

# IMAGING COGNITIVE & PSYCHOLOGICAL FUNCTION IN EPILEPSY

An alternative and accessible version of this presentation is available at 11:10 am in the [Videocast of Day One](#)

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**I do not have significant financial interests related to this conference**

# FROM EPILEPSY TO HUMAN COGNITIVE NEUROSCIENCE

*Hemispheric Specialization*  
commissurotomy

*Medial Temporal Lobes & Memory*

H.M. & amnesia

*Frontal Lobes & Thinking*

WCST task

*Sensorimotor Maps*

Penfield stimulation studies

**FROM EPILEPSY TO HUMAN  
COGNITIVE NEUROSCIENCE**

***FROM HUMAN COGNITIVE  
NEUROSCIENCE TO EPILEPSY?***

# Task Design - Semantic Encoding

*Abstract?*

**COIN**

**thought**

**potato**

**PRIDE**

*Upper Case?*

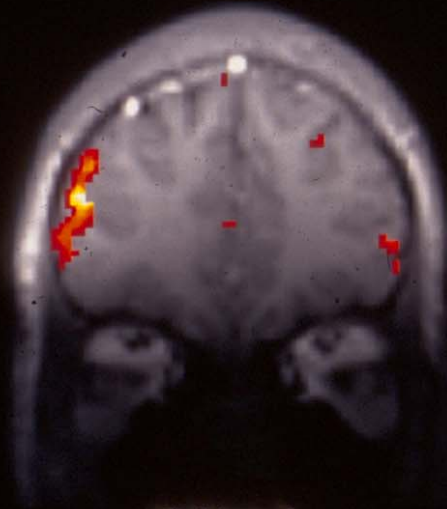
**mountain**

**SORROW**

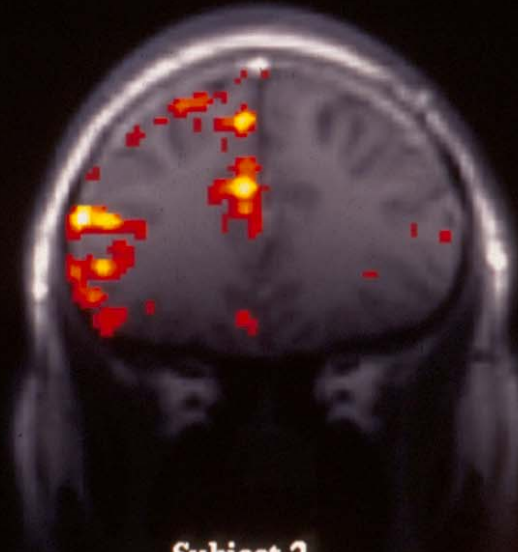
**PAPER**

**affection**

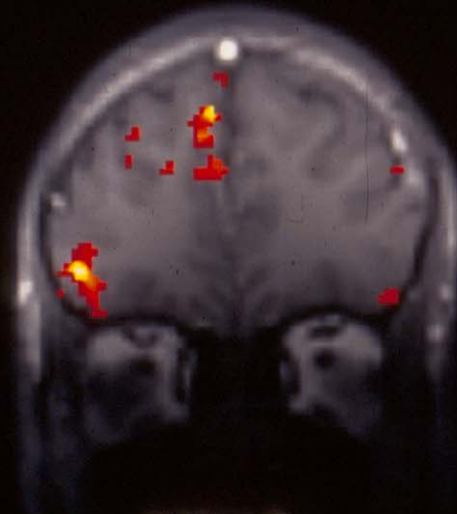
# Semantic Encoding



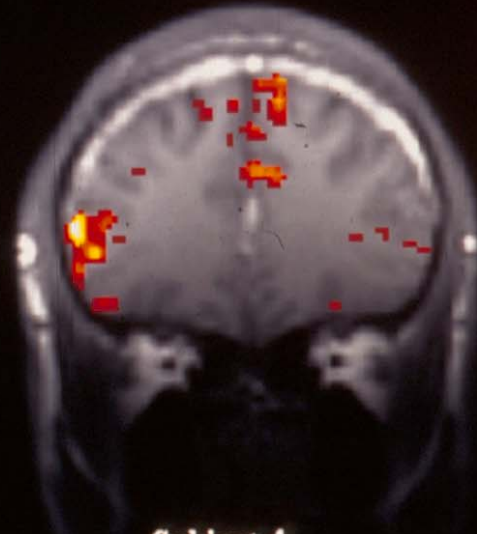
Subject 1  
y = +39 mm



Subject 2  
y = +32 mm



Subject 3  
y = +39 mm



Subject 4  
y = +32 mm

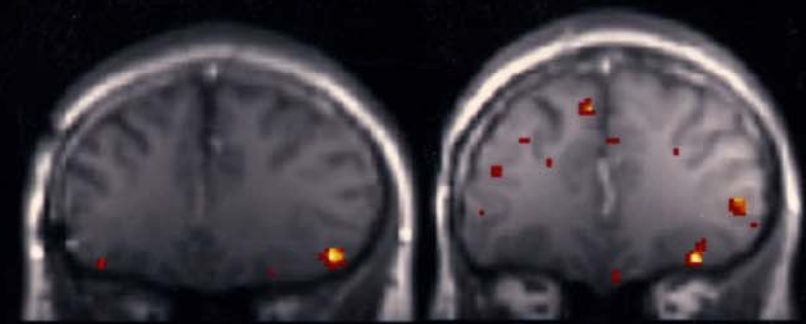
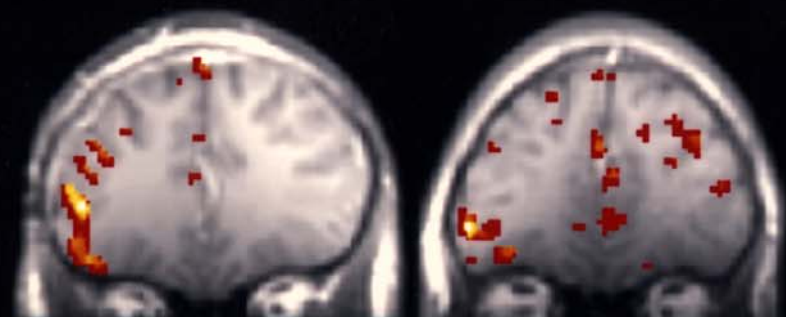


# Patients Tested

<b>Subj</b>	<b>Age</b>	<b>Sex</b>	<b>Wada</b>	<b>Surgery</b>
<b>SL1</b>	<b>32</b>	<b>M</b>	<b>Left</b>	<b>L ant temporal lobectomy</b>
<b>SL2</b>	<b>20</b>	<b>F</b>	<b>Left</b>	<b>Pre-Surgical</b>
<b>SL3</b>	<b>35</b>	<b>F</b>	<b>Left</b>	<b>L temporal lobectomy</b>
<b>SL4</b>	<b>53</b>	<b>M</b>	<b>Left</b>	<b>R temporal lobectomy</b>
<b>SR1</b>	<b>31</b>	<b>F</b>	<b>Right</b>	<b>L temporal lobectomy</b>
<b>SR2</b>	<b>39</b>	<b>F</b>	<b>Right</b>	<b>L temporal lobectomy</b>
<b>SR3</b>	<b>28</b>	<b>M</b>	<b>Right</b>	<b>L temporal lobectomy</b>

