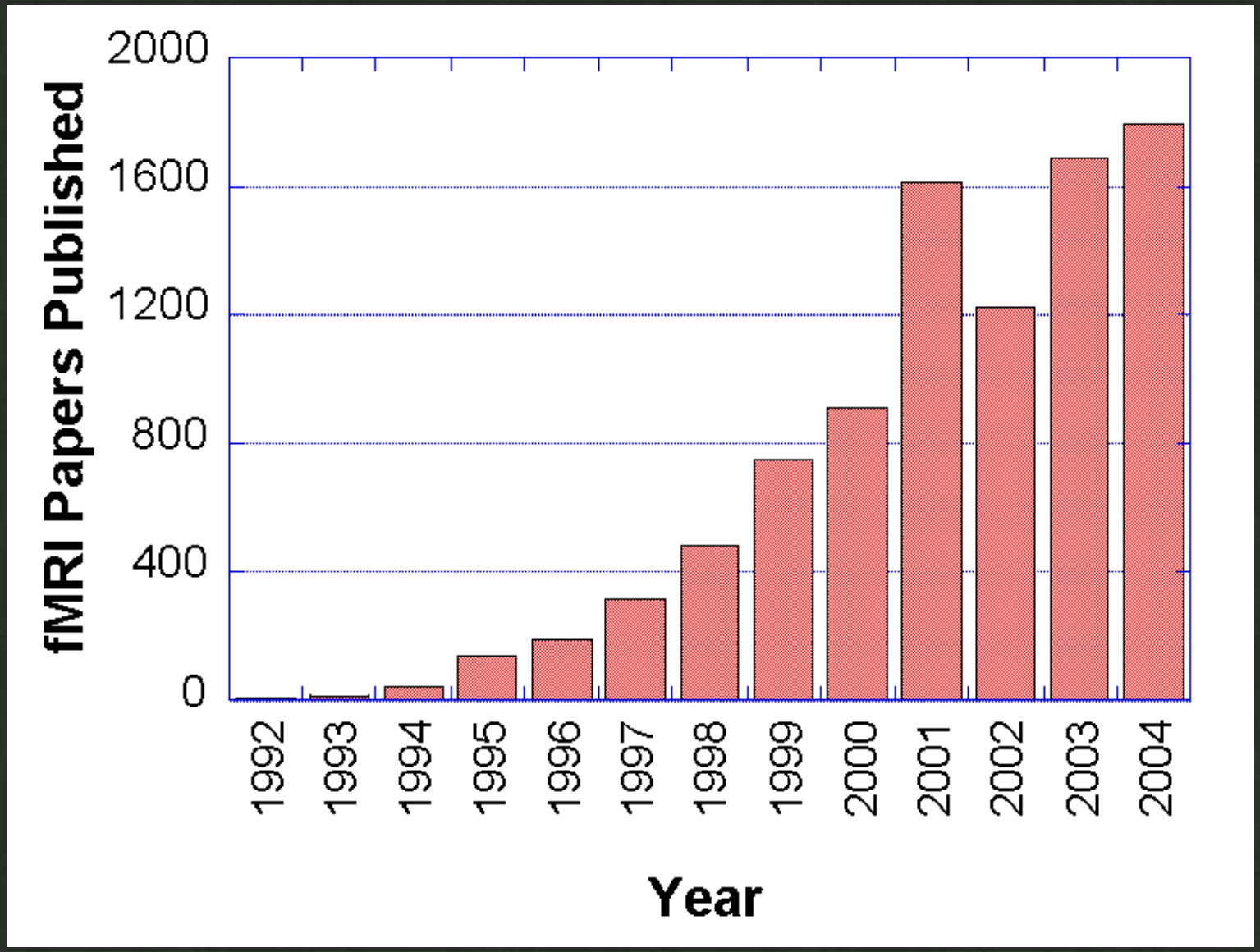
http://fim.nimh.nih.gov

Laboratory of Brain and Cognition

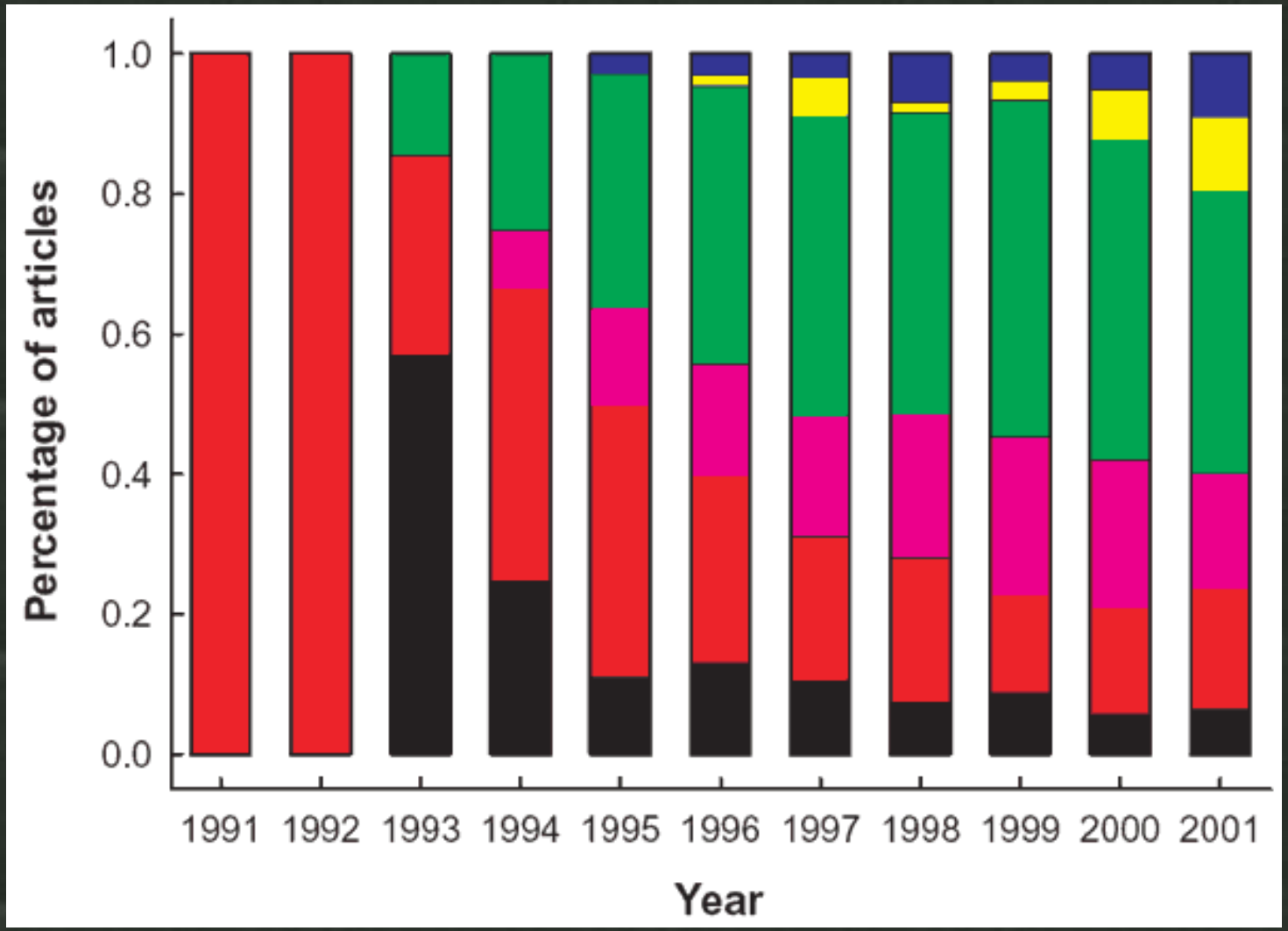
&

Functional MRI Facility

http://fmrif.nimh.nih.gov



"fMRI" or "functional MRI"



Motor (black)
Primary Sensory (red)
Integrative Sensory (violet)
Basic Cognition (green)
High-Order Cognition (yellow)
Emotion (blue)

J. Illes, M. P. Kirschen, J. D. E. Gabrielli,
Nature Neuroscience, 6 (3)m p.205

Uses

Understanding normal brain organization and changes
- -networks involved with specific tasks (low to high level processing)
- -changes over time (seconds to years)
- -correlates of behavior (response accuracy, performance changes…)

Clinical research
- -correlates of activated networks to clinical populations
- -presurgical mapping

Future Uses

Complementary use for clinical diagnosis
- -utilization of clinical research results
- -prediction of pathology

Clinical treatment and assessment
- -therapy, rehabilitation, biofeedback
- -epileptic foci mapping
- -drug effects

Non clinical uses
- -complementary use with behavioral, anatomical, other modality results
- -lie detection
- -prediction of behavior tendencies
- -brain/computer interface

Technology

Coil arrays
Higher field strength
Higher resolution

Methodology

"Resting state"
Fluctuation assessment
Multi-modal integration
Pattern classification
Novel Functional Contrasts

