Lecture 20: Mentalizing
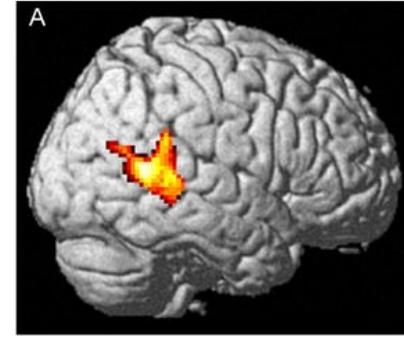

Outline:

I. Intro: Inferring mental states to understand people
    thinking about what this entails

II. Do we have special brain mechanisms for mentalizing?
    false belief vs false photo
    specificity (not just anything about a person)
    generality: nonverbal pixar movies

III. Moral Reasoning as a Test Case of ToM

IV. Many other facets of social cognition,
    Example: perceiving and thinking not just about
individuals, but *interactions between two people*

V. Quiz

Major Experimental Design Assignment is due this Friday

many slides from this lecture from Rebecca Saxe

Humans are Profoundly Social Beings

» Our relationships with other people make up the fabric of our lives

» Other people are the source of our:
– Deepest Happiness
– And Greatest Suffering (e.g. worst form of punishment = solitary confinement)

» Impairment in understanding other people is devastating (autism)

» Other people are the source of much of what we know

» Greatest feats of the humanity (art, science) are products of groups of people working together

» Social cog = a major driver of brain evolution

» Social cog = large *percent* of human cognition
– in minutes of every day, and
– In cortical area
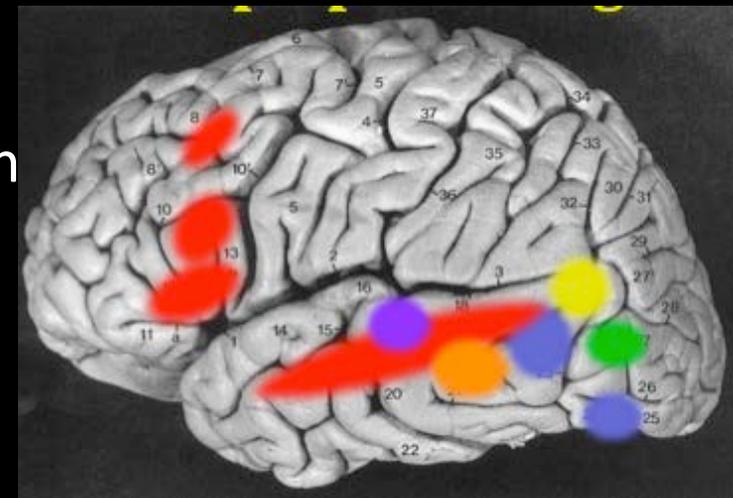
So: What exactly is entailed in social cognition?
To get a sense of this, watch these 18-month-old infants,
    thinking about what abilities these kids must have to do this. …..

2

What we need to figure out to understand another agent's actions:

1. *What* is this person doing?
    externally observable (perception)

2. *Why* are they doing that?
    not externally observable.
    to answer, need to infer *hidden mental states* (much more abstract*)*:
        the agent's percepts (what can they see/hear?)
            [what we *infer they can see*, not what *we* can see]
        the agent's desires/goals (what do they *want*?)

How might we figure these things out?
In narrow domains, simple cues may suffice.
        e.g., person reaching for X wants X
But we can do so much more than that.
And percepts and goals are not sufficient.
Consider this case…

Case: Why did Romeo Reach for the Bottle?

Observed

Body motions

To understand this action, need to perceive and infer:

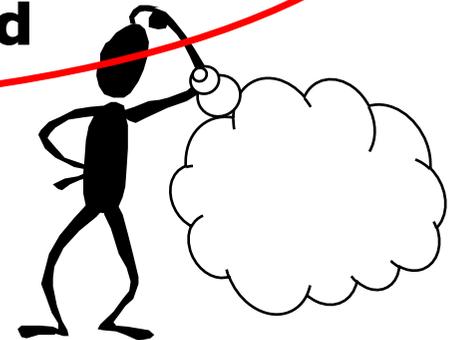**A hand reaching for a bottle**

His intention: to drink the liquid

Belief and Desires:

- **Unobservable**

- **Abstract**

- **Best way to explain & predict behaviour**

- **The crux of fiction, deception, metaphor, irony, and morality**

He believes the liquid is poison

He wants to die

He believes Juliet is dead

What does Perceiver Infer?

Slide adapted from Rebecca Saxe

Mentalizing
(inferring other people's mental states)

1. *What* are they doing?
   externally observable

2. *Why* are they doing that? (and what will they do next?)
   not externally observable.

   to answer need to infer hidden mental states:
   percepts   the agent's percepts (what can they see/hear?)
      [remember: what we *infer they can see* $\neq$ what *we* can see]
   desires   the agent's desires/goals (what do they want?)
   beliefs   the agent's beliefs (what do they think?)

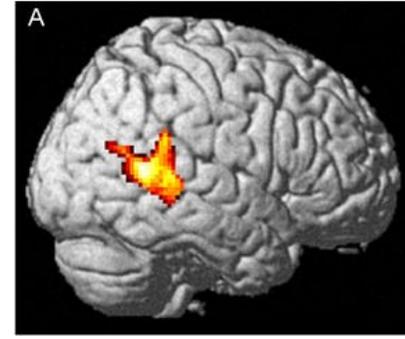No current computer system can do all this.
No animal can do it (except in very restricted cases).
Specific cues (like: reaching for X means wanting X) will help,
       but will only get us so far.
Humans do so much more than this.
How?...