LEFT-DOMINANT  
PATIENTS

RIGHT-DOMINANT  
PATIENTS

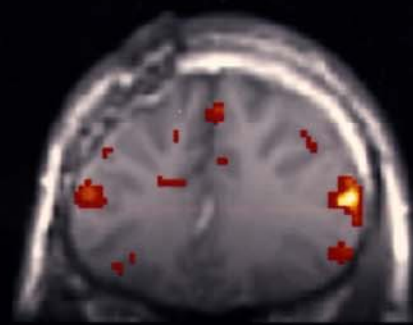
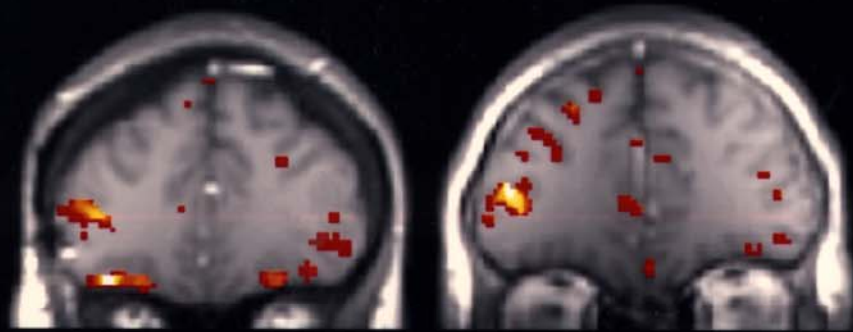


SL1

SL2

SR1

SR2



SL3

SL4

SR3

# fMRI & Language in Patients with Epilepsy

**Correlation to Wada of .96 in 22  
consecutive patients**

*Binder et al., 1996*

**fMRI prediction of postoperative naming  
decline**

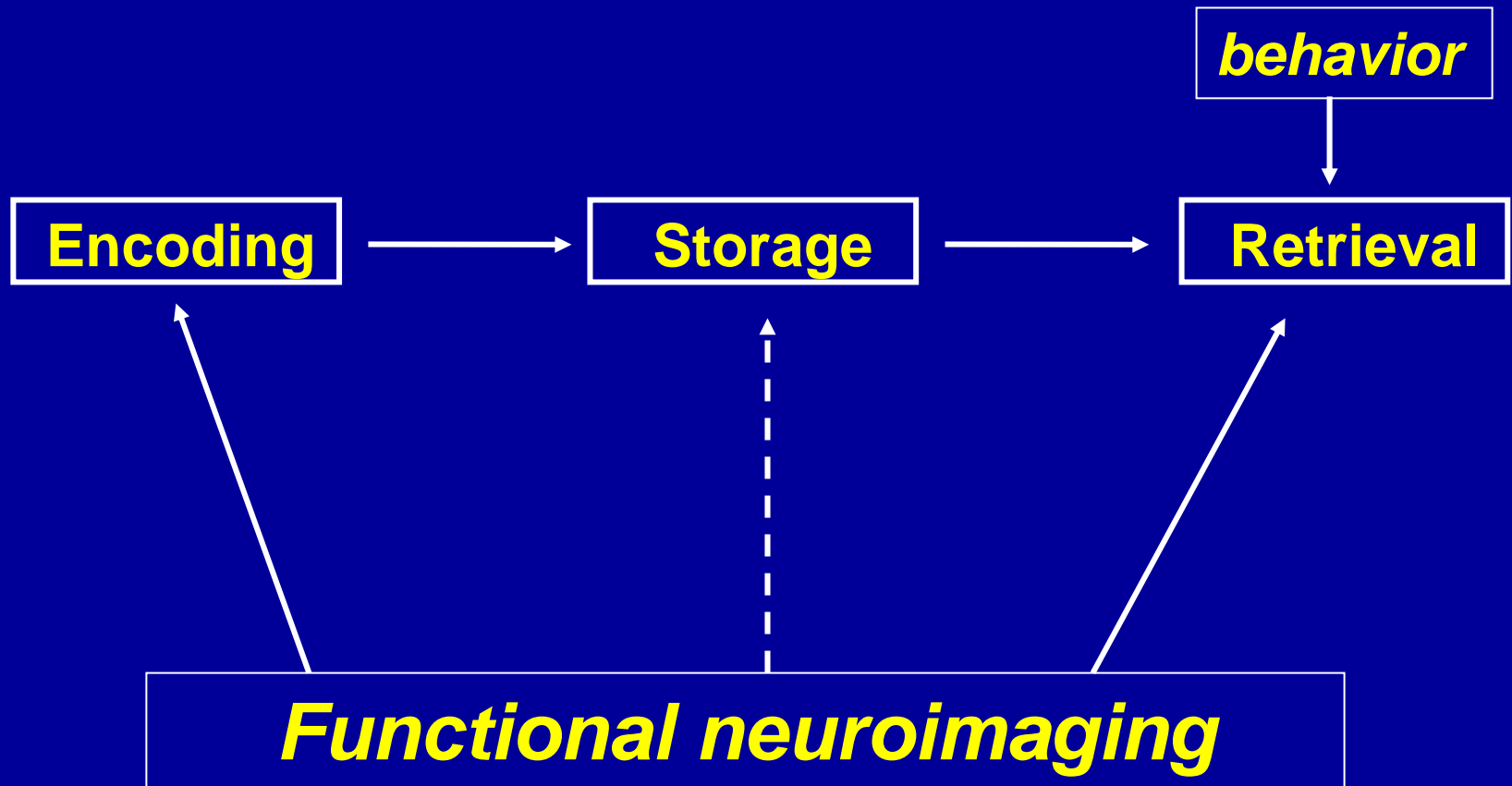
*Sabsevitz et al., 2003, better than age at onset seizure,  
preoperative naming performance, Wada test*



# ***FROM HUMAN COGNITIVE NEUROSCIENCE TO EPILEPSY***

- **memory**
- **attention/cognitive control (ADHD)**
- **language & thought**

# Stages of Memory











# Visual Encoding Task

“indoor or outdoor?”



Event



Event



Event



Event

fixation  
point

fixation  
point

fixation  
point

24 events  
X 4 runs

...

