Reading Minds

Mary ET Boyle, Ph.D.
Department of Cognitive Science, UCSD
Complexity of Social Cognition
orrelaon across primate species between the size of their social group and the relative volume of neocortex
unification

Action perception

Mirror Neuron system

Action execution
Each time an individual observes another individual performing an action, a set of neurons that encode that action is activated in the observer’s cortical motor system.
Monkey see, Monkey brain do
Enables one to understand the actions and intentions of others.
Iacoboni M. 2009.
Annu. Rev. Psychol. 60:653–70
| Contains neurons that discharge when: | - a monkey *executes* a specific motor act 
| | -a monkey *observes* another individual performing the same motor act. |
The parieto-frontal circuit containing mirror neurons: between areas F5, PFG and AIP (the anterior intraparietal area.)

The parieto-frontal circuit is under control of the frontal lobe (area F6 or pre-supplementary motor area and the ventral prefrontal cortex (VPF)

There is convincing evidence that an action observation–action execution mirror circuit also exists in humans.

fMRI study: subjects either executed a grasp or observed a video of grasping an object while having their brains scanned. Results: Same parieto-premotor circuit is active in humans!

This study is of great interest because the mirror mechanism of this area encodes body-directed motor acts. The function of mirror neurons is related to the motor properties of the area in which they are located.

The activity in area F5 (in monkeys) related to the goal of the activity not of the specific motor action.

The implication: mirror neurons may encode the goal of the motor acts of another individual!

Downwards traces indicate that the hand closes, whereas upwards traces indicate that the hand opens.

This paper showed a marked difference between the activation during the observation of object-related and non-object-related actions.

Any time an object is the target of an action, the parietal lobe is strongly activated.

**Bottom line:**
the *same* neural structures are active when the action is observed or executed!!

Buccino, G. et al. (2001) Action observation activates premotor and parietal areas in a somatotopic manner: an fMRI study
Humans have a strong tendency to align their behavior with their fellows during social interactions. (Lieberman 2007)

Why imitate? Perhaps it facilitates social interactions, increases connectedness and liking, gets people closer to each other, and fosters mutual care.

Imitation, Empathy, and Mirror Neurons

Marco Iacoboni

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Good imitators should also be good at recognizing emotions in other people, which in turn may lead to greater empathy.

Recent data show that *dysfunction of the mirror neuron system* in humans might be a core deficit in autism.

**a**
Normal imitation activity - MNS  

**b**
Autistic imitation activity – significantly lowered MNS
Imitation is the most widely used form of learning during development.
The higher the Autism Diagnostic Observation Schedule score the lower the activity in the MNS.
Understanding autism: insights from mind and brain

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Autism is a developmental disorder characterized by impaired social interaction and communication as well as repetitive behaviours and restricted interests. The consequences of this disorder for everyday life adaptation are extremely variable. The general public is now more aware of the high prevalence of this lifelong disorder, with *ca.* 0.6% of the population being affected. However, the signs and symptoms of autism are still puzzling. Since a biological basis of autism was accepted, approaches from developmental cognitive neuroscience have been applied to further our understanding of the autism spectrum. The study of the behavioural and underlying cognitive deficits in autism has advanced ahead of the study of the underlying brain abnormalities and of the putative genetic mechanisms. However, advances in these fields are expected as methodological difficulties are overcome. In this paper, recent developments in the field of autism are outlined. In particular, we review the findings of the three main neuro-cognitive theories of autism: theory-of-mind deficit, weak central coherence and executive dysfunction.
Autism: Is the most severe childhood neuropsychiatric condition diagnosed today.

- Speech and communication
- Social functioning
- Imagination
- Repetitive
- Restricted interests
- Complex behavioral disability

M:F ratio: 4:1
0.6% population
Appears during the first three years of life

American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders (4th ed.),
<table>
<thead>
<tr>
<th>Autistic Spectrum Disorders</th>
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<tbody>
<tr>
<td>Pervasive Developmental Disorder (PDD)</td>
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</table>

- Autistic Disorder
- Asperger's Disorder
- Childhood Disintegrative Disorder (CDD)
- Rett's Disorder
- PDD-Not Otherwise Specified (PDD-NOS)
• Insistence on sameness; resistance to change

• Difficulty in expressing needs; uses gestures or pointing instead of words

• Repeating words or phrases in place of normal, responsive language

• Laughing, crying, showing distress for reasons not apparent to others

• Prefers to be alone; aloof manner

• May not want to cuddle or be cuddled.

• Little or no eye contact.
- Unresponsive to normal teaching methods
- Sustained odd play
- Spins objects
- Inappropriate attachments to objects.
- Apparent over-sensitivity or under-sensitivity to pain.
- No real fears of danger
- Noticeable physical over-activity or extreme under-activity.
- Uneven gross/fine motor skills.
- Not responsive to verbal cues; acts as if deaf although hearing tests in normal range.
<table>
<thead>
<tr>
<th>Language Development</th>
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<tbody>
<tr>
<td>delayed &amp; deviant</td>
</tr>
<tr>
<td>Peculiar use of sounds and words</td>
</tr>
<tr>
<td>Social Development</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td><strong>Physical and emotional distance from others.</strong></td>
</tr>
<tr>
<td><strong>Failure to develop social attachments</strong></td>
</tr>
<tr>
<td><strong>Difficulties in reacting to or recognizing other people’s feelings.</strong></td>
</tr>
<tr>
<td><strong>Lack of cooperative group play</strong></td>
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</table>
## Intellectual Development

<table>
<thead>
<tr>
<th>Poor on verbal ability</th>
<th>May perform above average on memory or spatial tasks</th>
<th>May be talented in music or drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-35% have IQ &gt; 70</td>
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## Diagnosing Autism