Lecture 20: Mentalizing

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IV. Many other facets of social cognition,
        Example: perceiving and thinking not just about
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Question:

Might attributing thoughts/beliefs to another agent be a distinct domain of cognition?

the classic paradigm in this field……
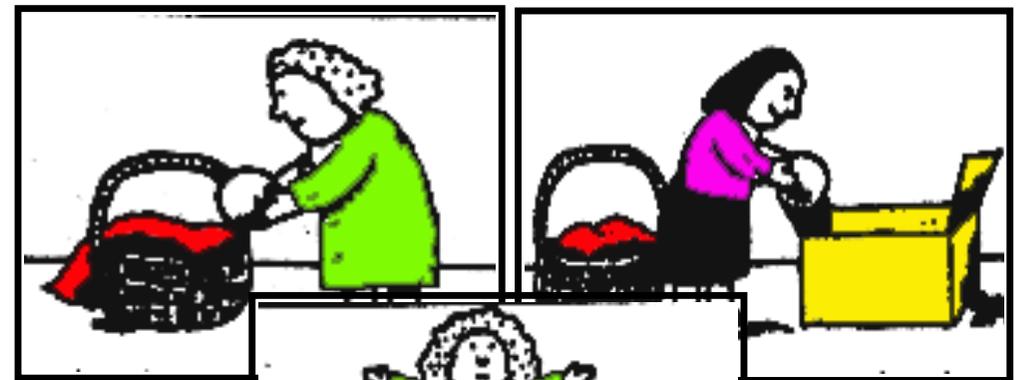
The "False Belief" Paradigm

False beliefs: Action prediction based on false belief is different from the prediction based on reality.

The Sally-Anne problem
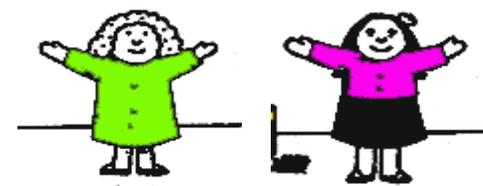
Sally   **Anne**

Where will Sally look for her ball?

Age 3: "In the box."

Age 5: "In the basket."

(Wimmer & Perner 1983, Wellman, Cross and Watson 2001)

Slide courtesy of Rebecca Saxe
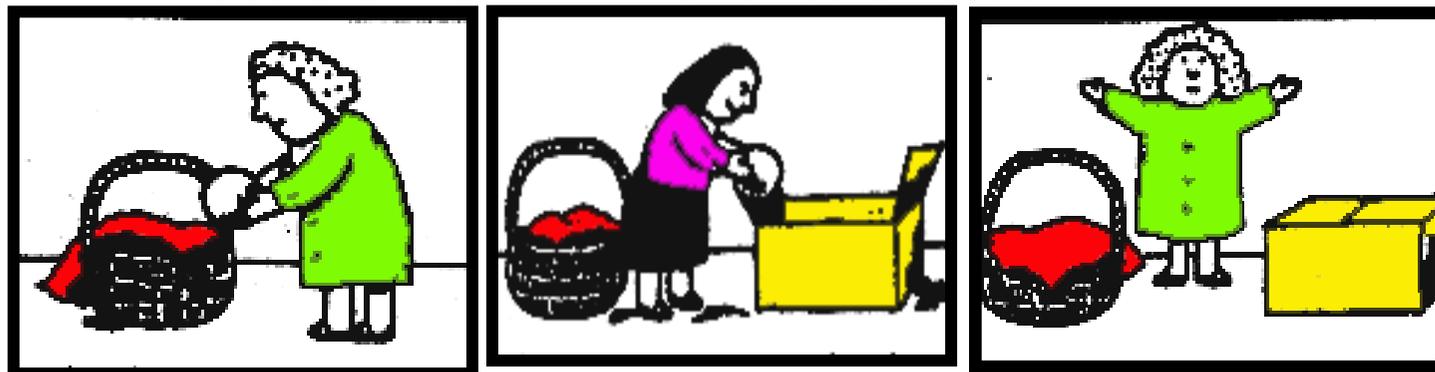
8

Illustration of children doing the false belief task

Rebecca Saxe, *How we read each other's minds*. TEDGlobal 2009.

Go to 2:42 in the video for portion on false belief task.

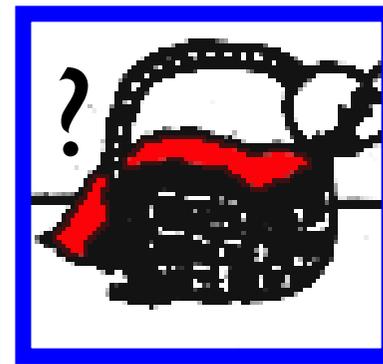So, typical kids fail FB at age 3 and pass by age 5. What about kids with autism?
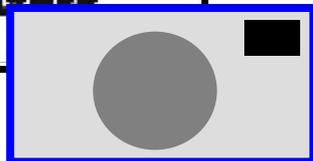
False Belief Stories

WHY?

- Attributing thoughts

~~- Choice between competing representations~~

~~- Inhibition of "prepotent" response~~

False "Photo" Stories

Photograph

Slide adapted from Rebecca Saxe

Many kids with ASD fail FB but not FP!

Zaitchik 1990

Question:

Might attributing thoughts/beliefs be a distinct domain of cognition?

1. Evidence from typical children
   systematic appearance between age 3 and 5
2. Evidence from autism
      FB develops well after FP
3. What about fMRI?
   Is there a special part of the brain for ToM?

Thinking about thoughts

Saxe & Kanwisher (2003) fMRI Experiment 1

False Belief stories   **False Photo stories**

Susie parked her sports car in the driveway. In the middle of the night. Nathan moved her car into the garage to make room for his minivan. Susie woke up early in the morning.

She expects to see in the drive
a sportscar   a minivan

A volcano erupted on this Caribbean island three months ago. Barren lava rock is all that remains. Satellite photos show the island as it was before the eruption.