15.84 s

2.88 s

10.08 s

0 s

380 s

# Event-Related Design For Subsequent Memory

Separate response recorded for each stimulus



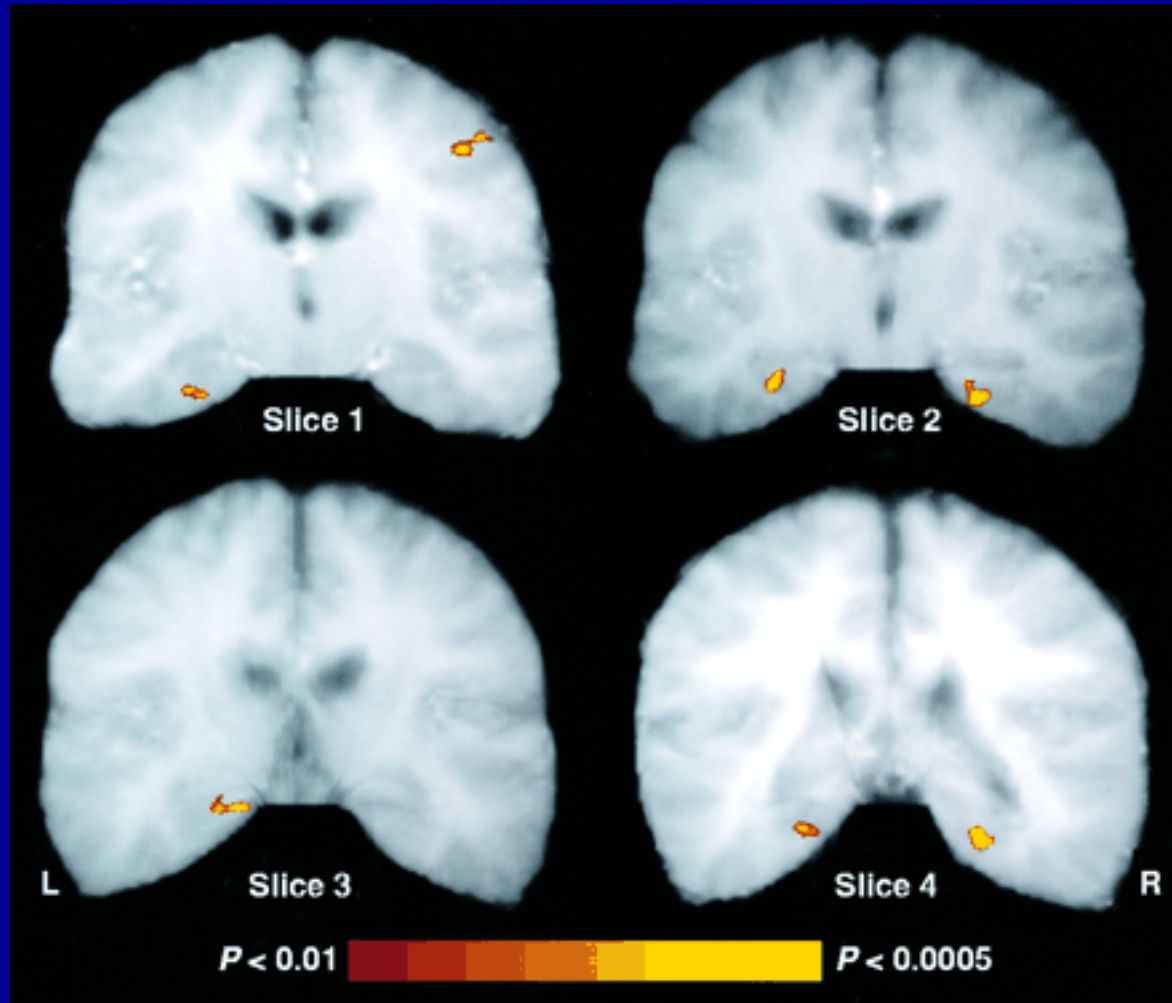
Later memory test



Compare fMRI responses leading to  
successful vs unsuccessful memory encoding



# Greater Medial Temporal Lobe and Frontal Lobe Activation Correlated with Successful Memory Formation



## 9.5 year old girl, scanned 3 times over 6 months



Moriattt

You have let me have more fun in 3 days than I could have in any other place.

Just think of it I'm playing a game when at the same time I'm a research ginny pig

and who knows I might help someone else my age if they have any brain problems, while still earning money.

And what do you think bants that? Nothing. Thanks -

# Experimental Design

Participants: 14 adults (ages 19-24 years), 35 children (ages 8-17 years)

## Memory Task:

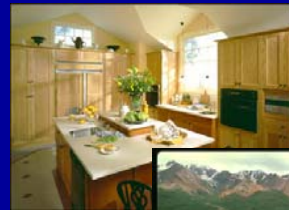
*Encoding (scanned):*

250 scenes



*Recognition test: Item*

500 scenes



**Old; Remembered**

**R**



**Old; Familiar**

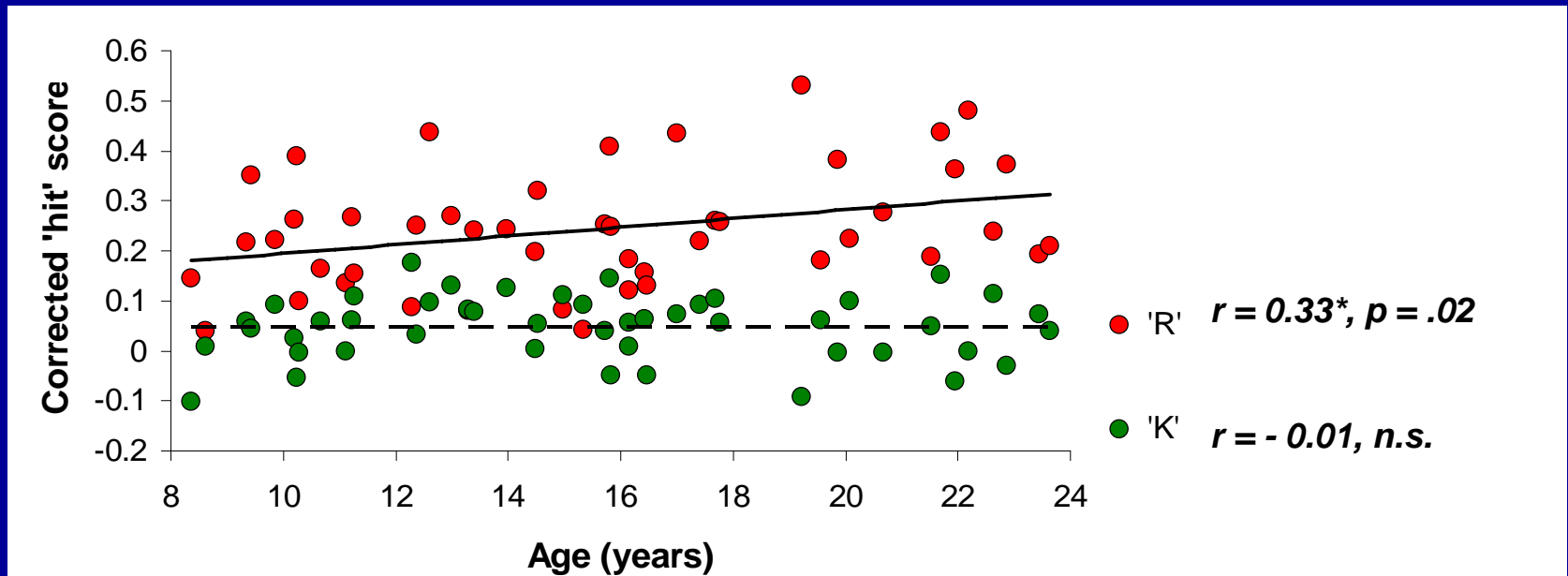
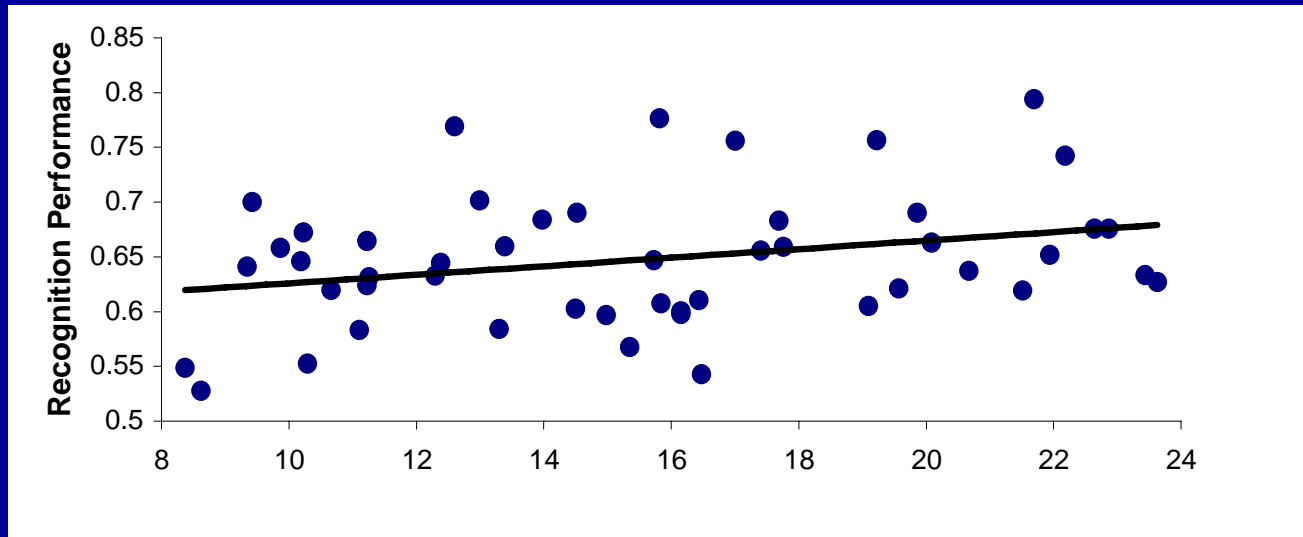
**K**



