

Lecture 11

Part One: The Challenge

The Challenge

- In *Cortex*, 2006 Coltheart issued a challenge:
 - What has fMRI told us about the mind so far?
 - When has *fMRI* provided *data that has adjudicated between rival cognitive psychological theories*?

Plan

- Understand the challenge
 - Look (briefly!) at fMRI
 - What is it for a theory to be a ‘cognitive psychological’ theory?
 - What is it for data to ‘adjudicate’ between cognitive psychological theories
 - Consider some of the background around the challenge

fMRI

- fMRI - functional magnetic resonance imaging
- An indirect measure of neural activity
 - Measures H₂O
 - H₂O concentrations higher in blood than surrounding tissue
 - More H₂O in an area means more blood is in an area
 - More blood flows to areas that have been active (to renourish them)

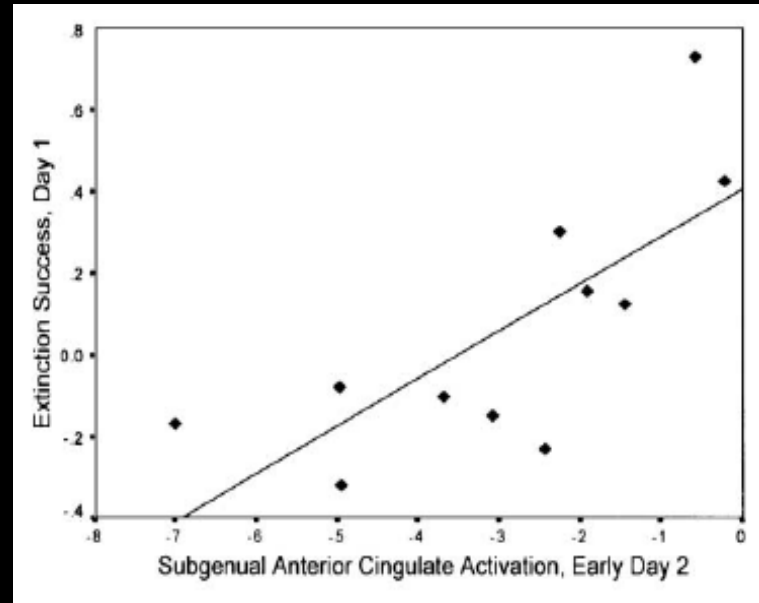
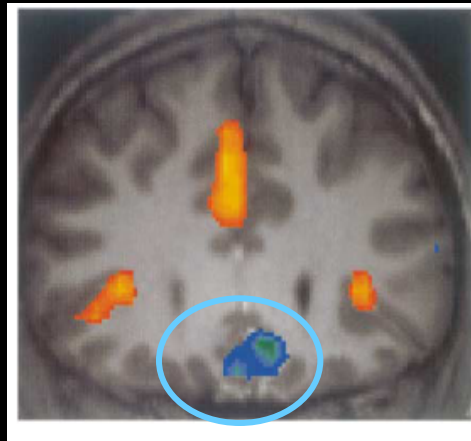
fMRI

- fMRI is but one method of neuroimaging
 - EEG, MEG, PET, CAT, X-RAY, SCR etc...
- All have virtues and vices
- Virtues of MRI:
 - Most hospitals have them (detect soft tissue damage)
 - Relatively inexpensive
 - Non-invasive
 - Fairly good localization
 - Psychologically attractive data

fMRI

- Most fMRI trials are TIME BLOCKED
 - The data is not of activity in one instant, but an average of activity over a 2 second period
- Since blood takes some time to flow (and occurs after neural activity) the temporal resolution of fMRI is poor

FMRI evidence for vmPFC role during delayed fear extinction



correlation with amygdala ($r = .8, p < .01$)

Phelps et al., *Neuron*, 2004

Cognitive Psychology

- Cognitive psychology is the scientific study of cognitive processes
 - Perception, attention, language, memory
- Cognitive psychological theories predict (and are answerable) to behavioral data
 - Accuracy of responses, kinds of errors, response times