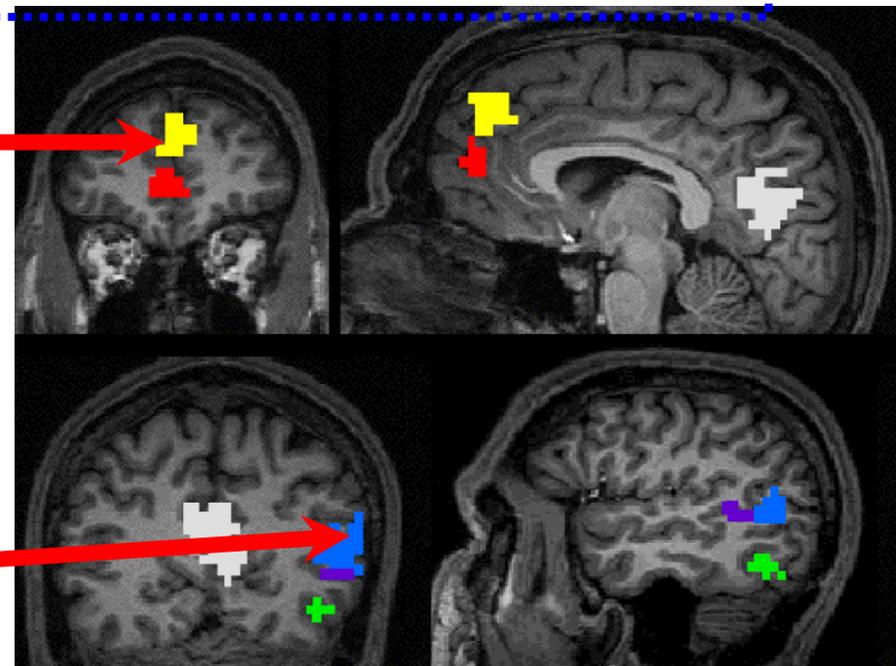In the photos the island is covered in
rock   vegetation

Belief > Photo

Saxe & Kanwisher 2003, Experiment 2 N=25 native English speaking volunteers, 1.5 T scanner at MGH, whole brain, 4mm slices

+25

MPFC

RTPJ

Thinking about thoughts
Experiment 1

False Belief stories

Susie parked her sports car in the driveway. In the middle of the night. Nathan moved her car into the garage to make room for his minivan. Susie woke up early in the morning.
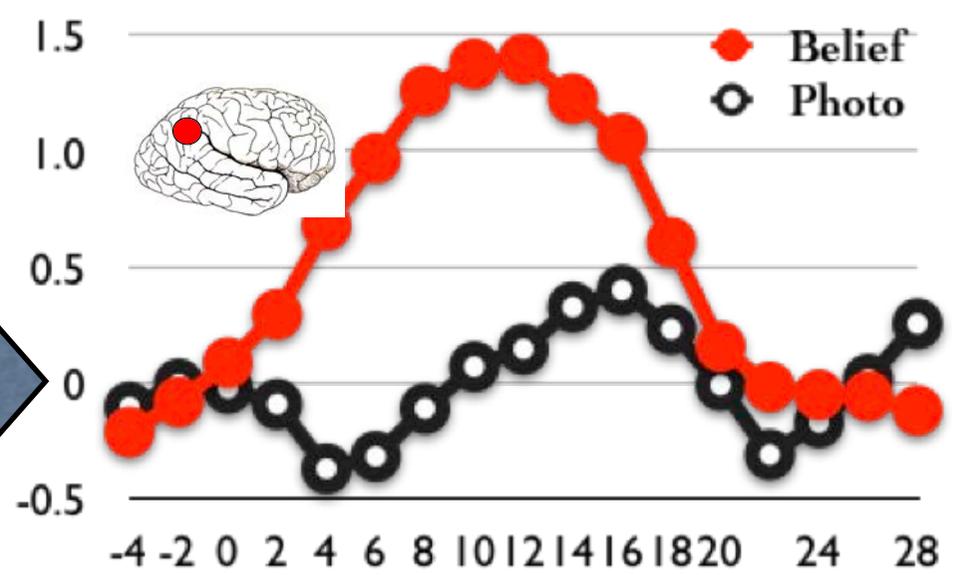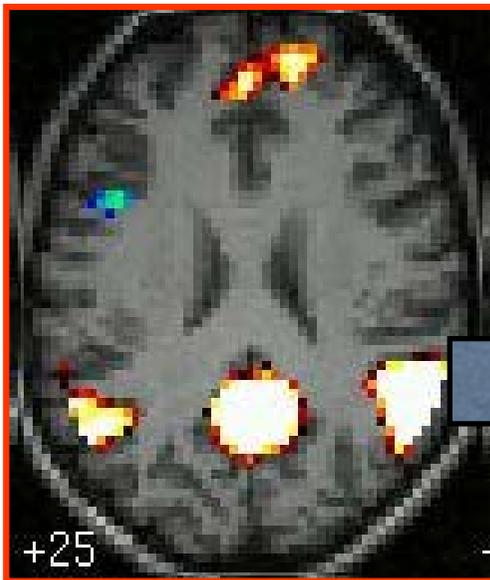
She expects to see in the drive
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False Photo stories

A volcano erupted on this Caribbean island three months ago. Barren lava rock is all that remains. Satellite photos show the island as it was before the eruption.

In the photos the island is covered in
rock   vegetation

Belief > Photo

Saxe & Kanwisher 2003, Experiment 2
N=25, p<0.0001;
ROI data from:
Saxe & Wexler 2005,
N= 12 , scanned at 3T

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Thinking about thoughts

Experiment 1

False Belief stories

False Photo stories

Susie parked her sports car in the driveway. In the middle of the night. Nathan moved her car into the garage to make room for his minivan. Susie woke up early in the morning.

A volcano erupted on this Caribbean island three months ago. Barren lava rock is all that remains. Satellite photos show the island as it was before the eruption.

