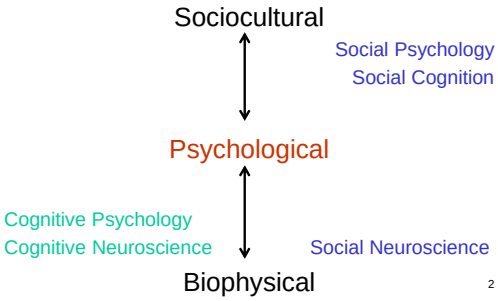
Social-Cognitive Neuroscience

Fall 2015

1

Levels of Analysis in the Behavioral Sciences



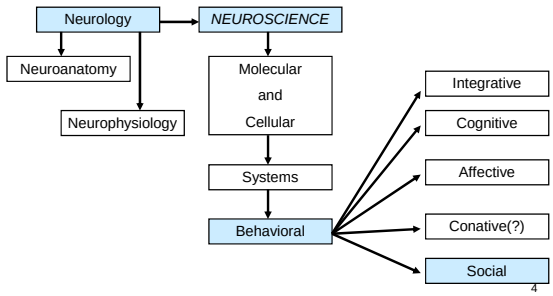
2

On Terminology

- Physiological Psychology (1870s)
  - Animal Research
- Neuropsychology (1955, 1963)
  - Behavioral Analysis
  - Brain Insult, Injury, or Disease
- Neuroscience (1963)
  - Interdisciplinary
    - Molecular/Cellular
    - Systems
    - Behavioral

3

The Evolution of Social Neuroscience



4

Physiological Psychology

Morgan (1943), p. 1

"[P]hysiological psychology… [is] the study of the relation between the organism's physiological processes and its behavior; or, since behavior is the outcome of physiological events, we may say that physiological psychology is the study of the *physiological mechanisms of behavior*."

5

Physiological Psychology

Teitelbaum (1967), p. 2

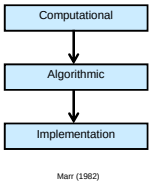
"Physiological psychology… is a *method of approach* to the understanding of behavior as well as a *set of principles* that relate the function and organization of the nervous system to the phenomena of behavior."

6

An Agenda for *The Cognitive Neurosciences*, 1e

Gazzaniga (1995), p. xiii

"At some point in the future, cognitive neuroscience will be able to describe the algorithms that drive structural neural elements into the physiological activity that results in perception, cognition, and perhaps even consciousness."

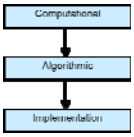


Marr (1982)

7

Another Take on Levels of Analysis

Marr (1982)



- Computational
  - Computations Relating Inputs to Outputs
- Algorithmic Level
  - How that Computation is Executed at the Level of Information-Processing
- Implementational Level
  - How Algorithm is Embodied as a Physical Process

8

An Agenda for *The Cognitive Neurosciences*, 3e

Gazzaniga (2004), p. 1213

"Cognitive neuroscience attempts to understand the biological underpinnings of complex cognition", [and to] "offer mechanistic analysis of cognition from gene expression up to cognition."

9

Methods for Social-Cognitive Neuroscience

- Traditional Neuropsychology
  - Social Cognitive Effects of Brain Lesions
- Brain Imaging
  - Functional Magnetic Resonance Imaging
  - Event-Related Potentials
  - "Single-Cell" Recording
- Brain Stimulation
  - Electrical Stimulation
  - Transcranial Magnetic Stimulation
  - Transcranial Electrical Stimulation

10

An Agenda for Social-Cognitive Neuroscience

Fiske & Taylor (2013), p. 20-22

"Brains Matter…

"Taken together, these measures open new doors into the life of the social mind.

"For social cognition researchers, the possibilities also allow dissociating distinct social cognitive processes on the basis of distinct neuroscientific responses."

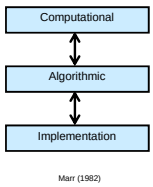
11

The Rhetoric of Constraint in Cognitive Neuroscience

Gazzaniga et al. (1998), p. xiii

"The disciplines of cognitive psychology, behavioral neurology, and neuroscience now feed off each other, contributing a new view to the understanding of the mechanisms of the human mind."

"Any computational theory must be sensitive to the real biology of the nervous system, constrained by how the brain actually works."