Interpretation

Fluctuations
Dynamics
Cross - modal comparison

Applications

Basic Neuroscience
Behavior correlation/prediction
Pathology correlation

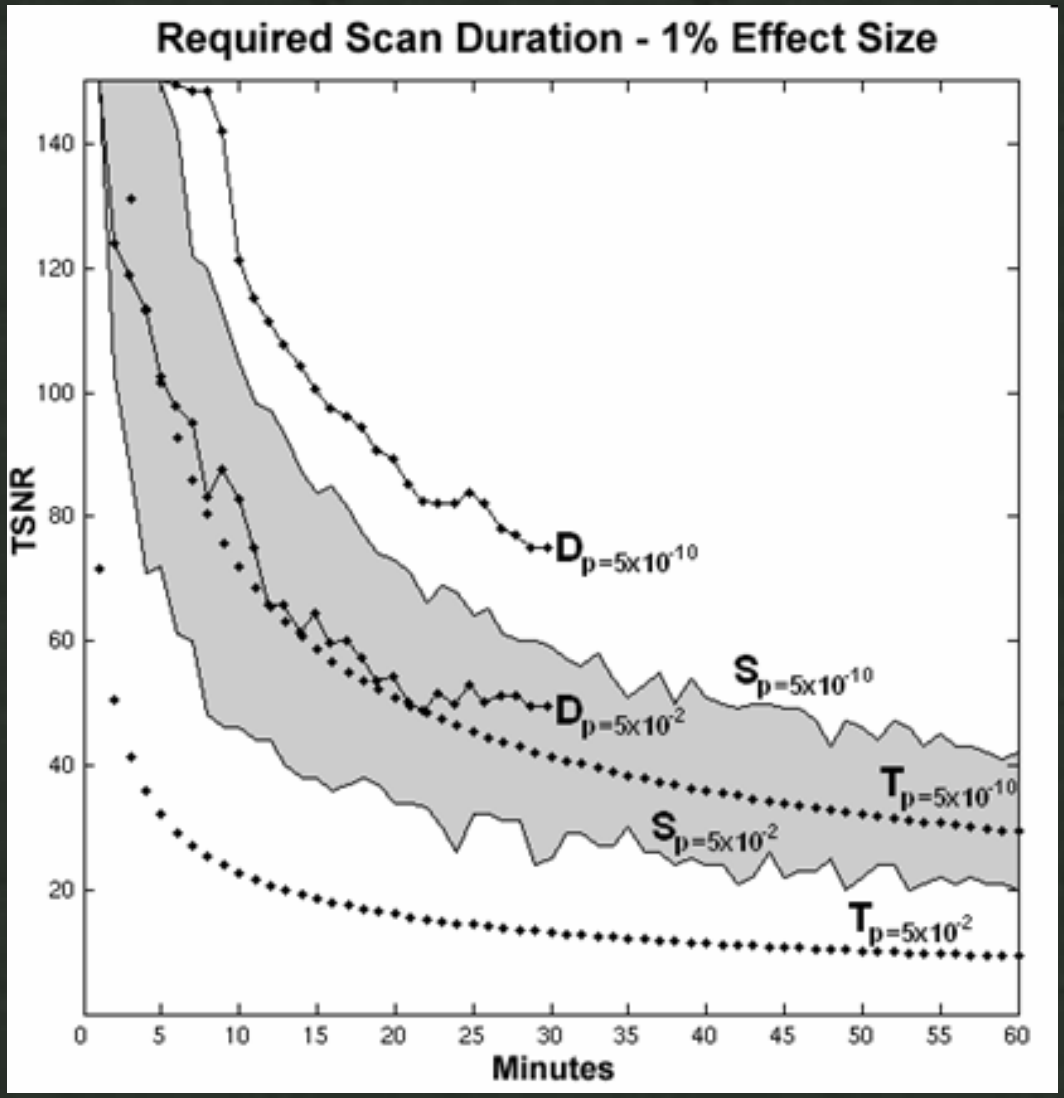
CRADA: fMRI

Goals:

- Single shot voxel volume = 1 to 1.5 mm^2
- Embedded (simultaneous) contrasts at high res.:
  - -volume, BOLD, flow, diffusion
- Eliminate signal dropout (better shimming)

Applications:

- High spatial frequency information and simultaneous multiple contrast information is novel and could increase clinical utility of fMRI.



Reasons for higher SNR

-Shorter scan duration
-Higher Resolution
-More subtle comparisons

Murphy et al.