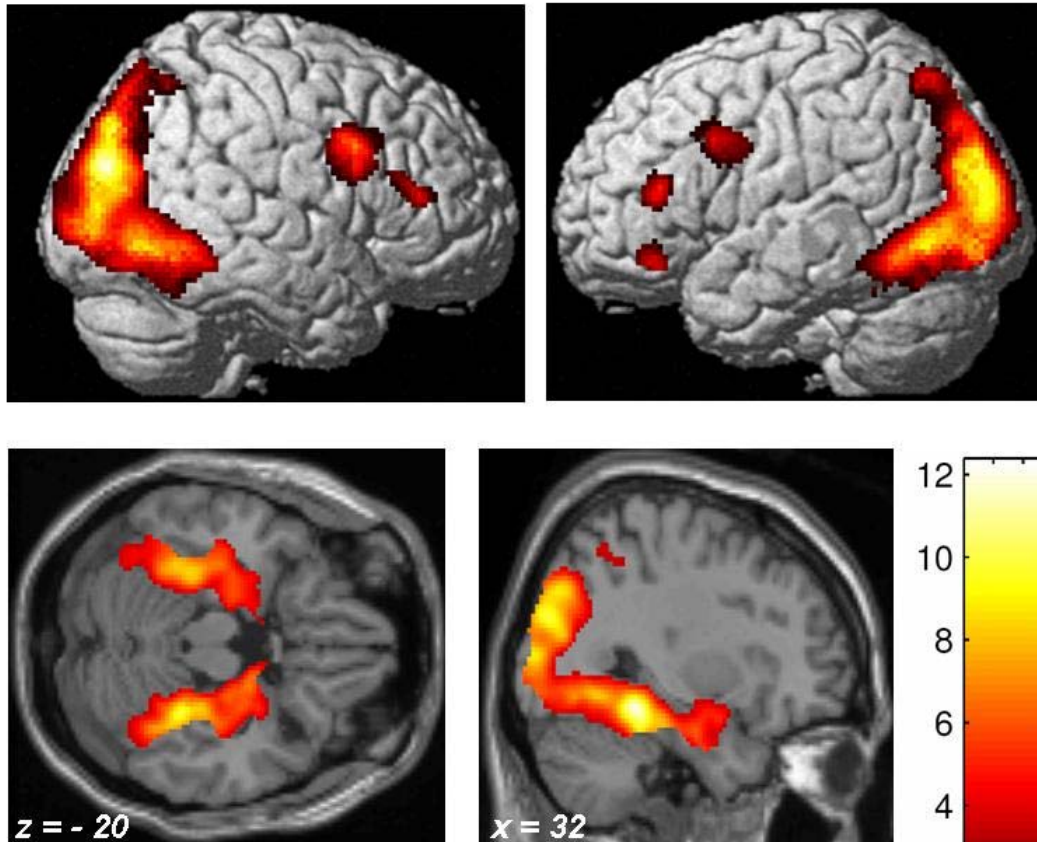
**New**

**F**

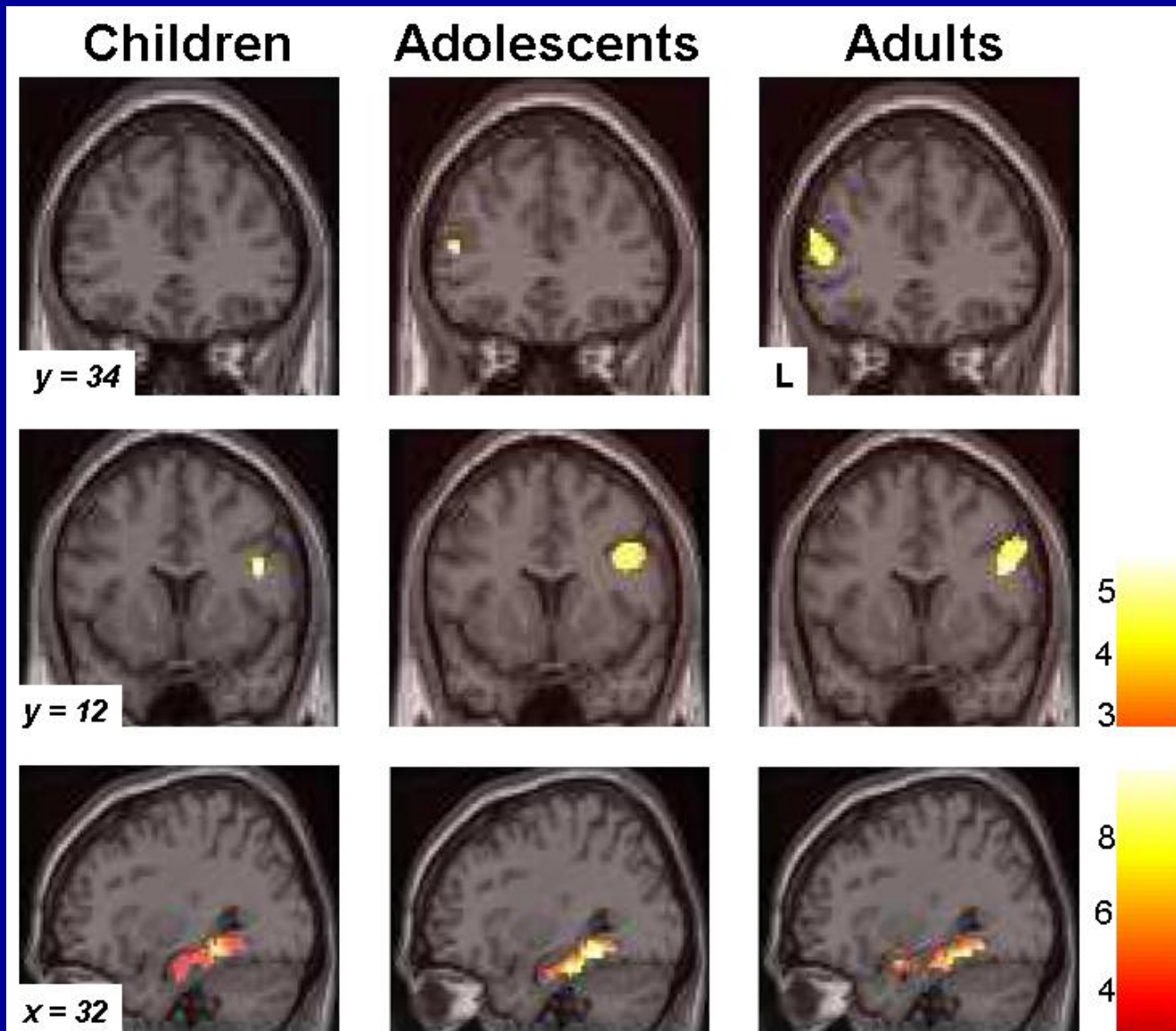
# Behavioral Results



# Regions of Interest: Remembered > Forgotten



# Remembered > Forgotten



# Development of Memory Systems

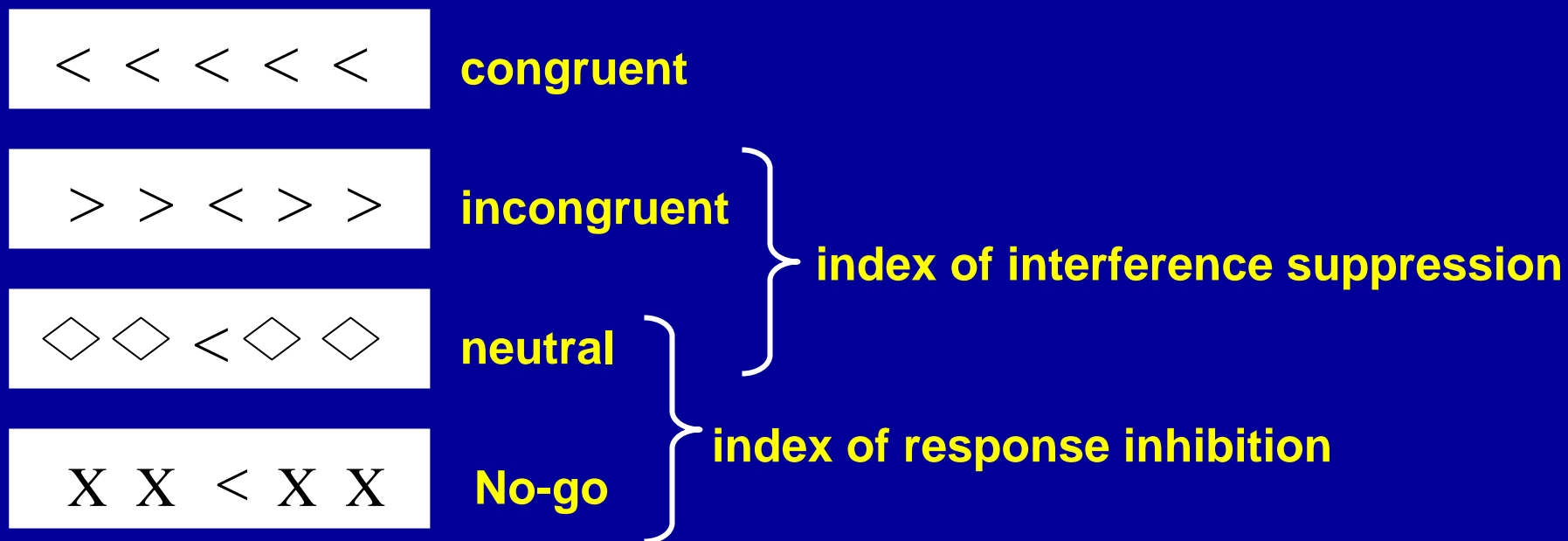
- medial temporal lobe  
*earlier development*
- prefrontal cortex  
*later development*

# ***FROM HUMAN COGNITIVE NEUROSCIENCE TO EPILEPSY***

- **memory**
- **attention/cognitive control (ADHD)**