Marr (1982)

12

"Dry Mind" vs. "Wet Mind"

Kosslyn & Koenig (1992), p. 4

"Mental events can be examined without regard for the brain. This approach is like understanding the properties and uses of a building independent of the materials used to construct it; the shapes and functions of rooms, windows, arches, and so forth can be discussed without reference to whether the building is made of wood, brick, or stone. We call this approach *Dry Mind*.

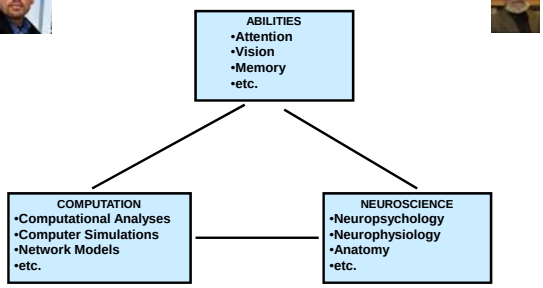
In contrast, we call the approach of cognitive neuroscience *Wet Mind*. This approach capitalizes on the idea that *the mind is what the brain does*: a description of mental events is a description of brain function, and facts about the brain are needed to characterize these events….

Although the nature of the materials restricts the kinds of buildings that can be built, it does not characterize their function or design. Nevertheless, the kinds of designs that are feasible depend on the nature of the materials. Skyscrapers cannot be built with only boards and nails, and minds do not arise from just any substrate."

13

The Cognitive Neuroscience Triangle

Ochsner & Kosslyn (1999), p. 324, 325



"Explanations [of cognitive abilities] rest on conceptions of how the brain computes."

14

The Rhetoric of Constraint in Social-Cognitive Neuroscience

"Knowledge of the body and brain can usefully constrain and inspire concepts and theories of psychological function...."

Cacioppo & Berntson (1992), p. 1025

"Cognitive psychology underwent [a] transformation as data about the brain began to be used to constrain theories about the cognitive processes underlying memory, attention, and vision, among other topics."

Ochsner & Lieberman (2001), p. 726

15

"Rethinking Social Intelligence"

Goleman (2006), p. 324

The new neuroscientific findings on social life have the potential to reinvigorate the social and behavioral sciences. The basic assumptions of economics, for example, have been challenged by the emerging "neuro-economics", which studies the brain during decision-making. Its findings have shaken standard thinking in economics….

A rethinking of social intelligence should more fully reflect the operation of the social brain, so adding often-ignored capacities that nonetheless matter immensely for our relationships.

16

Explaining Hippocampal Amnesia

- "Learning"
- Short-Term vs. Long-Term
- Encoding vs. Retrieval
- Shallow vs. Deep Processing
- Procedural vs. Declarative Memory
- Episodic vs. Semantic Memory
- Explicit vs. Implicit Memory
- Relational vs. Non-Relational Memory

17

Psychology and Neuroscience

Kihlstrom (2010)

- "Psychology without neuroscience is still the science of mental life.
- "Neuroscience without psychology is just the science of neurons."

18

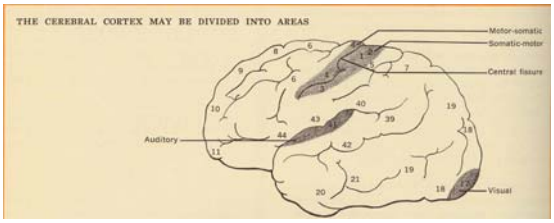
Two Views of Brain Function

- Brain as General-Purpose Information-Processor
  - – Learning
  - – Associationism
- Doctrine of Functional Specialization
  - – Localization of Function
  - – Brain Systems

19

Functional Organization of the Cortex

Morgan & King (1966), Fig. 20.1

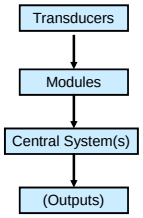


"The extreme frontal area of the cortex, sometimes called the prefrontal cortex, Is a region about which much has been claimed, but little has been proved."