Experimental Comparison of Signal-to-Noise Between 16 and 8 Element Receive-Only Brain Gapped Array Coils and Birdcage Head Coil at 3 Tesla.

J. Bodurka[1], J. Duyn[2], L. Talagala[3], P. Bandettini[1,4]

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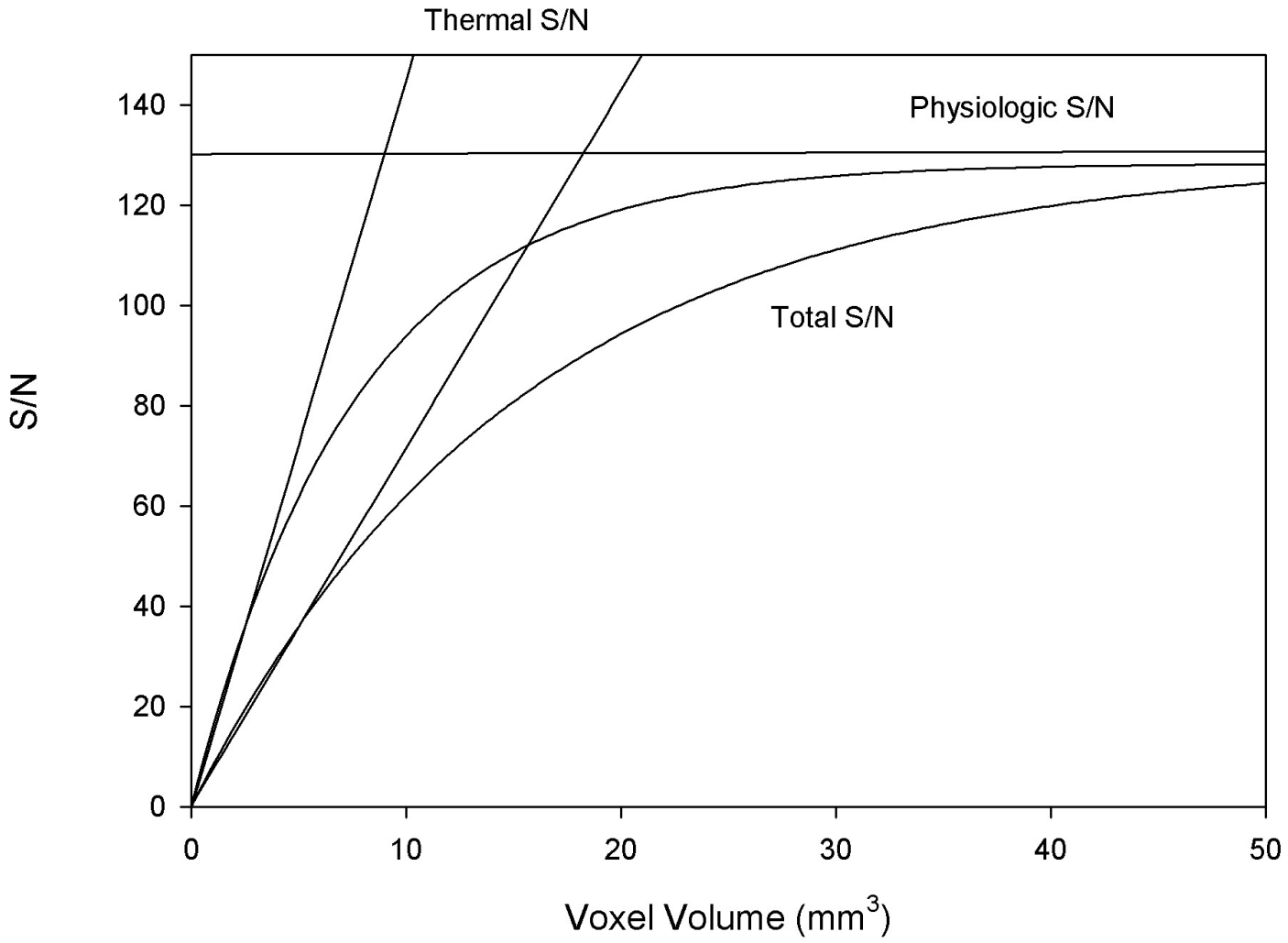
Table1	GRE		SE		EPI		GRE+SE+EPI	
(N=3)	R2=coil2/coil1	R3=coil3/coil1	R2	R3	R2	R3	R2	R3
bROI	2.7 +/- 0.2	2.8 +/- 0.1	2.0 +/- 0.3	2.4 +/- 0.1	2.8 +/- 0.3	3.0 +/- 0.2	2.5 +/- 0.4	2.7 +/- 0.3
cROI	1.5 +/- 0.1	1.6 +/- 0.1	1.5 +/- 0.2	1.7 +/- 0.1	1.7 +/- 0.2	2.0 +/- 0.1	1.6 +/- 0.1	1.8 +/- 0.2
pcROI	5.2 +/- 0.2	5.7 +/- 0.6	4.9 +/- 0.7	5.8 +/- 0.3	4.4 +/- 0.3	5.6 +/- 0.4	4.8 +/- 0.4	5.7 +/- 0.1