- **language & thought**



**“Press button in response  
to the direction of central arrow”**

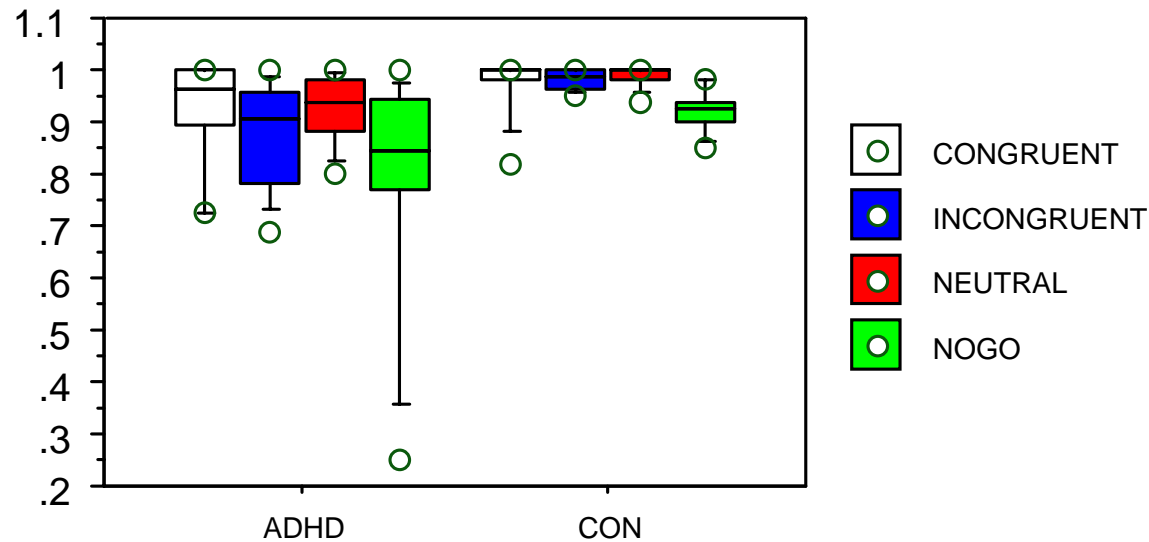


**10 Combined-type ADHD children 7 - 11 years (8 med naive)  
10 age and IQ-matched controls**

# **What is the functional signature of reduced inhibitory control in ADHD?**

- **same neural network as healthy children but activated to reduced/greater extent?**
- **distinct neural network relative to healthy children due to distinct strategies?**