20

The Doctrine of Modularity

Fodor (1983)



- Domain-Specific
- Mandatory
- Limited Central Access
- Fast
- Informationally Encapsulated
- Shallow Outputs
- Characteristic Breakdown
- Characteristic Development
- **Fixed Neural Architecture**

21

Examples of Modularity

- Language
- Visual Perception
- Motor Behavior
  - – Including Speech
- Social Cognition?
  - – And other aspects of social interaction

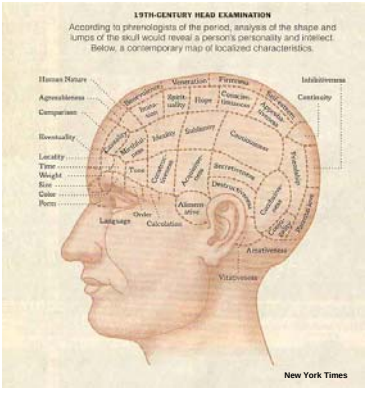
22

The Phrenological Faculties

Spurzheim (1834)

AFFECTIVE FACULTIES		INTELLECTUAL FACULTIES	
PROPENSITIES	SENTIMENTS	PERCEPTIVE	REFLECTIVE
? Desire to live	10 Cautiousness	22 Individuality	34 Comparison
* Alimentiveness	11 Approbativeness	23 Configuration	35 Causality
1 Destructiveness	12 Self-Esteem	24 Size	
2 Amativeness	13 Benevolence	25 Weight and Resistance	
3 Philoprogenitiveness	14 Reverence	26 Coloring	
4 Adhesiveness	15 Firmness	27 Locality	
5 Inhabitiveness	16 Conscientiousness	28 Order	
6 Combativeness	17 Hope	29 Calculation	
7 Secretiveness	18 Marvelousness	30 Eventuality	
8 Acquisitiveness	19 Ideality	31 Time	
9 Constructiveness	20 Mirthfulness	32 Tune	
	21 Imitation	33 Language	

23



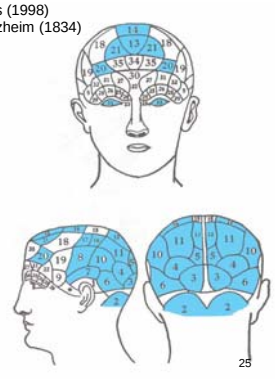
A Classic Phrenological Head

24

Social Faculties in Phrenology

Gross (1998)
after Spurzheim (1834)

1. Destructiveness
2. Amativeness
3. Philoprogenitiveness
4. Adhesiveness
5. Inhabitiveness
6. Combativeness
7. Secretiveness
8. Acquisitiveness
10. Cautiousness
11. Approbativeness
12. Self-Esteem
13. Benevolence
14. Veneration
16. Conscientiousness
17. Hope
20. Mirthfulness
21. Imitativeness
22. Individuality
33. Language
35. Causality



25

Milestones in Functional Specialization

- Language Function
  - Broca (1860)
    - Motor (Expressive) Aphasia
  - Wernicke (1874)
    - Sensory (Receptive) Aphasia
- Personality and Social Interaction
  - Harlow (1848, 1850, 1868)
    - The Case of Phineas Gage

26

The Case of Phineas Gage

Harlow (1848, 1850, 1868; Macmillan (1986, 2000)

- Duttonville (Cavendish), Vermont
  - 4:30 PM, Wednesday, September 13, 1848
- Foreman on Railroad Construction Crew
  - Rutland & Burlington Railroad
  - Tamping Blasting Powder into Rock
    - 3'8" Long, 1-1/4" Diameter
- Treated by John Martyn Harlow
- Survived, Returned Home to Lebanon, N.H.
  - 12 Weeks After Near-Total Frontal Lobotomy

27

Phineas Gage

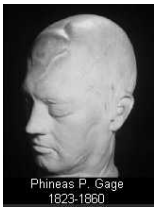
Macmillan (2000)

Mr Joseph Larkin Austin, eldest son of Mr Eleazer Austin, was found drowned near the south bridge in Salem. He is supposed he fell overboard between 2 and 3 o'clock in the morning, while fishing.

Horrible Accident.—As Phineas P. Gage, a foreman on the railroad in Cavendish, was yesterday engaged in tamkin for a blast, the powder exploded, carrying an iron instrument through his head an inch and a fourth in circumference, and three feet and eight inches in length, which he was using at the time. The iron entered on the side of his face, shattering the upper jaw, and passing back of the left eye, and out at the top of the head.

The most singular circumstance connected with this melancholy affair is, that he was alive at two o'clock this afternoon, and in full possession of his reason, and free from pain.—*Ludlow, Vt., Union.*

The chief of the Philadelphia doglillers, a black man named George Horsey, attempted to kill his wife. He broke into her room armed with a pistol and knife; she threw herself out of the second story window to escape, breaking her leg in the fall; he pursued her, and attacked and injured her severely. She was taken to the hospital. Horsey was fully committed for trial.