She expects to see in the drive

a sportscar   a minivan

In the photos the island is covered in

rock   vegetation

Belief > Photo

Saxe & Kanwisher 2003, Experiment 2 N=25, p<0.0001; ROI data from: Saxe & Wexler 2005, N= 12 , scanned at 3T
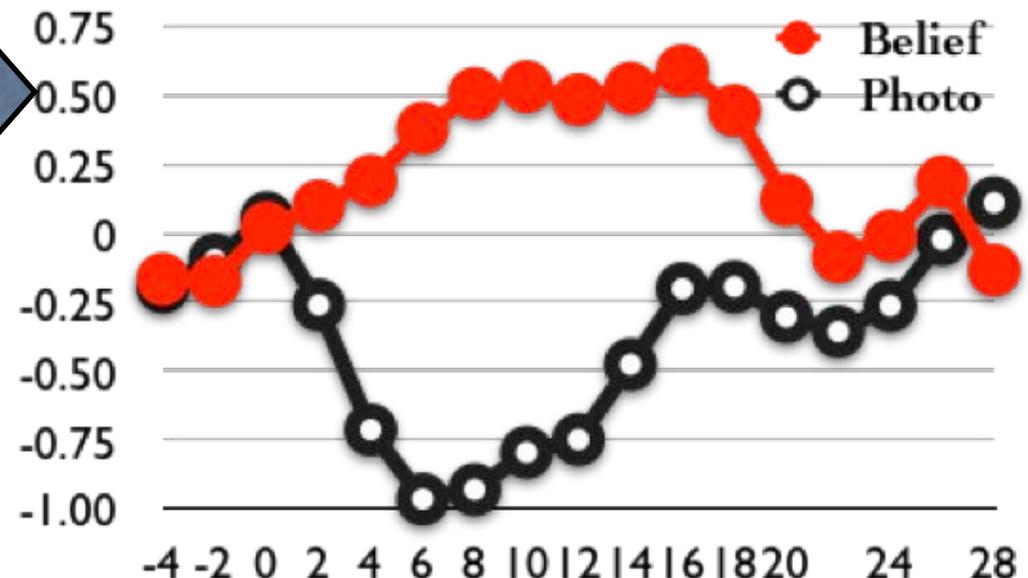
Thinking about thoughts

Experiment 2

Belief > Photo is consistent with *three hypotheses:*
1. **Anything about a person**
2. **Any internal, invisible state**
3. **Attributing thoughts/desires**

External:
"Andrew had just had a growth spurt, so he was gangly and rather awkward. Like most teenagers he had bad skin and bad taste in clothes. He wore mostly baggy jeans and flannel shirts."

Visceral:
"Sheila skipped breakfast because she was late for the train to her mother's. By the time she got off the train she was starving. Her stomach was rumbling, and she could smell food everywhere."

Thoughts:
"Nicky knew that his sister's flight from San Francisco was delayed ten hours. Only one flight was delayed so much that night, so when he got to the airport, he knew that flight was hers"

Thinking about thoughts

Experiment 2

Belief > Photo is consistent with *three hypotheses:*

1. **Anything about a person**
2. **Any internal, invisible state**
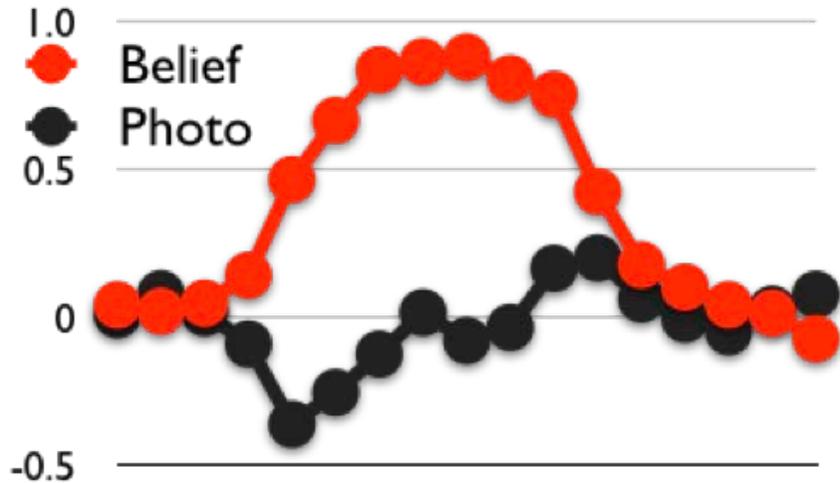3. **Attributing thoughts/desires**

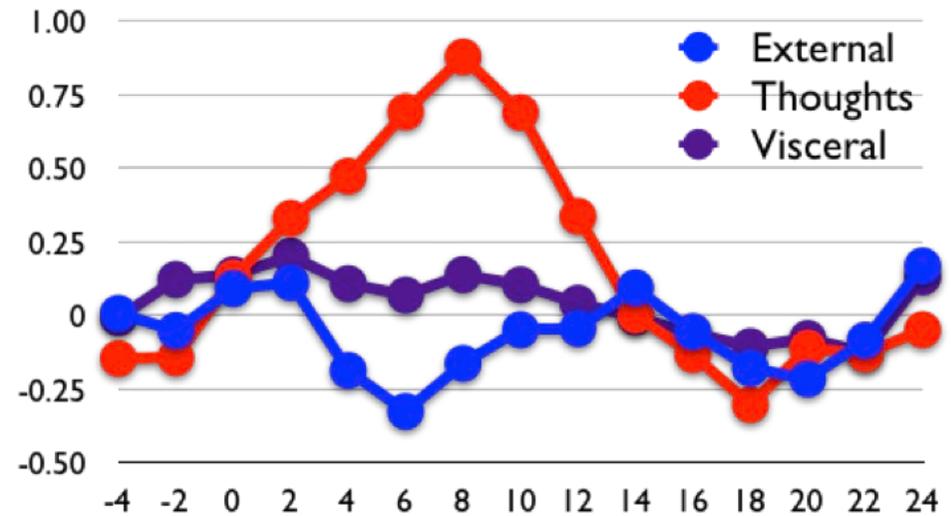|	Extern. (gangly teenager)	Visceral (hunger)	Thoughts (delayed flight)
1. Person			
2. Internal			
3 Thoughts			

Which conditions are predicted to produce a strong response in rTPJ for each hypoth?