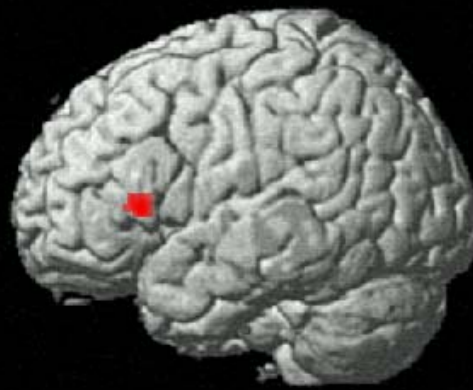
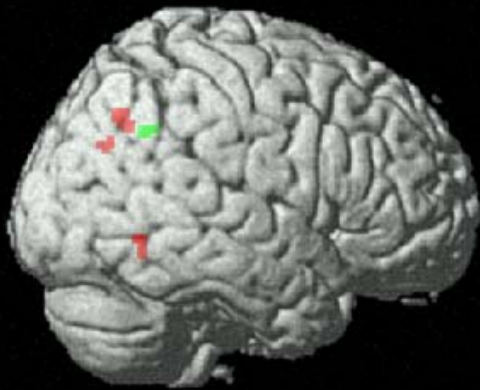
# Impaired Interference Suppression & Response Inhibition in ADHD



# Interference Suppression

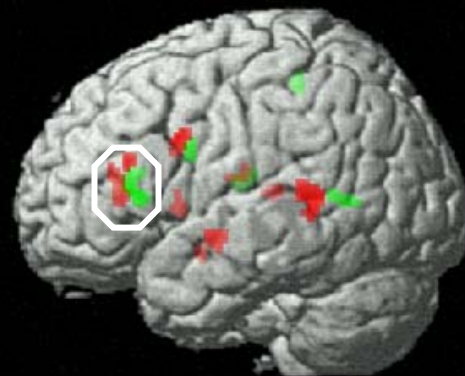
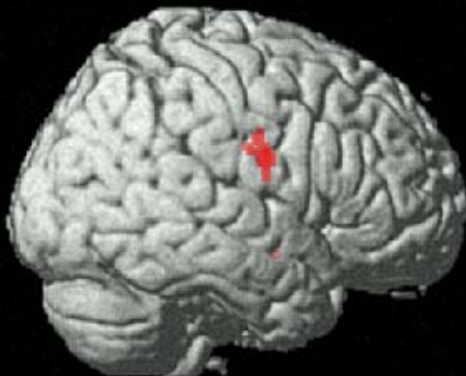
Incongruent > Neutral

A. Group average



■ ADHD  
■ CONTROLS

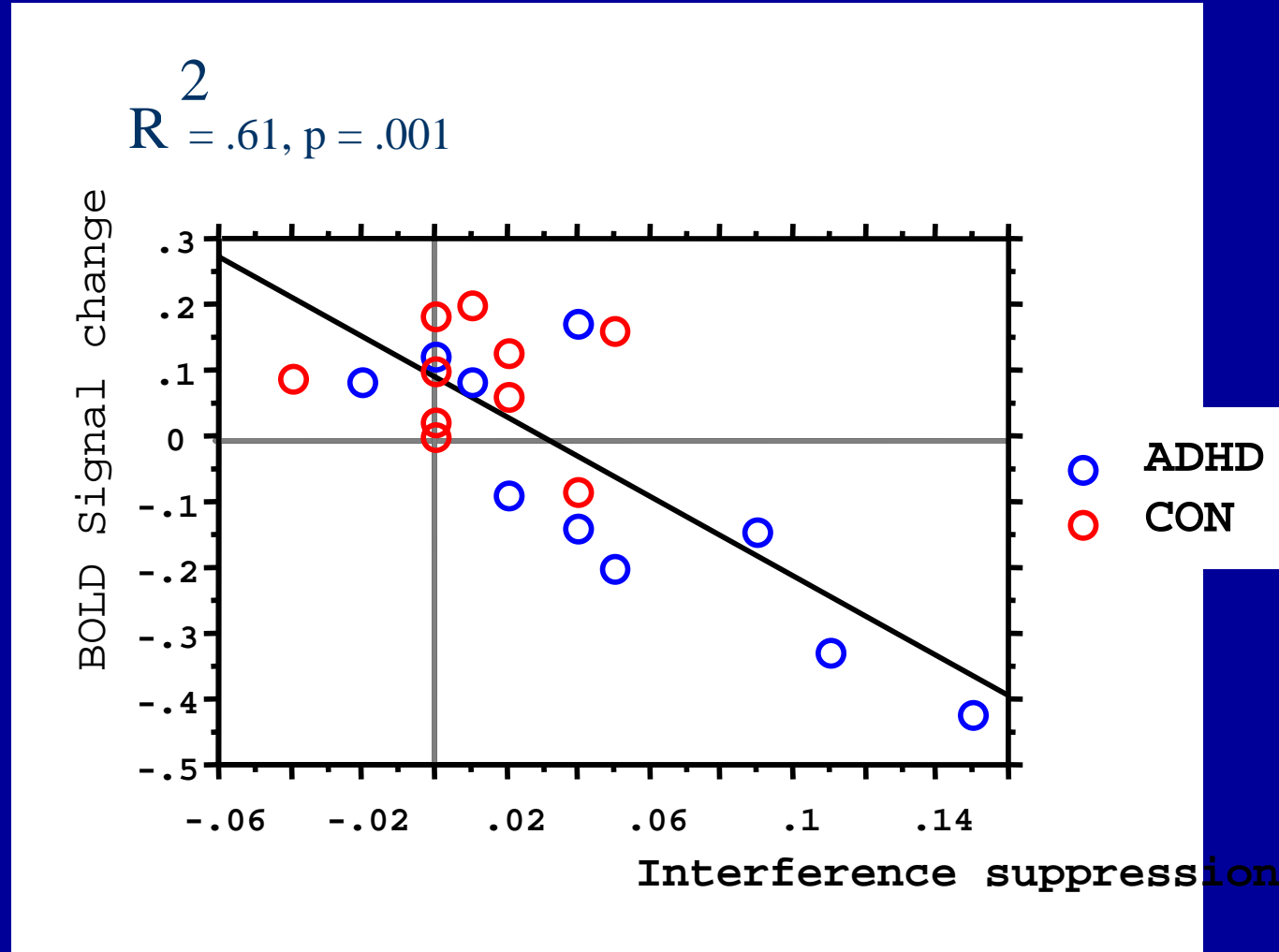
B. Positive correlation with success of interference suppression