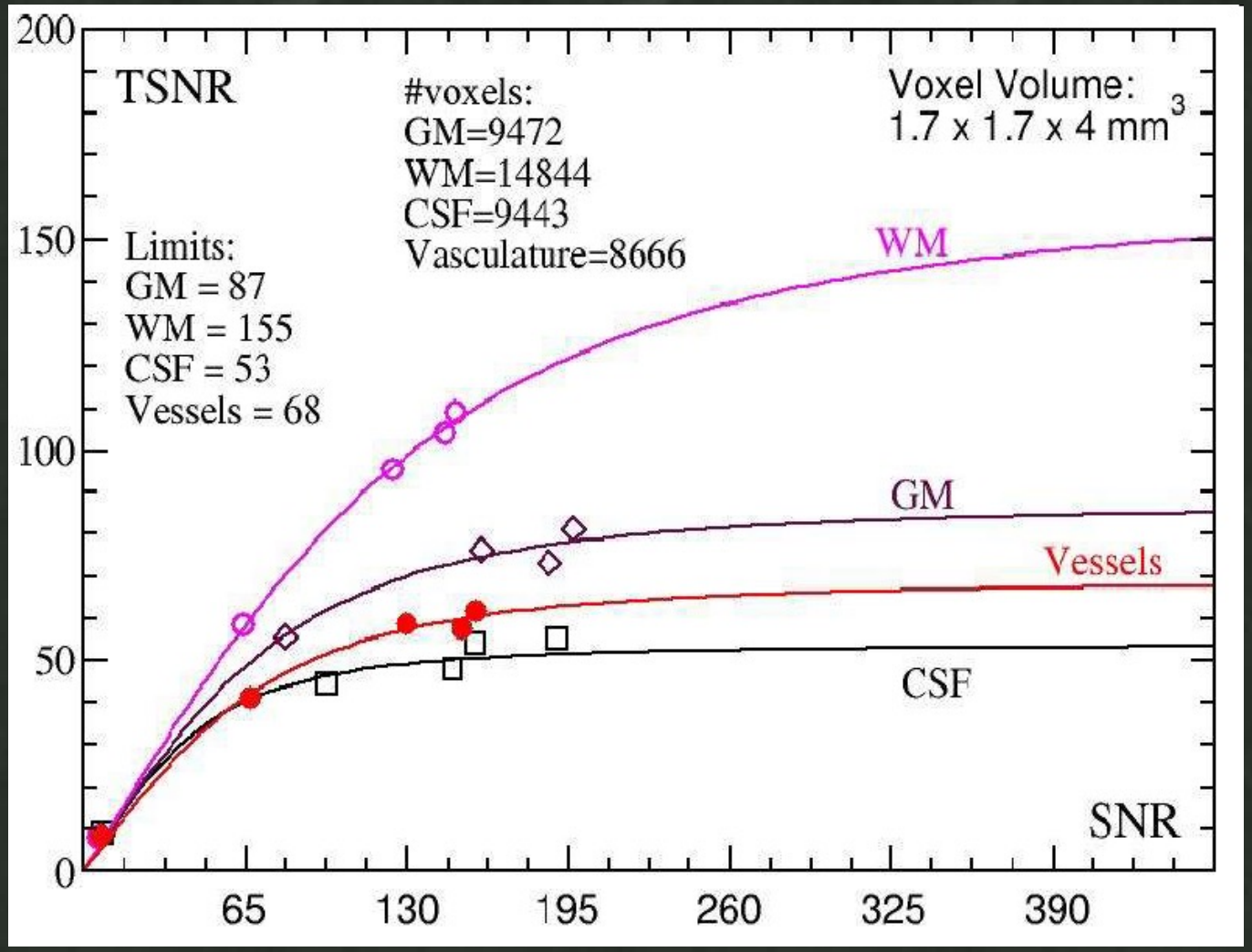
Increasing number of array elements from 8 to 16 results in SNR gains of 10%, 13% and 18% in the whole brain, brain center and periphery, respectively.