28

Illustrations from Macmillan (2000)

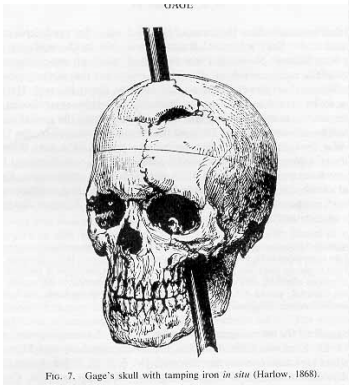


Fig. 7. Gage's skull with tamping iron *in situ* (Harlow, 1868).

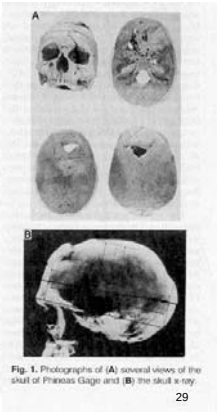


Fig. 1. Photographs of (A) several views of the skull of Phineas Gage and (B) the skull x-ray.

29

Harlow's Final Assessment of Gage

Harlow (1868), in Macmillan (2000)

The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities, seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of future operation, which are no sooner arranged than they are abandoned in turn for others appearing more feasible. A child in his intellectual capacity and manifestations, he has the animal passions of a strong man. Previous to his injury, though untrained in the schools, he possessed a well-balanced mind, and was looked upon by those who knew him as a shrewd, smart business man, very energetic and persistent in executing all his plans of operation. In this regard his mind was radically changed, so decidedly that his friends and acquaintances said he was "no longer Gage."

30

Gage Was "No longer Gage"

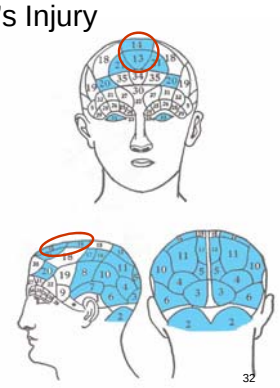
Harlow (1868)

Premorbid Personality	*Postmorbid Personality*
• Efficient, Capable	• Fitful
• Shrewd, Smart	• Capricious
• Energetic	• Impatient of Advice
• Persistent	• Obstinate
	• Lacking in Deference

31

Gage's Injury

1. Destructiveness
2. Amativeness
3. Philoprogenitiveness
4. Adhesiveness
5. Inhabitiveness
6. Combativeness
7. Secretiveness
8. Acquisitiveness
10. Cautiousness
11. Approbativeness
12. Self-Esteem
13. **Benevolence**
14. **Veneration**
16. Conscientiousness
17. Hope
20. Mirthfulness
21. Imitativeness
22. Individuality
33. Language
35. Causality



32

Immediate Aftermath

Harlow (1868), Macmillan (1986, 2000)

- Attempted to return to work, 1849
  - – First Epileptic Seizure
- Traveled Around New England 1849-1851
  - – Barnum's Museum (?)
- Livery Stable, Stagecoaching
  - – New England, 1851-1852
  - – Chile, 1852-1859
- San Francisco (1859)
  - – Farm Laborer
  - – Seizures Persisted

33

Later History of Phineas Gage

Harlow (1868), Macmillan (1986, 2000)

- Died May 21, 1860 (*Not* 1861)
  - – Buried at Lone Mountain Cemetery, Laurel Hill
- Exhumed 1867
  - – Skull Taken to Harvard Medical School, 1868
    - David Dustin Shattuck, Brother-in-Law
      - – Member of S.F. Board of Supervisors
  - – Brain Not Preserved
- Remains Removed to Colma
  - Cypress Abbey
    - – Laurel Hill Mound, Pioneer Monument

34

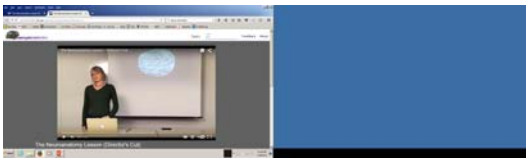
An Odd Kind of Fame

Macmillan (2000)

35

A Cute Introduction to the Doctrine of Modularity

http://nancysbraintalks.mit.edu/video/neuroanatomy-lesson-directors-cut



36

Theory of Multiple Intelligences

Gardner (1983)