# Reduced activation in left inferior frontal regions in ADHD during interference suppression



Left inferior frontal gyrus



good ← ————— → poor

# fMRI of interference suppression in ADHD

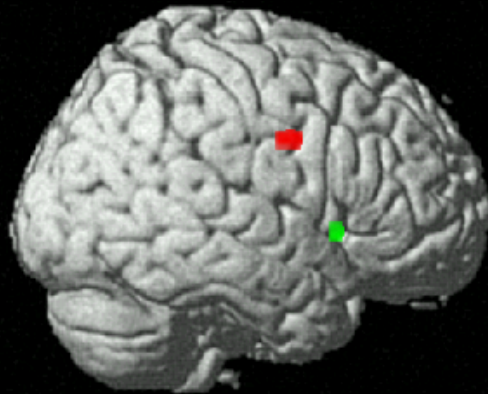
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- Similar cortical regions subserved interference suppression in ADHD and controls
- ADHD children fail to recruit the neural network *to the same extent as control children*

# Response Inhibition

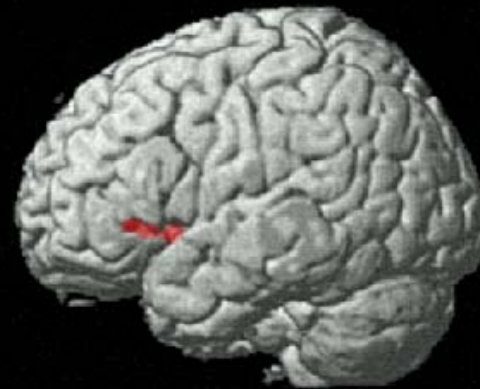
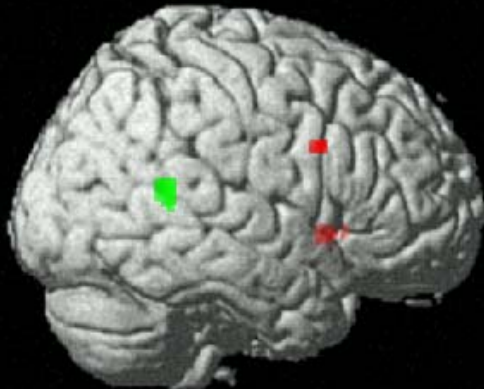
No-Go > Neutral

A. Group average



ADHD  
CONTROLS

B. Positive correlation with success of response inhibition



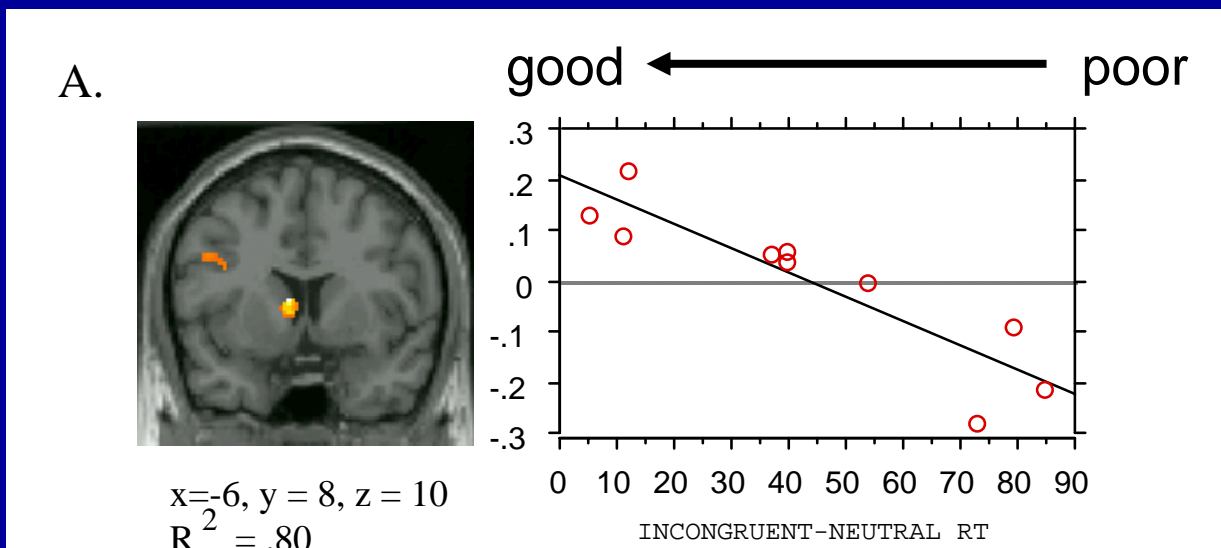
# fMRI of response inhibition in ADHD

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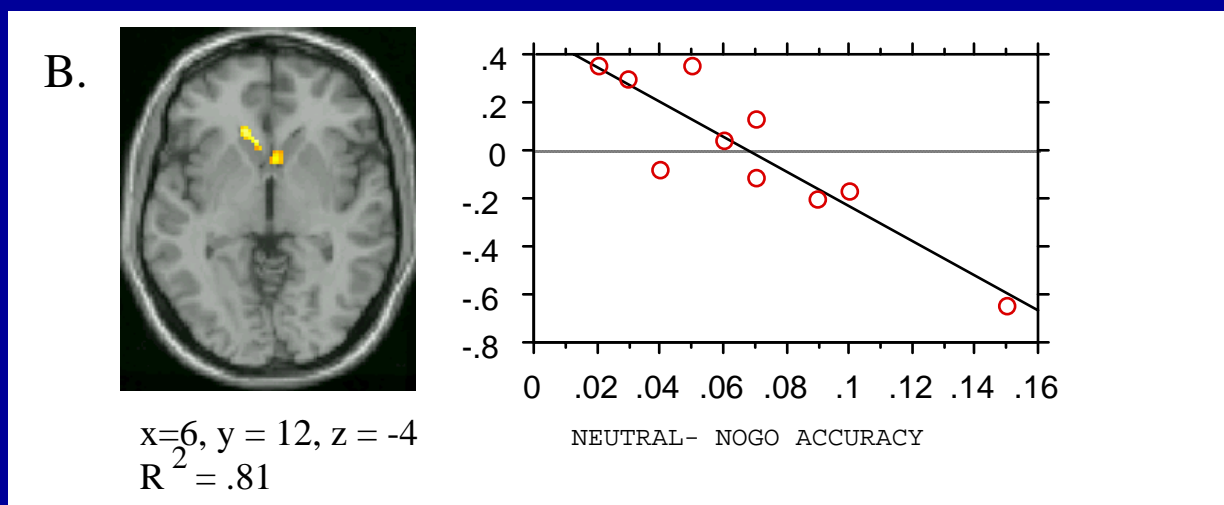
- **Successful response inhibition was related to recruitment of frontal cortex in controls but right posterior temporal cortex in ADHD**
- **ADHD children fail to recruit the neural network *that is typically recruited by controls***