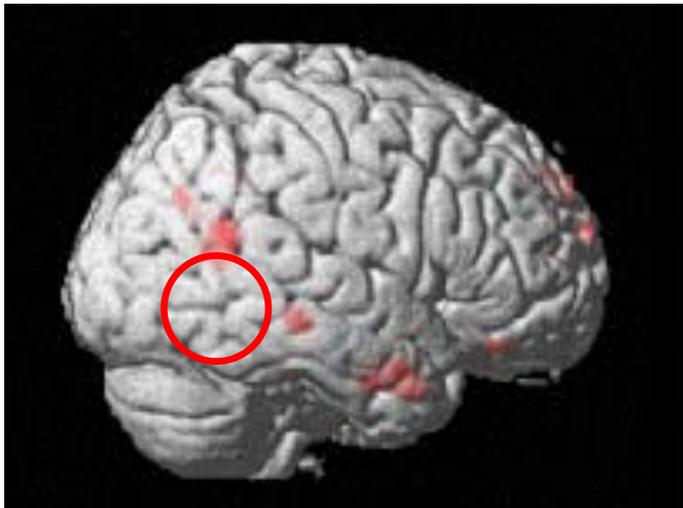# Thinking about thoughts E2

RTPJ Resp to Localizer

RTPJ Response in Main Expt

- sig. higher for Thoughts than E & V
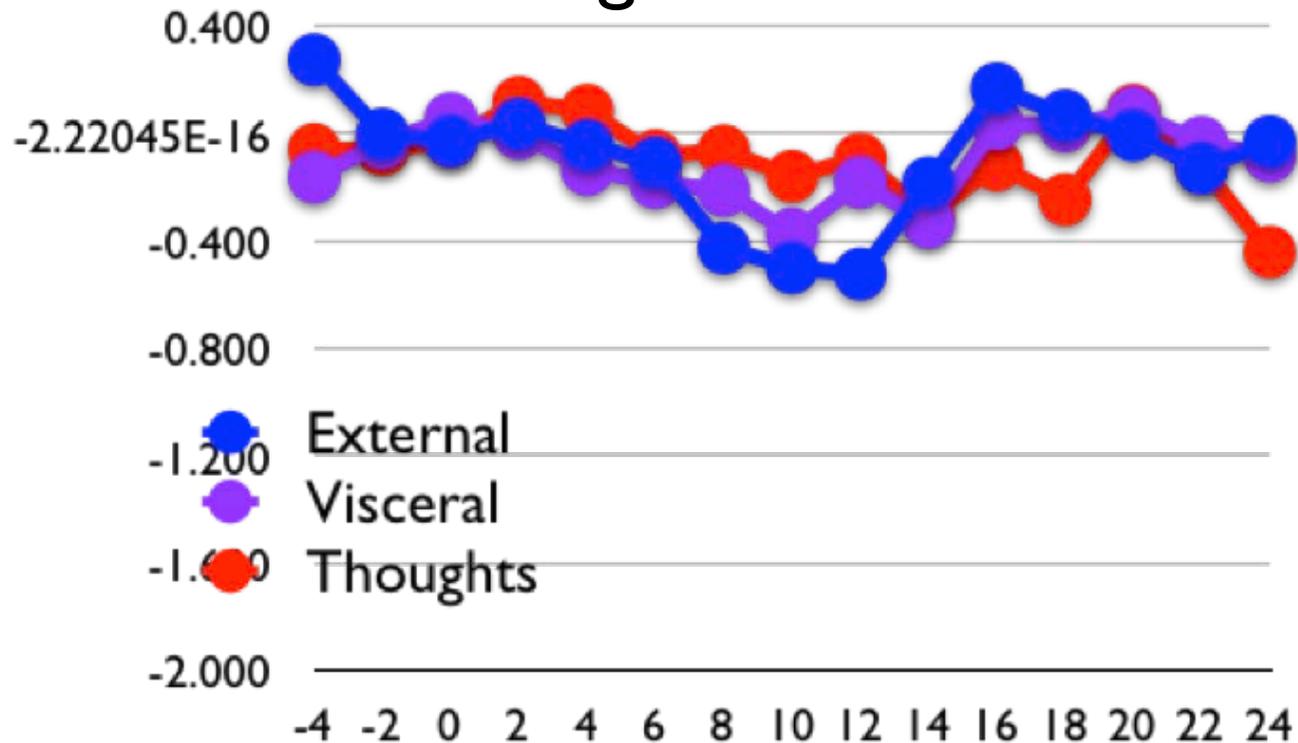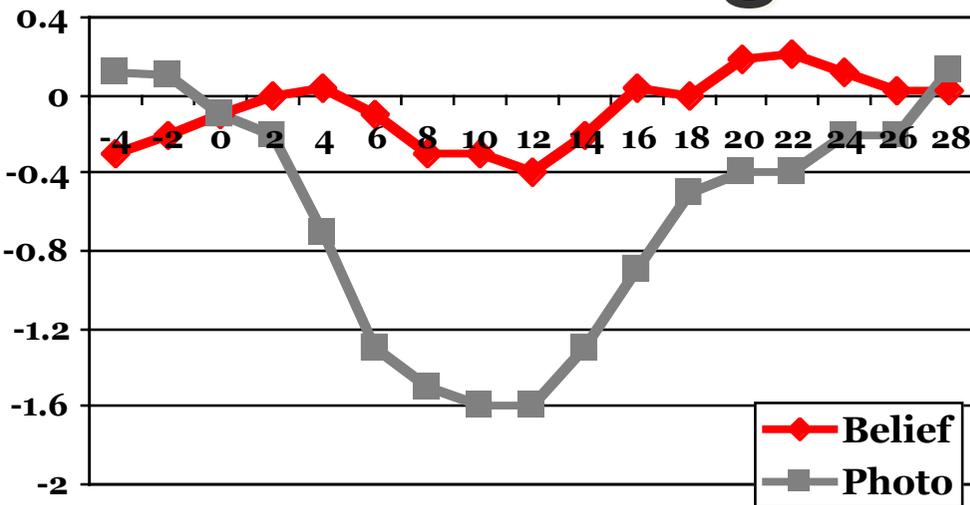- no sig. diff betwn 'External' & 'Visceral'