coil1 coil2 coil3 coil volumes: V1>V3>V2

Simulated gains in TNSR with doubling sensitivity

Temporal SNR




TSNR
#voxels:
GM=9472
WM=14844
CSF=9443
Vasculature=8666
Voxel Volume:
1.7 x 1.7 x 4 mm3
Limits:
GM = 87
WM = 155
CSF = 53
Vessels = 68
WM
GM
Vessels
CSF
SNR
200
150
100
50
0
65
130
195
260
325
390

J. Bodurka

Neuron, Vol. 35, 975–987, August 29, 2002, Copyright ©2002 by Cell Press

Neural Correlates of Visual Working Memory: fMRI Amplitude Predicts Task Performance

Luiz Pessoa,[1] Eva Gutierrez, Peter A. Bandettini, and Leslie G. Ungerleider
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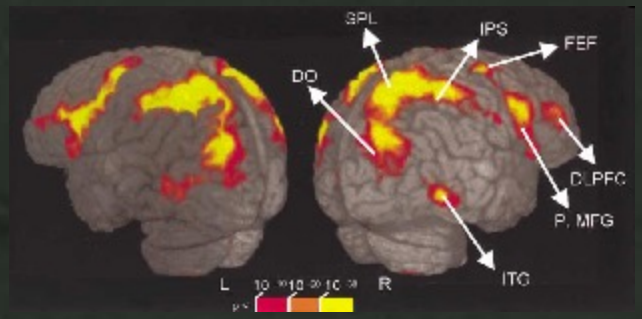
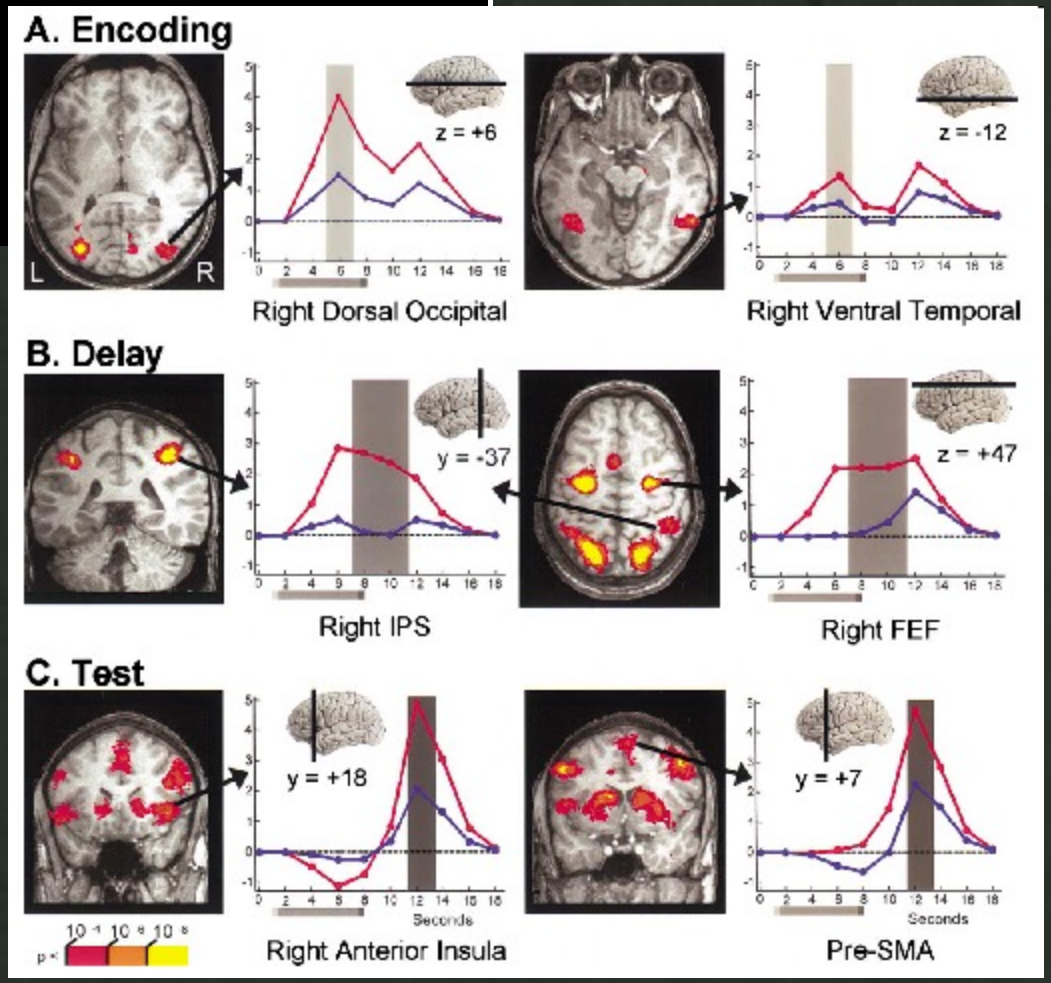
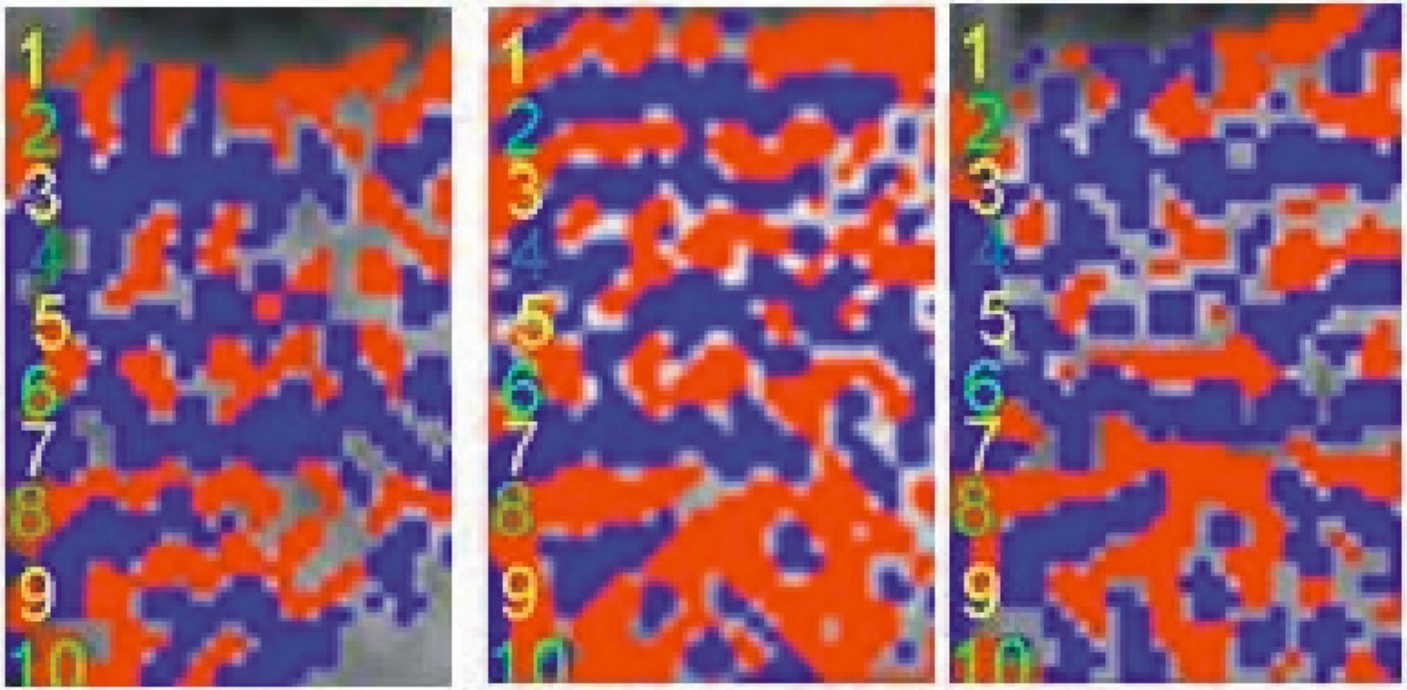