- Linguistic
- Logical-Mathematical
- Spatial
- Musical
- Bodily-Kinesthetic
- Intrapersonal
  - – Ability to Gain Access to One's Own Internal, Emotional Life
- Interpersonal
  - – Ability to Notice and Make Distinctions Among Other Individuals

37

Methods for Identifying Multiple Intelligences

Gardner (1983)

- Identifiable Core Operations
  - – Impression-Formation, Causal Attribution
- Psychometrics
  - – Vineland Test of Social Maturity
- Experimental Tasks
  - – Detection of Deception
- Exceptional Cases
- Isolation by Brain Damage

38

Isolation by Brain Damage

- Impair Cognitive, Spare Social
  - – Alzheimer's Disease
  - – Down Syndrome
  - – The Case of Zazetsky (Luria, 1972)
- Impair Social/Emotional, Spare Cognitive
  - – The Case of Phineas Gage (Harlow, 1868)
  - – Pick's Disease
  - – Fronto-Temporal Dementia

39

Elements of Mindreading

Baron-Cohen (1995)

- Intentionality Detector
  - – Interpret Events in Terms of Goals/Desires
- Eye-Direction Detector
  - – Detects the Presence of Eyes
  - – Computes Direction of Gaze: "At Me" or Not
- Shared-Attention Mechanism
  - – Assumes Relation Between Knowledge, Seeing
- Theory-of-Mind Mechanism
  - – Infer Another's Mental States from Behavior

40

Functions of the Social Brain

Goleman (2006)

Social Awareness

- Primal Empathy
- Empathic Accuracy
- Listening
- Social Cognition
- etc.

Social Facility

(Relationship Management)

- Interaction Synchrony
- Self-Presentation
- Influence
- Concern for Others
- etc.

41

A *Faculty* of Social Cognition?

Jackendoff (1992, 1994)

- Possible Central Modules
  - – Conceptual Structure
  - – Spatial Cognition
  - – Body Representation
  - – Music?
  - – Social Cognition
    - Who is it?
    - What is this person's relation to me and others?

42

Arguments for a Faculty of Social Cognition

- Domain Specificity
  - Social Organization Unrelated to Perception
- Specialized Input Capacities
  - Face and Voice Recognition
  - Affect Detection
  - Intentionality
- Developmental Priority
  - Proper Names
    - Animate vs. Inanimate Objects

43

Arguments for a Faculty of Social Cognition

- Universality of Cultural Parameters
  - Kinship
  - Ingroup-Outgroup Distinctions
  - Social Dominance
  - Ownership, Property Rights
  - Social Roles
  - Group Rituals
- Evolution
  - Mammalian Social Structure
    - Primates

44

Modules for Social Cognition

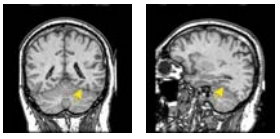
Jackendoff (1992, 1994, 2007)

Specialized Input Capacities	*Universal Cultural Parameters*
Face Recognition	Kinship
Voice Recognition	Ingroup vs. Outgroup
Affect Detection	Social Dominance
Intentionality Detection	Ownership, Property Rights
Developmental Priority	Social Roles
Animate vs. Inanimate	Group Rituals
Proper Names	

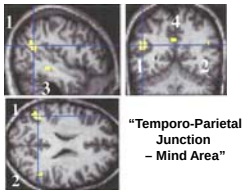
45

Some Social Modules in the Brain

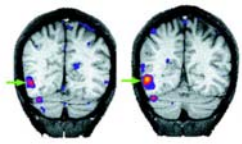
Kanwisher et al. (1997); Downing et al. (2001); Saxe & Kanwisher (2003)



"Fusiform Face Area"



"Temporo-Parietal Junction – Mind Area"



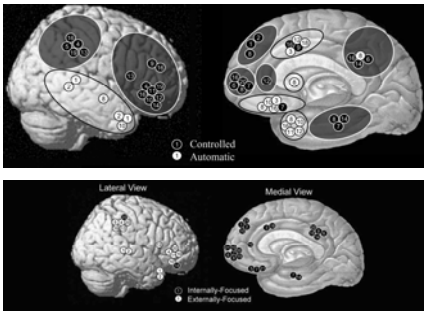
"Extrastriate Body Area"