Group whole brain analysis:
thoughts >
external & visceral

Saxe & Powell 2006

Thinking about thoughts E2

MPFC ROI in 8/12 subjects:

- no difference between conditions
- sig. interaction with RTPJ

Saxe & Powell 2006

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Thinking about thoughts

Experiment 2

Belief > Photo is consistent with *three hypotheses:*

1. **Anything about a person** MPFC
2. **Any internal, invisible state**
3. **Attributing thoughts/desires** rTPJ

External:
"Andrew had just had a growth spurt, so he was gangly and rather awkward. Like most teenagers he had bad skin and bad taste in clothes. He wore mostly baggy jeans and flannel shirts."

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Thoughts:
"Nicky knew that his sister's flight from San Francisco was delayed ten hours. Only one flight was delayed so much that night, so when he got to the airport, he knew that flight was hers"

But all these experiments use words! ...

Experiment 3: Is this specifically verbal?
Test with animated Silent Film

Mental > Body / Pain

Pixar short: *Partly Cloudy (6 min)*

Screenshot removed due to copyright restrictions
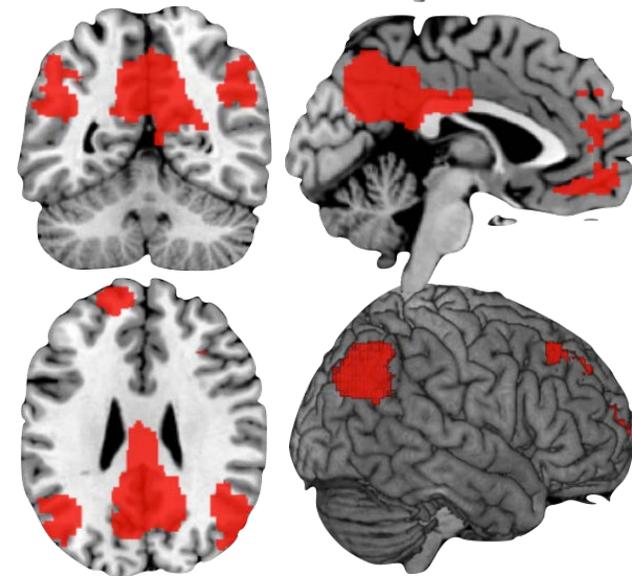

Belief > Photo

Any inference about anothers' thoughts,
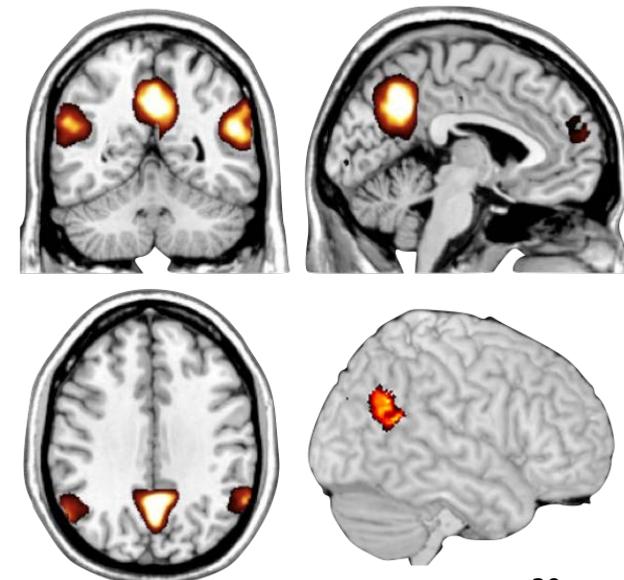   (not bodily sensations),
    even if nonverbal.

Powerful generalization.

Also: can use on kids!

Whole brain response figures courtesy Elsevier, Inc., https://www.sciencedirect.com. Used with permission. Source:
N Jacoby, et al. NeuroImage 126, 1 Feb 2016, 39-48. https://doi.org/10.1016/j.neuroimage.2015.11.025

20
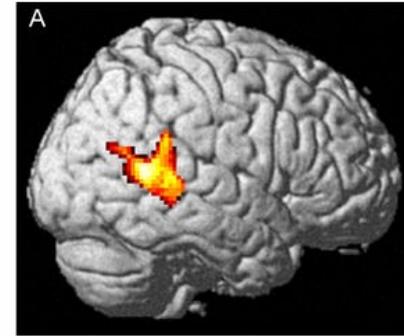
Lecture 20: Mentalizing

I. Intro: Inferring mental states to understand people
   percepts, beliefs, & desires

II. Do we have special mind/ brain mechanisms for mentalizing?

YES! rTPJ is very selective for thinking about other peoples' thoughts

✔ false belief vs false photo

✔ specificity (not just anything about a person)
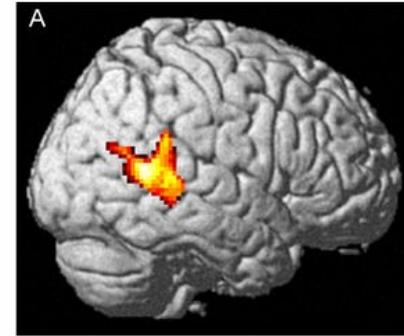
✔ generality: nonverbal pixar movies

III. Moral Reasoning as a Test Case of ToM

IV. Many other facets of social cognition,
   Example: perceiving and thinking not just about
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V. Quiz

many slides from this lecture from Rebecca Saxe

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Why moral reasoning?
Because the moral status of
an action depends on:
   What the person *intended* &
   What the person *knew.*
For example…

Moral Reasoning

Example 1: How morally permissible is Grace's action?