HSE-BOLD demonstration of ocular dominance columns

human, 7T, 0.5×0.5×3 mm^3



day 1 **day 2** **day 3**

Yacoub et al: differential maps contrasting stimulation of the left and right eye

SNR improvements allow for high resolution fMRI

.com/natureneuroscience

Unraveling multisensory integration: patchy organization within human STS multisensory cortex

Michael S Beauchamp[1], Brenna D Argall[1], Jerzy Bodurka[2], Jeff H Duyn[3] & Alex Martin[1]

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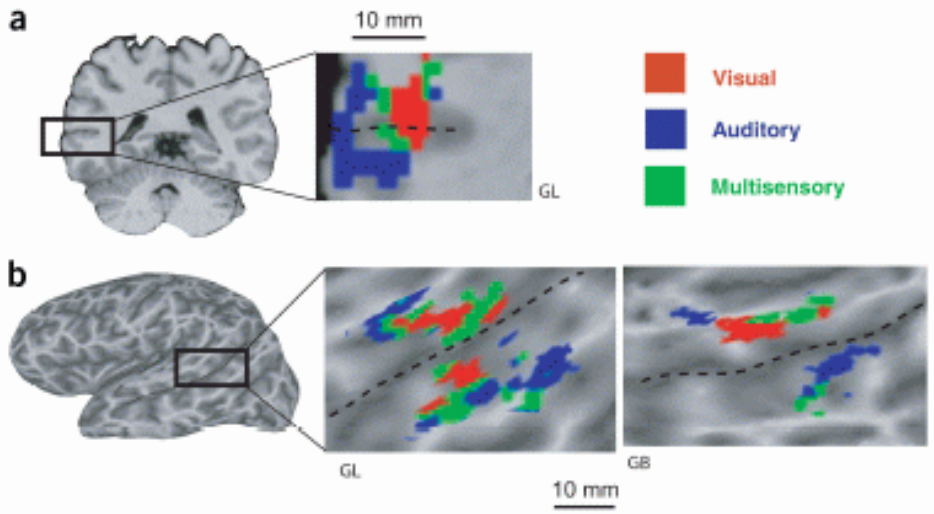
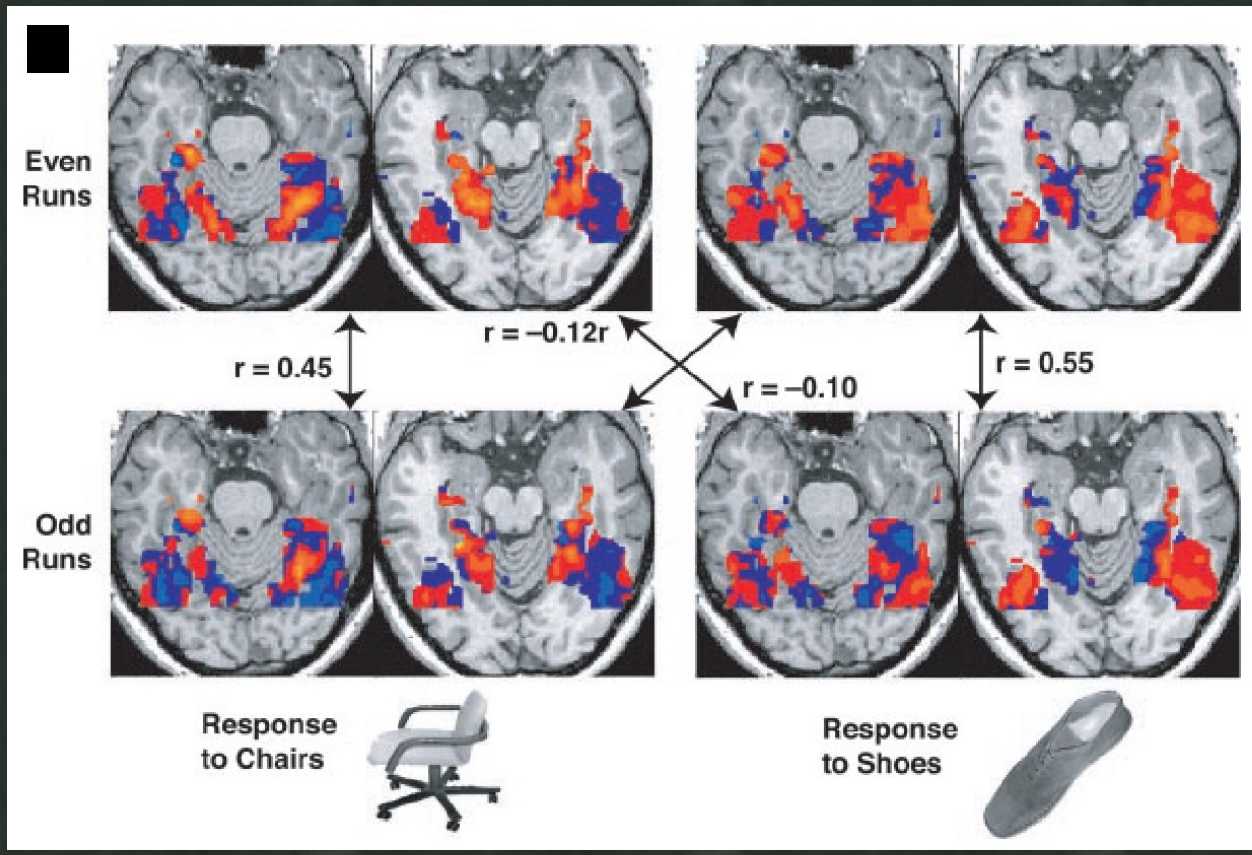


Ventral temporal category representations

- Object categories are associated with distributed representations in ventral temporal cortex

  - Present photos of common objects **blocked by category**.
  - Use fMRI to measure the pattern of high and low responses across large areas of ventral temporal cortex.
  - Observe **stable**, distributed "category representations"



Functional magnetic resonance imaging (fMRI) "brain reading": detecting and classifying distributed patterns of fMRI activity in human visual cortex

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[c] HyperVision, Inc., P.O. Box 158, Lexington, MA 02420, USA