46

Topography of the Social Mind

After Lieberman (2007), Figures 2 and 3

1. Theory of Mind
2. Dispositional Attribution
3. Empathy
4. Visual Self-Recognition
5. Agency Judgments
6. Self-Reflection
7. Autobiographical Memory
8. Self-Knowledge
9. Impulse Control
10. Reappraisal
11. Affect Labeling
12. Placebo Effects
13. Mirror Neuron System
14. Reflected Appraisals
15. Judging Similar Others
16. Attitude Processes
17. Social Connection
18. Social Rejection
19. Social Reasoning
20. Moral Decision-Making
21. Fairness and Trust Processes



47

The Face as a Social Stimulus

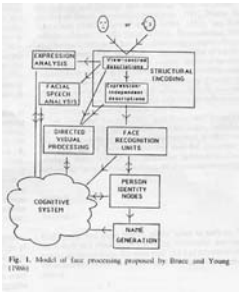
- Universal Social Stimulus
  - Obvious Evolutionary Significance
- Contact Between Infant, Caregiver
  - Beginnings of Attachment
- Face in Social Interaction
  - Physical Attraction
  - Communicate Emotion
  - Cues to Deception

48

Aspects of Face Perception

Bruce & Young (1986).

- Structural Description
  - Viewpoint-Centered
  - Expression-Independent
- Expression Analysis
- Facial Speech Analysis
- Face Recognition
- Name Generation



Dissociations Among Neurological Patients

Analogous to Dyslexias

49

Visual Object Agnosia

- Can Describe an Object
- But Cannot…
  - Name Object
  - Recognize Object as Familiar
  - Demonstrate How Object is Used

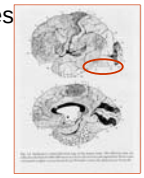
"Normal Percept Stripped of Meaning"

50

Prosopagnosia

Bodamer (1947)

- Specific Deficit in Recognizing Faces
  - Not in Perceiving, Describing Faces
  - Inability to Put Name to Face
- "Pure"
  - Specific to Face



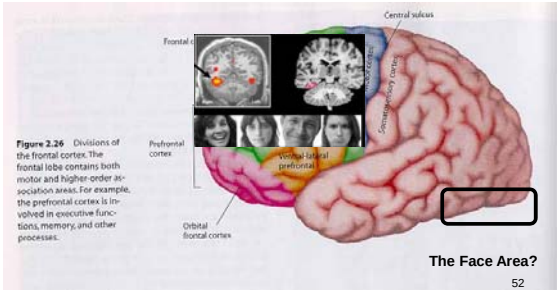
- Bilateral Damage, Visual Association Cortex
  - Occipital, Temporal Lobes
    - Brodmann's Areas 18, 19, 37
  - The "Face Area"?

51

The Fusiform Face Area?

In Extra-Striate Cortex

Sergent et al. (1992); Kanwisher et al. (1997)



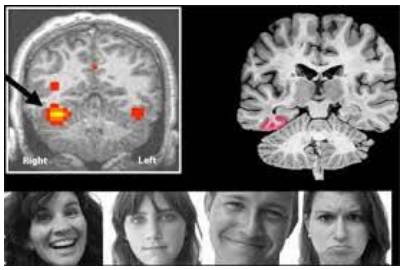
The Face Area?

52

Strong Modularity in Face Perception

Kanwisher (2000)

"[A] cognitive function with its own private piece of real estate in the brain"



53

What's This?

54

What's This?

55

What's This?

56

Who's This?

57

What's This?

58

Levels of Categorization

Gauthier (1998); Gauthier & Tarr (2000); Tarr & Gauthier (2000)

- Basic Object Level
  - "What is this?"

- Subordinate Level
  - "Who is this?"

59

Levels of Categorization

Gauthier (1998); Gauthier & Tarr (2000); Tarr & Gauthier (2000)

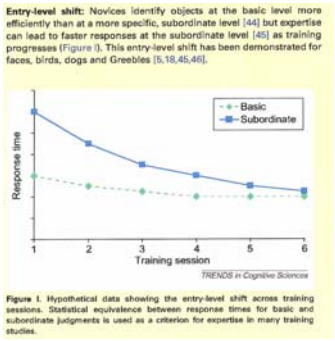
- Subordinate Object Level
  - "What is this?"

- Subordinate Level
  - "Who is this?"