Grace and her friend are taking a tour of a chemical plant. When Grace goes over to the coffee machine to pour some coffee, Grace's friend asks for some sugar in hers. There is white powder in a container by the coffee.

The white powder is a very toxic substance left behind by a scientist, and therefore deadly when ingested in any form. **accidental harm**

The container is labeled "sugar", so Grace believes that the white powder by the coffee is sugar left out by the kitchen staff.

Grace puts the substance in her friend's coffee. Her friend drinks the coffee and dies.

How morally permissible is Grace's action?

1=morally forbidden; 7=morally permissible

Moral Reasoning

Example 2: How morally permissible is Grace's action?

Grace and her friend are taking a tour of a chemical plant. When Grace goes over to the coffee machine to pour some coffee, Grace's friend asks for some sugar in hers. There is white powder in a container by the coffee.

The white powder is a very toxic substance left behind by a scientist, and therefore deadly when ingested in any form. **accidental harm**

~~The container is labeled "sugar", so Grace believes that the white powder by the coffee is sugar left out by the kitchen staff.~~

The container is labeled "toxic", so Grace believes that the white powder is toxic substance left behind by a scientist. **intentional harm**

Grace puts the substance in her friend's coffee. Her friend drinks the coffee and dies.

How morally permissible is Grace's action?

1=morally forbidden; 7=morally permissible

So: Moral reasoning requires understanding a person's *beliefs* and *intent*. How do you think might it be affected in ASD? During TMS to the rTPJ?

Moral Reasoning

1. NT people agree that accidental harm is more morally permissible than intentional harm.

2. ASDs? Less forgiveness for accidental harm than NTs.

3. Role of rTPJ?

   Forgiveness for accidental harms is correlated in NTs with activation in the rTPJ during moral judgment (Young & Saxe, 2009).

4. Causal role? TMS to the rTPJ:

   attempted harm rated more permissible (Young et al, 2010)

All these findings fit with the ideas that
   • the rTPJ is causally engaged in understanding the difference between intentional and accidental actions
   • this ability is specifically disrupted in ASD

all of which leads to a natural prediction about the rTPJ in ASD…..

So: Moral reasoning requires understanding a person's *beliefs* and *intent*.
   How do you think might it be affected in ASD? During TMS to the rTPJ?

Obvious Question: Is rTPJ Affected in ASD?

Dufour et al (2013)
ToM localizer: false beliefs versus false photo run on
      462 neurotypical individuals
      31 high-functioning ASDs

Result:
Region-of-interest and whole-brain analyses find
      no group differences in size, location or response magnitude
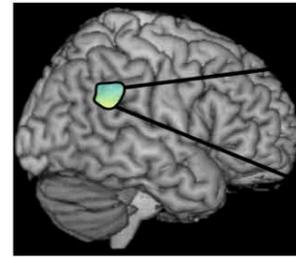   for Theory of Mind tasks

??!!
Really?
How could this possibly be?
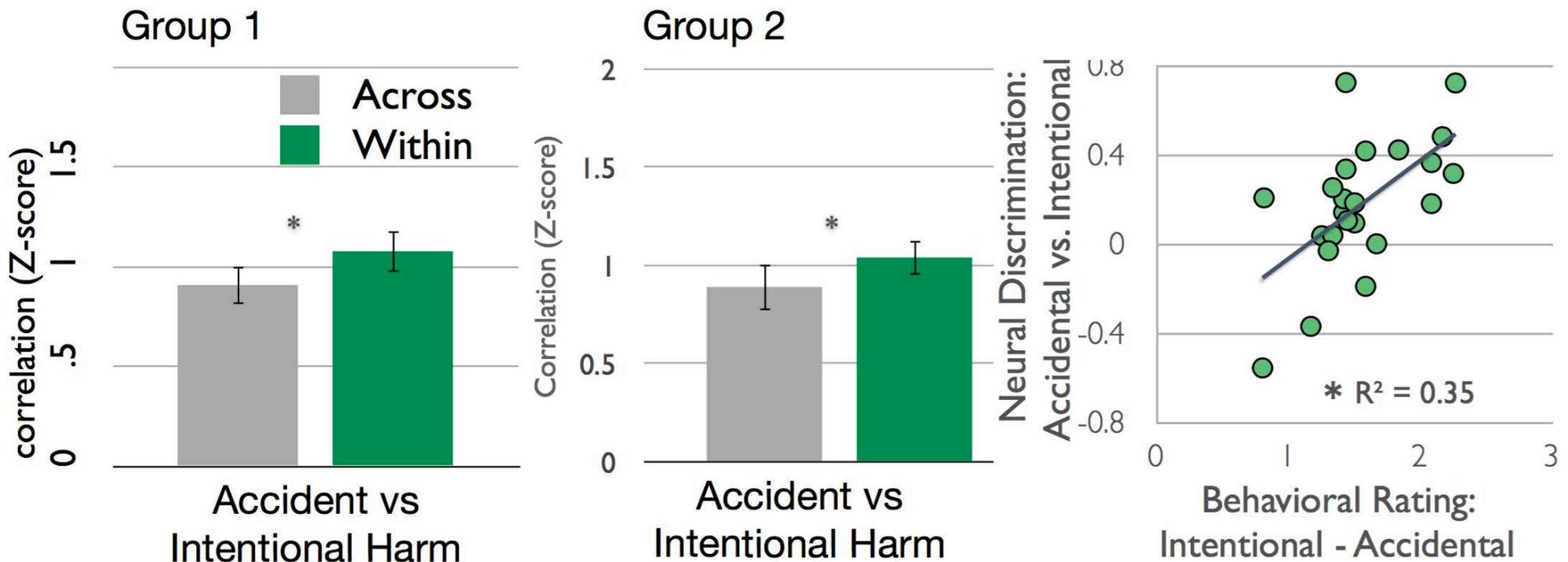Does this mean that the rTPJ is not affected in ASD?