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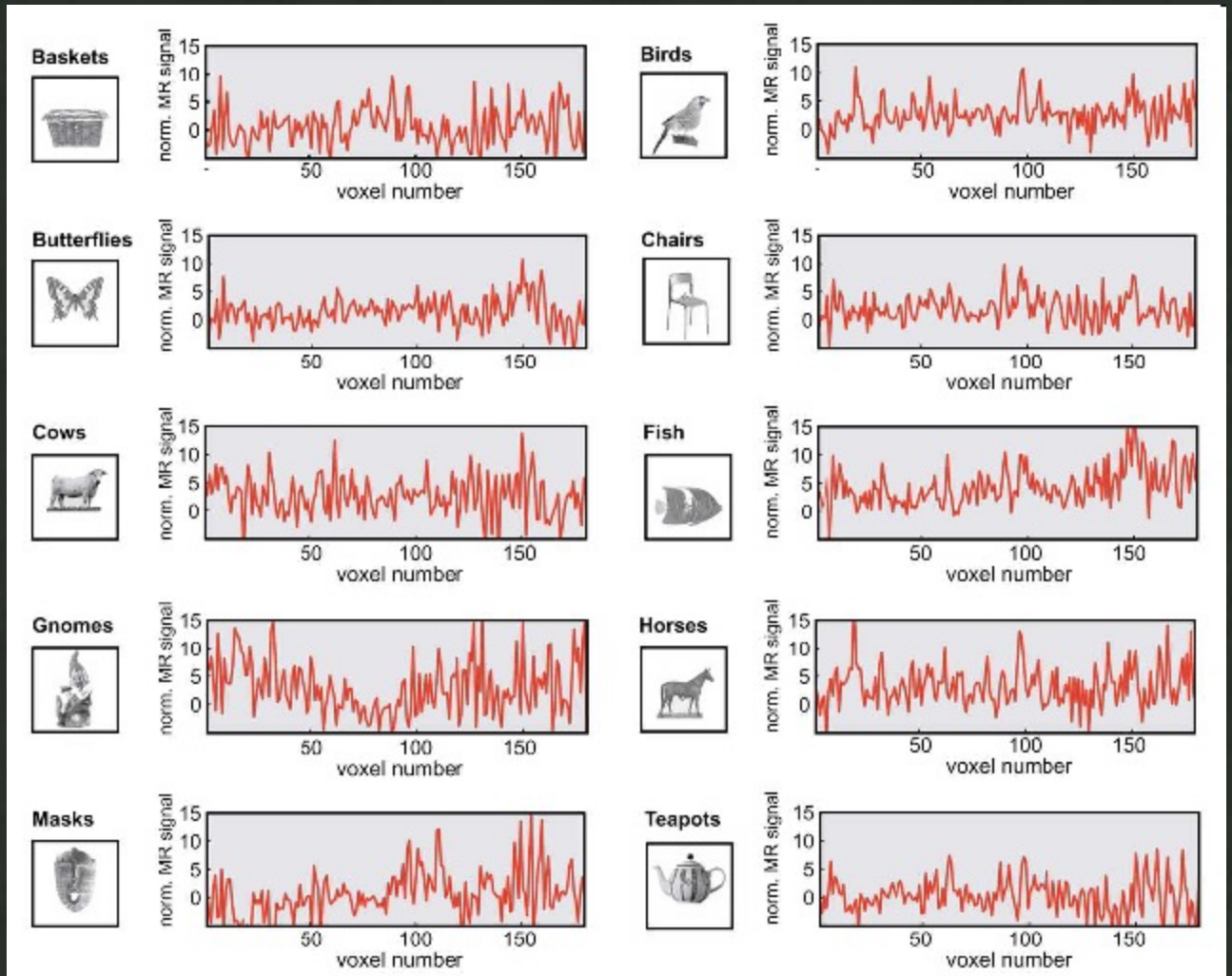
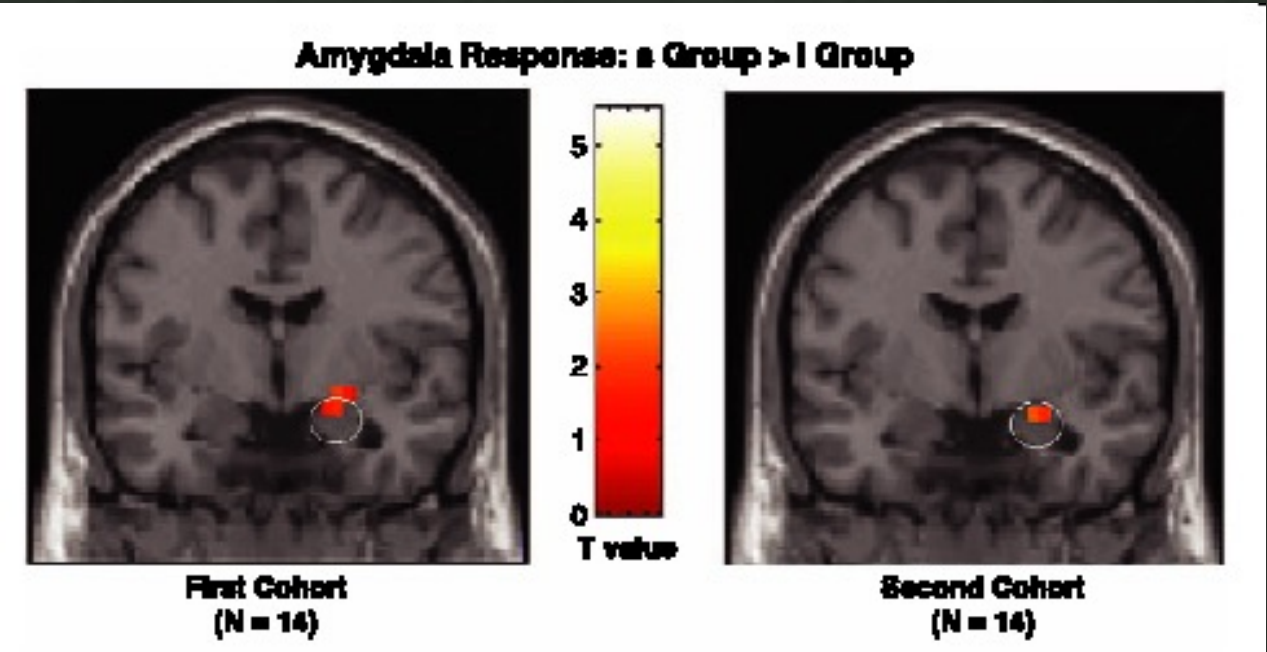


Comparison of two groups of *normal* individuals with differences in the Serotonin Transporter Gene

Serotonin Transporter Genetic Variation and the Response of the Human Amygdala

Ahmad R. Hariri,[1] Venkata S. Mattay,[1] Alessandro Tessitore,[1] Bhaskar Kolachana,[1] Francesco Fera,[1] David Goldman,[2] Michael F. Egan,[1] Daniel R. Weinberger[1]*



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