Data Adjudication in Cognitive Psychology

- Let T_a and T_b be two different cognitive psychological theories
 - T_a
 - T_b
- T_a and T_b predict different behavioral data (accuracy of response, kind of error, response time etc)
 - IF T_a THEN B_1
 - If T_b THEN NOT B_1 (perhaps B_2 instead)
- If B_1 were found this would adjudicate between the theories by providing support for T_a over T_b

Example

- Ta - Irregular word reading requires access to semantics (Plaut et al, Rogers et al)
- Tb - Irregular word reading does not require access to semantics (Goodall and Phillips, Patterson and Shewell, Lytton and Brust, Coltheart et al, etc)
- Ta predicts *all* patients with impairments to the semantic system will be impaired at irregular word reading (B1)
- Tb predicts *some* patients with impairments to the semantic system will have normal irregular word reading (NOT B1)

Example

- There are patients with impairments to the semantic system who have normal irregular word reading (NOT B1)
- So in this case the above behavioral data supports theory Tb over theory Ta
- Coltheart wants examples where neuroimaging data has adjudicated between two rival cognitive theories in the same way that the behavioral data adjudicated between two rival cognitive theories in the previous example

Background to the Challenge

- Philosophy background
- Cognitive Neuroscience background
- Cognitive Psychology background
 - Coltheart does not explicitly mention this

Philosophy Background

- ‘Rather a lot of people believe you can’t learn anything about cognition from studying the brain (Harley, Coltheart, Colby, Morton, van Orden and Paap, Uttal, Fodor)’
- Some philosophers have claimed that neuroscience can’t show us anything about the structure of cognitive processes *in principle*
 - E.g., If you want to learn about the structure of Microsoft Word then learning about the hardware *is irrelevant*

Cognitive Neuroscience Background

- In contrast to this many cognitive neuroscientists maintain that fMRI (in particular) has much to show us about the nature of cognitive processes
- Cognitive neuroscience textbooks typically say that we have made significant advances in understanding cognition as the direct result of advances in neuroimaging techniques

Background for Cognitive Neuroscientists

- ‘How might these people be shown the error of their ways? All that is needed to do this is to provide them with actual examples where neuroimaging data have successfully been used to distinguish between competing psychological theories. They all claim that this cannot happen. Has it ever happened?’

Background for Philosophers

- ‘If it turns out that none of this work (so far) can be used to distinguish between competing psychological theories, the in-principle question of whether cognitive neuroimaging data can ever serve this function will deserve much more attention than it has so far been given’

Cognitive Psychology Background

- Coltheart considers himself a 'pure cognitive psychologist'
- He also considers himself a 'cognitive neuropsychologist'
 - Neurological patients
- He does not consider himself a 'cognitive neuroscientist'
 - A cognitive psychologist who has started to use neuroimaging - much more prevalent these days

Cognitive Psychology Background

- Both cognitive psychologists and cognitive scientists characterize behaviorists as clinging to a dying paradigm
- Cognitive neuroscientists tend to think of the age of the brain and the development of neuroimaging techniques being a new paradigm for the science of the mind
- Cognitive psychologists are concerned that neuroimaging has psychological appeal but isn't helping us learn about the mind
 - The 'new phrenology'

The Challenge

- Restricted to what has been found so *far*
 - Failure to find a case doesn't entail that there won't be a case in the future
 - Though it might get us thinking on why there hasn't been a case and whether there is likely to be a case in future

The Challenge

- Restricted to fMRI
 - Failure to find a case doesn't entail that other neuroimaging techniques are similarly unsuccessful
 - Though it might get us thinking on why there hasn't been a case and whether there is likely to be a case for other neuroimaging techniques

The Challenge

- Restricted to what fMRI can tell us about *cognitive processes*
 - Concerned solely with data adjudicating between two *cognitive theories* and explicitly not concerned with data adjudication between two *brain theories*
 - fMRI might well have told us lots about the brain. That isn't relevant, however. We are solely interested in what it has told us about the mind

The Challenge:

- When has *fMRI* provided *data that has adjudicated* between two *rival cognitive psychological* theories?

PROVIDE A CASE!!

– (Ideally in print)