# Interference suppression related to caudate activation in controls but not ADHD



# Response inhibition related to caudate activation in controls but not ADHD

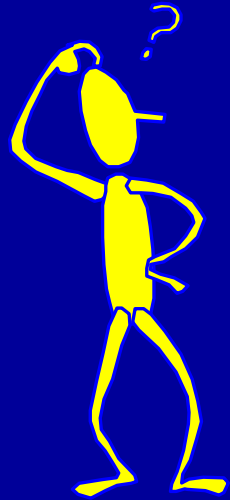


# ***FROM HUMAN COGNITIVE NEUROSCIENCE TO EPILEPSY***

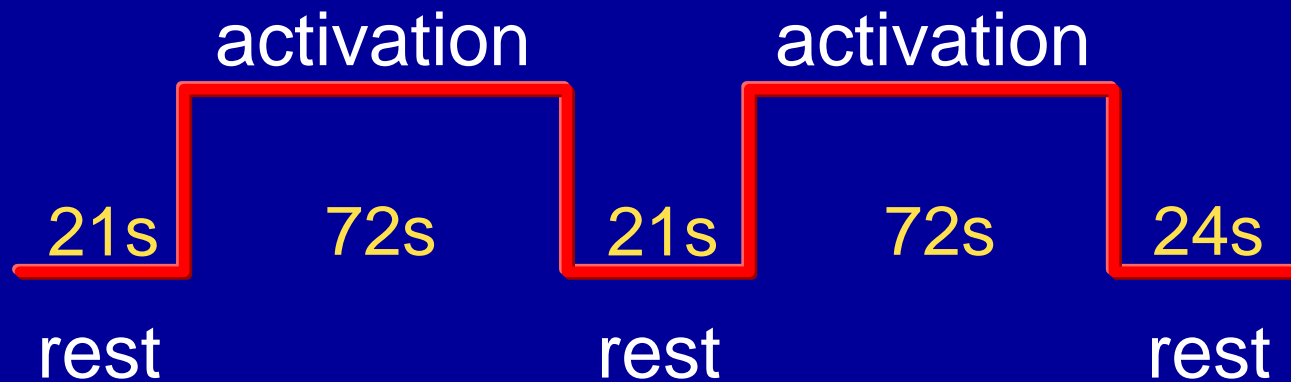
- **memory**
- **attention/cognitive control (ADHD)**
- **language & thought**

*(Caplan et al., 2003; Dapretto et al., 2005)*

Does this answer make sense?



## Reasoning

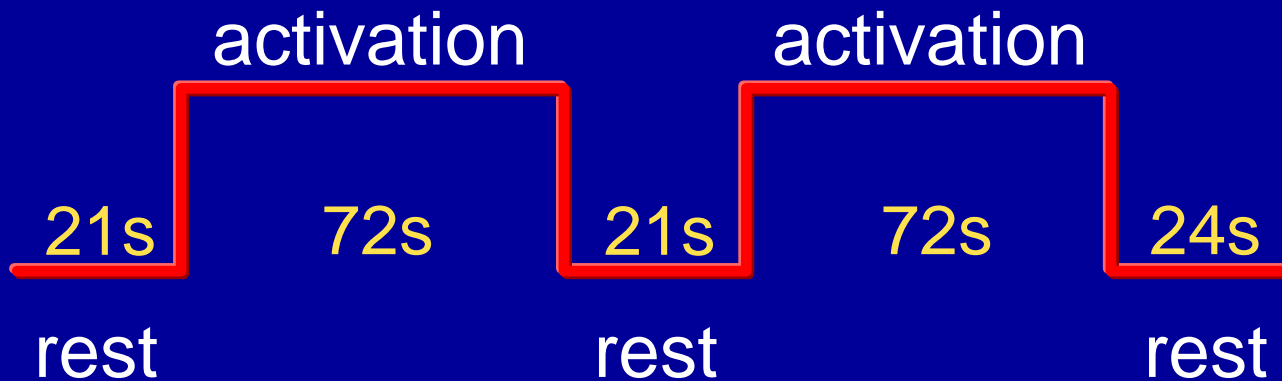


**Q:** *"Why are you wearing a raincoat?"*

**Logical A:** *"So I won't get wet."*

**Illogical A:** *"So I don't get tired."*

# Does this answer make sense?



**Q:** *"Do you believe in angels?"*

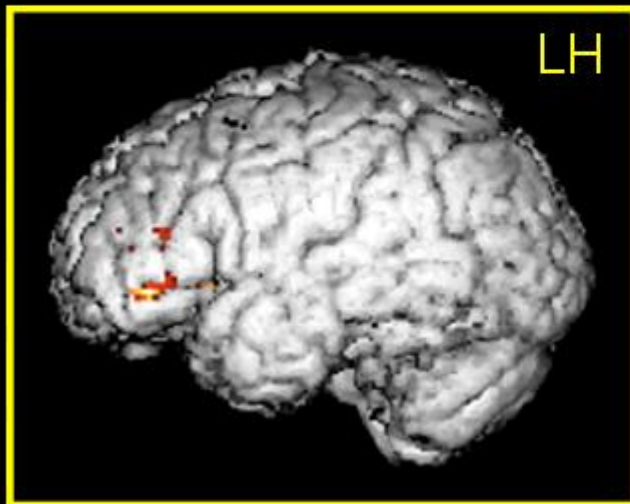
**On-Topic A:** *"I have my own special angel."*

**Off-Topic A:** *"I have my own special sandwich."*

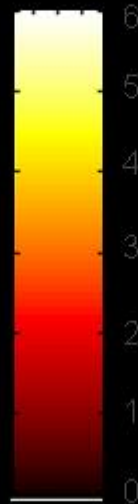
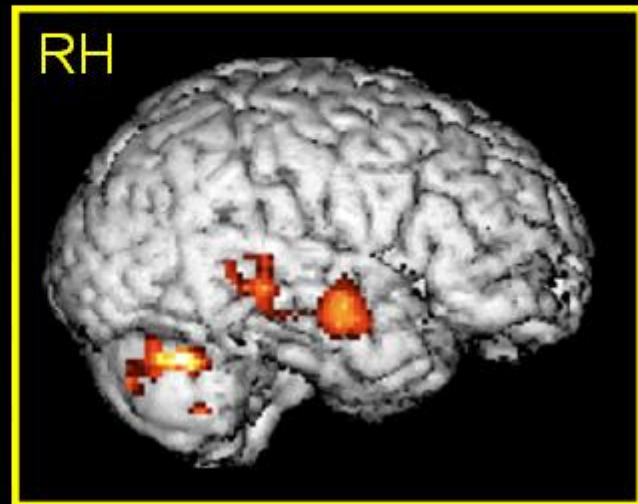
# TD Control > CPS Group

(Dapretto et al., 2006)

## Reasoning



## Topic Maintenance



Significantly greater activity in controls than CPS children in the left IFG and in right temporal cortex for the reasoning and topic maintenance conditions, respectively.

**FROM EPILEPSY TO HUMAN  
COGNITIVE NEUROSCIENCE**

***FROM HUMAN COGNITIVE  
NEUROSCIENCE TO EPILEPSY***