60

The Entry-Level Shift

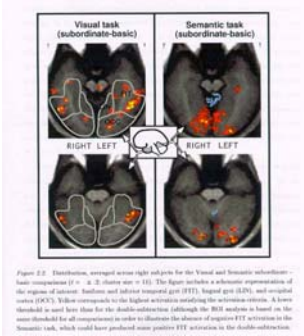
Bukach et al. (2006) after Rosch ((1976)



61

Is it a *Bird*? Is it a *Pelican*?

Gauthier et al. (1997)



62

Categorization and Expertise

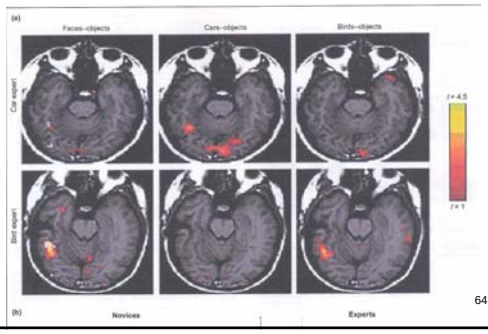
Bukach, Gauthier, & Tarr (2006)

- Expertise
  - Cars
  - Birds
- Expert Training
  - Greebles
  - Snowflakes
  - Fingerprints

63

Expertise and Categorization Level

Gauthier et al. (2000)



64

“Greeble” Stimulus Figures

Gauthier, Behrmann, & Tarr (1999), Exps. 3-4; Scott Yu

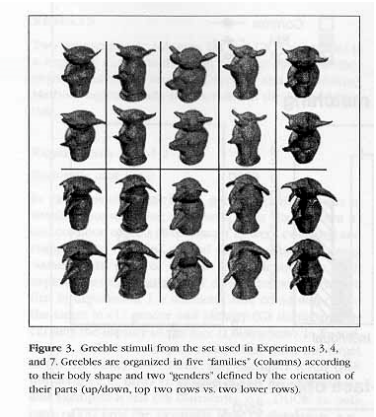
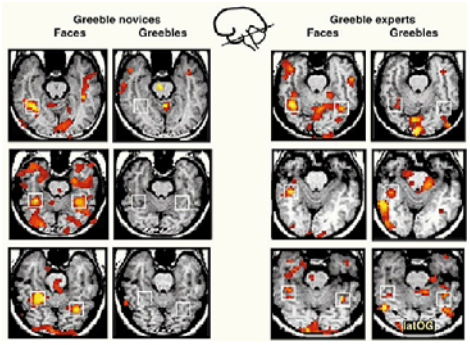


Figure 3. Greeble stimuli from the set used in Experiments 3, 4, and 7. Greebles are organized in five "families" (columns) according to their body shape and two "genders" defined by the orientation of their parts (up/down, top two rows vs. two lower rows).

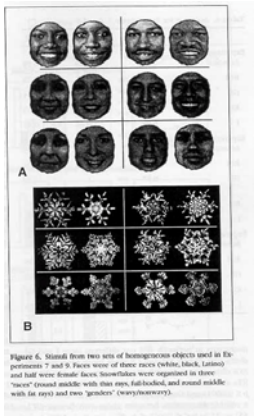
65

The FFA in Greeble Identification

Gauthier et al. (1999)



66



Face and Snowflake Stimuli

Gauthier, Behrmann, & Tarr (1999), Exps. 7, 9

67

Fusiform Face Area or Flexible Fusiform Area?

Tarr & Gautier (2000)

- Localization of Content
  - Recognition of Faces vs. Nonfaces
- Localization of Function
  - Recognition at Subordinate Levels of Categorization
    - Specific Faces, Nonfaces

68

Alternative Interpretations of the FFA

- Fusiform Face Area
  - Dedicated to Face Identification
- Flexible Fusiform Area
  - Dedicated to Subordinate-Level Classification
    - Faces a Universal Example
    - Also Underlies Other Areas of Expertise
- Fusiform Face Area Redux
  - Programmed for Face Identification
  - Can Be Recruited for Other Areas of Expertise

69

The Problem of Spatial Blurring

McGugin et al. (2012)

- Limited Resolution of Standard fMRI
  - Used in Expertise Studies
- True FFA Revealed by High-Resolution fMRI
  - Have Not Measured Expertise
- Nonface-Selective Regions Border True FFA
  - Need High-Resolution fMRI to Separate Them?