<table>
<thead>
<tr>
<th>New tests:</th>
<th>5 behaviors:</th>
</tr>
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<tbody>
<tr>
<td>Childhood Autism rating scale (CARS) Questionnaire</td>
<td>• babbling (1 yr)</td>
</tr>
<tr>
<td>Two year old screening</td>
<td>• gesturing (1 yr)</td>
</tr>
<tr>
<td></td>
<td>• Single words (16 mo)</td>
</tr>
<tr>
<td></td>
<td>• Two-word phrases (24 mo)</td>
</tr>
<tr>
<td></td>
<td>• Any loss of social skill (any age)</td>
</tr>
</tbody>
</table>
The savant is an individual with an islet of outstanding skill in one area, which can include calendar calculation, musical or artistic competence, often in the presence of modest or even low general intellectual ability.

Common reports of sensory abnormalities, which suggest heightened sensitivity to minute differences between stimuli, be they in sound, sight, taste or touch.
The term ‘autism’ is used to describe all individuals on the autistic spectrum.

Behavioral findings are based on high-functioning individuals.

Anatomical studies of the brain in autism are based on low-functioning individuals.
1st described

- Leo Kanner (1943)
- Hans Asperger (1944)

Explanation:

- “Refrigerator mother”
- Genetic
- Environment
The most consistent finding about the autistic brain to have emerged in recent years is that it is on average *larger and heavier* than the normal brain.
Importantly, the increased size is not evident from birth, but from *ca. 2–4 years*.

A reason for this increase could be a failure of the normal pruning process that occurs several times during development after an initial wave of proliferation of synapses.
• Differential growth pattern:
  • The frontal cortex and temporal cortex of the autistic brain grow quickly during the first two years of life but then show little or not increase in size during the next four years
  • The amygdala has an abnormal growth pattern:
    • At 4 years of age – it is larger
    • At adulthood – it is normal size – BUT fewer neurons

Growth pattern of lower order regions of the cerebral cortex – primary visual cortex and extrastriate cortex are relatively normal in the autistic brain.
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<tr>
<td>White matter problems, too.</td>
</tr>
<tr>
<td><strong>Volume of white matter containing short-range axons was increased</strong></td>
</tr>
<tr>
<td><strong>Volume of white matter containing long-range axons lower.</strong></td>
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</tbody>
</table>
Theory of Mind deficit: A fault in one component of the social brain can lead to the inability to understand certain basic aspects of communication.

mindblindness or mentalizing failure
Children were shown that Sally had a basket and Ann a box.

Sally puts a marble in her basket and goes outside.

While she is outside, naughty Ann moves Sally’s marble to her own basket.

Sally then comes back in and wants to play with her marble.

Children were asked, ‘where will Sally look for her marble?’

To a normally developing 4-year-old child, the answer is clear: Sally will look for her marble where she *thinks it is* and not where it *really is now*. Furthermore, the normally developing child can reason that Sally will look in her basket because this is where she put it and she does not know that it has been moved.

80% of children with autism, with a mental age equivalent to a 4 year-old or above, failed to answer this question correctly.

Individuals *with autism do not activate the face area* of the fusiform gyrus that is reliably activated by normal individuals when looking at faces as opposed to *objects.*
Social intelligence in the normal and autistic brain: an fMRI study

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3 Neuroimaging Research, Department of Clinical Neuroscience, Institute of Psychiatry, University of London, Denmark Hill, London SE5 8AF, UK
Task A: Male or Female?

Task B: What is mental state?

Results: High functioning autistic and AS adults could not perform the task. They also showed less extensive activation in frontal regions and no activation in the amygdala.
fMRI activation of the fusiform gyrus and amygdala to cartoon characters but not to faces in a boy with autism

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\textsuperscript{b} Department of Psychology, Vanderbilt University, Wilson Hall, Nashville, TN 37203, USA
\textsuperscript{c} Department of Diagnostic Radiology, Yale University School of Medicine, Magnetic Resonance Research Center, 300 Cedar Street, New Haven, CT 06510, USA
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Received 10 June 2003; accepted 29 June 2004
The slices containing the FG are highlighted in green and amygdala in red.

Right and left are reversed by radiological convention.

Because of DD’s expertise for individuating Digimon and his deficit in individuating faces, there was hypoactivation of the FFA to familiar and unfamiliar faces (compared to objects) but Digimon elicited activity in the area of the FG that is normally recruited for faces. The middle region of DD’s FG responded more to Digimon and masked Digimon than to familiar and unfamiliar faces and nonface objects.
Oxytocin is...

- nine-amino-acid peptide
- synthesized in the hypothalamus
- released into the bloodstream
- receptor binding sites in the limbic system
Affiliative behaviors...

• Sexual behavior

• Mother-infant
• Adult-adult pairing

• Separation distress

• Feeding & Grooming
• Stress response
Research report
Endogenous oxytocin is involved in short-term olfactory memory in female rats

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Received 24 January 1997; received in revised form 13 May 1997; accepted 13 May 1997
Oxytocin knock-out mice fail to recognize familiar conspecifics after repeated social exposures, despite normal olfactory and spatial learning abilities.

Oxytocin treatment fully restores social recognition. It was demonstrated that oxytocin acts in the medial amygdala during the initial exposure to facilitate social recognition.
Intranasal oxytocin or placebo was administered to male university students playing “the trust game,” in which participants make decisions about transferring money to an anonymous player; trusting the other player can lead to higher payoffs for both players because the money is tripled when transferred; but one runs the risk that the other player might violate one’s trust and not share his or her earnings.