MVPA IN RTPJ
Accidental vs Intentional Harm

Multi-voxel pattern analysis: spatial correlations

Are within-category pairs more similar than between category pairs?
Is the difference in spatial pattern related to behavioural judgments?
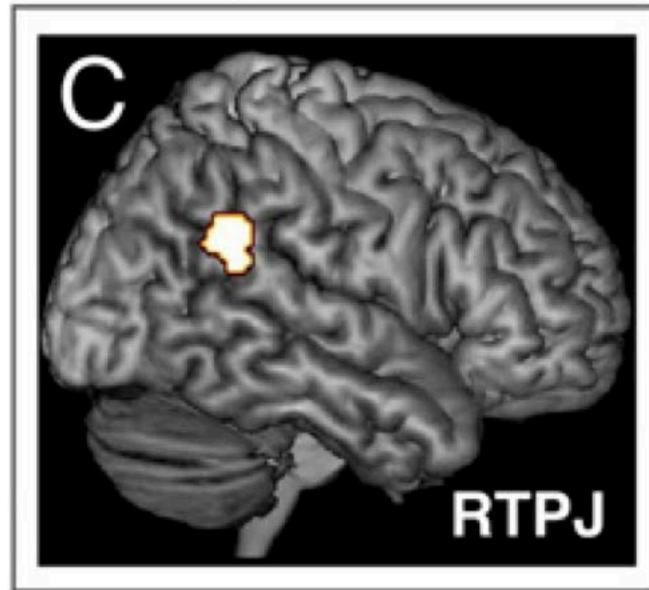

Group 1

Group 2

* $R^2 = 0.35$

Does the rTPJ distinguish between intentional & accidental harm in ASDs?

MVPA in rTPJ in ASD

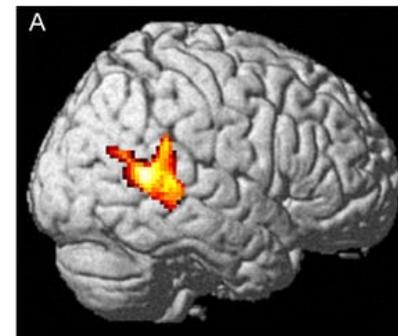Does the rTPJ distinguish between intentional & accidental harm in ASDs?
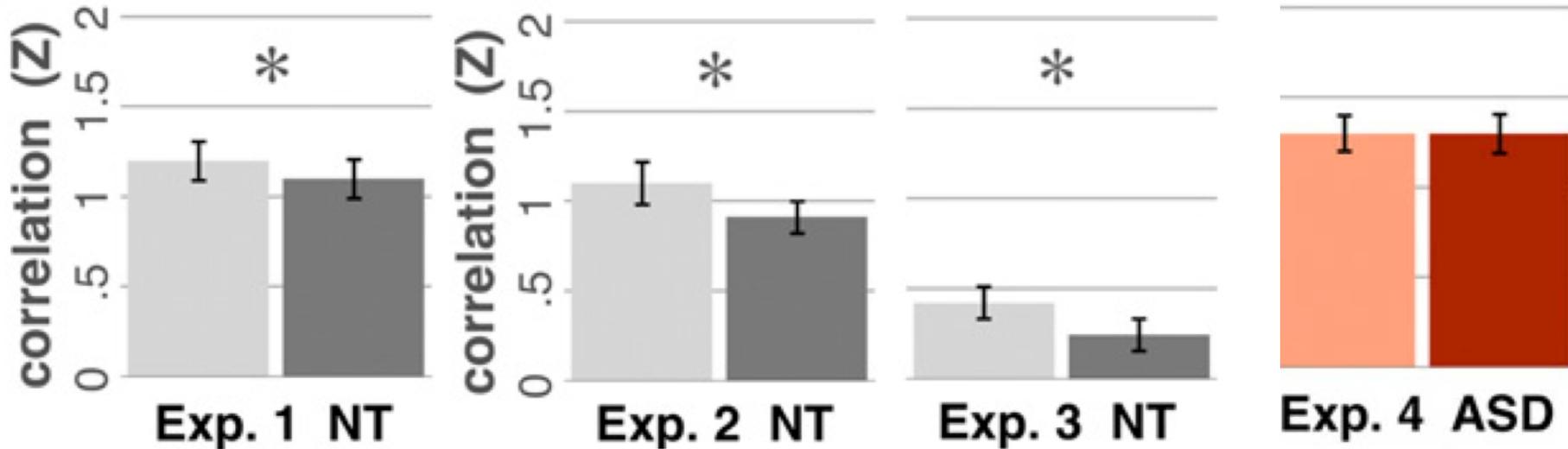
The rTPJ distinguishes between intentional and accidental harm, but only in NTs not ASDs!

Koster-Hale et al. (2013)

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II. Do we have special mind/ brain mechanisms for mentalizing?

YES! rTPJ is very selective for thinking about other peoples' thoughts

- ✔ false belief vs false photo
- ✔ specificity (not just anything about a person)
- ✔ correlation across stories
- ✔ generality: nonverbal pixar movies

III. Moral Reasoning as a Test Case of ToM

- ✔ less weight to beliefs in ASD (less forgiveness for accidental harm)
- ✔ TMS to rTPJ disrupts moral juegment
- ✔ MVPA: TPJ distinguishes between intentional vs accidental
- ✔ But not in ASD!

Here we focused on rTPJ & belief inference,
  = just one facet of social cognition, or many…

9.13 The Human Brain
Spring 2019