70

Stimulus Materials for HR-fMRI

McGugin et al. (2012)

71

Method

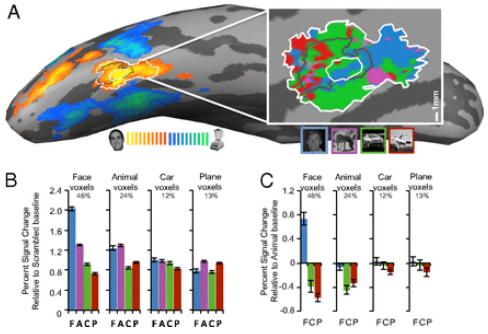
McGugin et al. (2012)

- 7-Tesla Magnet
  - Run at Standard Resolution (SR-fMRI)
  - Run at High Resolution (HR-fMRI)
- Subjects Varied in Car Expertise
- Matching Task
  - Same Person?
  - Same Make and Model of Car?
- Focus on FFA
  - Anterior (FFA1) vs. Posterior (FFA2)

72

The FFA in a Car-Expert

McGugin et al. (2012)



73

Summary of Findings

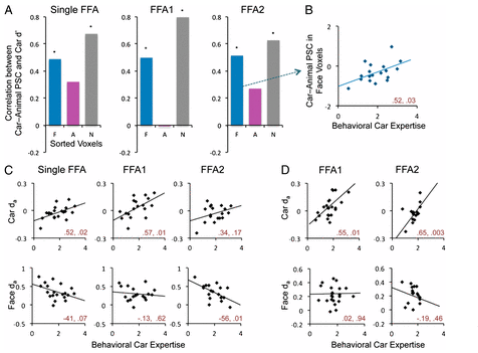
McGugin et al. (2012)

- HR-FFA Contains Non-Face Selective Voxels
- Car Expertise Effects in HR-FFA
  - Both Non-Selective and Face-Selective Voxels
- Expertise Effects Limited to Face-Selective Patch
- Overlap Between Object Expertise and Face-Selectivity

74

Separating Posterior and Anterior Regions

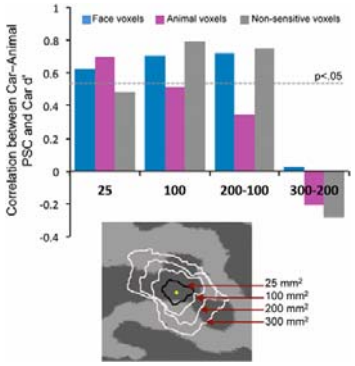
McGugin et al. (2012)



75

Correlations Outside FFA

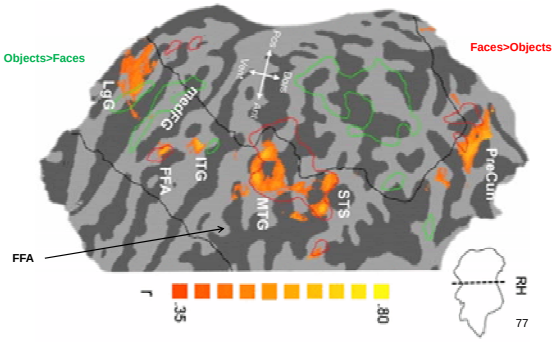
McGugin et al. (2012)



76

Activations in the Right Hemisphere

McGugin et al. (2012)



77

The Bottom Line (So Far) on the FFA

McGugin et al. (2012)

- When You Don't Consider Expertise
  - HR-fMRI Reveals Face-Selective Regions
- When You *Do* Consider Expertise
  - Object Sensitivity Present in "FFA"
- Expertise Overlaps with Face-Selectivity
  - Tight Spatial Contiguity
  - Especially When Expertise Involves Holistic Processing
- Face-Selectivity Still Possible
  - At Level of Individual Neurons

78

A New Approach: Brain Mapping

Gallant et al. (2011)

- "Brain Reading"
  - Record Entire Activity of Brain
    - As Subject Performs Some Task
  - Reconstruct Stimulus
    - From Pattern of Brain Activity
- Determine Whether Region of Interest Contains Task-Specific Information
- So Far, Nonsocial Perception
  - Faces May Come Soon!

79

Prospect for a Social Neuroscience

- The Social Psychology May Be Right or Wrong.
- The Neuroscience May Be Right or Wrong.
- But If the Social Psychology is Wrong, the Social Neuroscience Can't Be Right.

80