Neurocognitive Foundations for the Learning Sciences

Sashank Varma
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“The Cola Area”
Apple triggers 'religious' reaction in fans' brains, report says

By Mark Milian, CNN
May 19, 2011 6:33 p.m. EDT | Filed under: Gaming & Gadgets

At product launches, Apple store employees cheer for the first customers to buy the company's latest gadgets.
“The Love Area”
American Physiological Society
A new study suggests that an area of the brain known as the caudate is associated with passion.

What Brain Scans Can Tell Us About Marriage

Watching New Love as It Sears the Brain
By BENEDICT CAREY
Published: May 31, 2003
Neuro(cognitive) Topics

• Mathematics
• Language and embodiment
• Social processing
• Affective processing

• Learning
  • Scientific reasoning
  • Intelligence
  • Motivation and reward
  • Moral reasoning
  • Media and the arts
Mathematics Across Contexts

Butterworth et al. (2011)
Mock Scanner
Arithmetic Across Development

Decreasing w/ Development

Increasing w/ Development

Rivera et al. (2005)
Arithmetic Across Individuals

Grabner et al. (2007)
Arithmetic Across Cultures

English Speakers

Chinese Speakers

Broca, Wernicke; PMA, SMA

Tang et al. (2006)
The Language Network (Classical)
Meta-Analysis of fMRI Studies

Vigneau et al. (2006); Seurat (1989) *La Parade*
White Matter Tracts, DTI, and Fiber Tracking

Hagmann et al. (2008)
Network Connectivity Predicts Individual Differences

Beaulieu et al. (2005)
Network Connectivity Predicts Individual Differences

Beaulieu et al. (2005)
Mirror Neurons in Monkeys

Iacoboni & Dapretto (2006)
Mirror Neurons in Monkeys and Humans

Rizzolatti & Arbib (1998)
Motor Representations of Sentences

Leg sentence: 
I kick the ball.

Arm sentence: 
I grasp a knife.

Face sentence: 
I bite an apple.

Tettamanti et al. (2005); Pulvermuller et al. (2005)
The Social Network

Burnett et al. (2011)
Self-Perception and mPFC

Kelley et al. (2002)
Close Other vs. Far Other and mPFC

Ventral mPFC

Mean parameter estimate

self liberal  self conservative

similar to liberal  dissimilar from liberal

Mitchell et al. (2006)
Theory of Mind and R. TPJ

mPFC

L. TPJ  R. TPJ

Saxe & Wexler (2005)
Empathy and mPFC

Ames et al. (2008)
Biological Movement and STS

Allison et al. (2000)
Walking and R. STS

Pelphrey et al. (2003)
Grasping and R. pSTS

Pelphrey et al. (2004)
Intentional Eye Gaze and R. pSTS
Mutual Eye Gaze and R. pSTS

Pelphrey et al. (2004b)
Basic Facial Emotions

Ekman & Friesen (1971)
Affect in the Brain

Phan et al. (2002)
Amygdala Lesions and Facial Fear Production

Adolphs et al. (1995)
Amygdala and Memory for Emotion

Cahill et al. (1996); Hamann et al. (1999)
Stereotypes: Automatic and Controlled Processing

Cunningham et al. (2004)
Mathematics Learning and R. IPS

sample: mathematicians; R. IPS

Aydin et al. (2007)
Spatial Learning and HIP

Maguire et al. (2000)
Music Learning and L. IFG

Sluming et al. (2002)
Science Learning and R. HIP

Draganski et al. (2006)
Language Instruction and L. SMG/AG

Typical

Before Instruction

Impaired

After Instruction

Eden et al. (2004)
Visual Learning and Effective Connectivity

Büchel et al. (1999)
Neurocognitive Foundations for the Learning Sciences

- A new perspective on psychology and education
- Learning / training / instruction / remediation
- Development
- Individual differences
- Group differences
- Revealing surprises
- Revealing undetected differences