Lecture 5
Neuroimaging and neuropsychological correlates of control

Professor Ian Robertson
Course Outline

- Control: definitions and development
- Learned helplessness, depression and control
- Status Syndrome – socioeconomic factors in health
- Cognitive control – mechanisms of attentional control
- Neuroimaging and neuropsychological correlates of control
- Neurochemistry and neurophysiological covariates of control
- Molecular genetics and evolution of control
- The biology of social dominance
- Implicit processing in dominance hierarchies
- Lifespan development and control
- Control and personality
Oh the temptation.. video

See: http://vimeo.com/5239013
Delay of Gratification in Children

Walter Mischel, Yuichi Shoda, Monica L. Rodriguez

- Marshmallow test – one now or two later – how long do they wait before cracking?
- Harder when marshmallow present in front of them
- Children used different strategies
- Eg thinking about eating the two marshmallows – or distracting themselves
• Distraction was more effective than thinking about the marshmallow
• But creating a symbolic representation of the marshmallow (‘making a picture of it’) was equally effective
• *Control of attention* in the interval was crucial in determining delay
The Nature of Adolescent Competencies Predicted by Preschool Delay of Gratification

Walter Mischel and Yuichi Shoda
Columbia University

Philip K. Peake
Smith College

• 10 year follow up as teenagers, parent ratings
• Children able to wait longer at 4 or 5
  – more academically and socially competent
  – verbally fluent
  – rational, attentive
  – planful, and able to deal well with frustration and stress
  – Better scores on standardised scholastic tests
Attentional Control as a Gateway to Self–Control?

• Self–control as a gateway to cognitive, social and emotional development?

• See Lecture 10 on lifespan development and control
Attention, Self-Control, and Health Behaviors

Traci Mann¹ and Andrew Ward²

- attention plays key role in self-control (Baumeister, et al 1994).

- Focusing attention on the self, the repository of personal standards, leads to successful self-control.

- Predicts conditions that take attention away from the self (e.g., becoming anonymous in a large crowd will lead to loss of self-control)

- prediction that has been borne out in many research studies.
An aside on the history and culture of self….

• The notion of individual selves did not fully emerge in western literature until 12th century.

• Coincided with Christian concept of last judgment changed from on of collective to individual salvation.

• Only in 16th Century and Protestant reformation do inklings of self-improvement appear in literature.

Self in Collectivist versus Individualistic Cultures

- In collectivist (e.g., Chinese) cultures, self-concepts are more interdependent.
- Less often in a state of subjective self-awareness (attention to self).
- Less likely to attribute other peoples’ behaviours to stable internal attributions and more to contextual effects.

- See also Richard Nisbett – The Geography of Thought.
Culture-sensitive neural substrates of human cognition: a transcultural neuroimaging approach

Shihui Han and Georg Northoff
Nature Reviews Neuroscience volume 9 | august 2008 | 647
* Chinese people and Westerners conducted trait judgements of themselves, of their mother and of a famous person (an ‘other’).

* The ventral medial prefrontal cortex (VMPFC) and the perigenual ACC showed greater activation with self judgement than other judgement both groups.

* BUT signal changes in the VMPFC did not differentiate between self and mother judgements in Chinese participants.

* BUT did differentiate between them in American participants (American participants’ signals were greater for self judgement). Han and Northoff (ibid)
both Christian and non-religious participants conducted trait judgements of themselves and a public person.

Christian participants showed higher activation in the dorsal medial prefrontal cortex (DMPFC) for self judgement than for other judgement;

non-religious participants showed higher VMPFC activation for self judgement than for other judgement

? Surrender to external other – ‘God’ – reduce the internal self perspective?

Han and Northoff (ibid)
World Value Surveys showed that Asians (including Chinese, Japanese, and Koreans) report lower levels of perceived personal control than do non-Asians. Japanese participants in the group condition, relative to those in the individual condition, were more optimistic about obtaining a favorable outcome.

American men, on the other hand, were more optimistic in the individual condition.
Exercise – draw on forehead
Participants assigned to the highpower condition were instructed to recall and write about a personal incident in which they had power over another individual or individuals.

Participants assigned to the low-power condition were instructed to write about a personal incident in which someone else had power over them.

Power was defined as controlling the ability of another person to get something he or she wanted or being in a position to evaluate someone else.
• …Back to self–control and health behaviours

• Attentional myopia (Mann and Ward, 2007)

* Current Directions in Psychological Science 2007, Volume 16, p 280
Attentional Myopia

- Cognitive Load
- Physiological Arousal

Attentional Narrowing

- Situational Cues
  - Promoting cues more salient
  - Inhibiting cues more salient

- Self-Regulatory Consequences
  - Behavior promoted
  - Behavior inhibited
Attentional Myopia

• *self-control:* – management of conflict between competing pressures—prompted by situational and/or internal cues.

• Some of these cues impel engagement in behaviour while others act to prevent the individual from taking action.

• Model predicts that where conflicting behavioral pressures (e.g., attempting to diet while faced with the temptation of high-calorie food), limitations on attention – attentional myopia—will lead to:

  – loss of control if highly salient cues suggest the instigation or promotion of behavior, and,
  – enhanced self-control if highly salient cues instead suggest behavioral restraint.
Attentional Myopia

Previously showed that occupying attention disinhibited dieters’ normally restrained consumption

Then gave cues promoting eating (salient food items) or inhibit it (eg a scale and diet books)

given a high–fat milkshake and left alone to consume as taste test

Dieters remembering a 9-digit number consumed nearly twice as much when exposed to the promoting cues than when exposed to the inhibiting cues

Dieters on low–load task (remembering a single digit) less influenced by cues in either condition
Is Decreased Prefrontal Cortical Sensitivity to Monetary Reward Associated With Impaired Motivation and Self–Control in Cocaine Addiction?

- Sixteen cocaine abusers and 13 controls
- forced–choice task under three different levels of money reward for correct responses
  - 45 c versus 1 cent versus 0 cent
- Up to maximum of 50 dollars
Reward related changes in controls but much less in cocaine users
Abnormal brain activations to reward
Self-control ratings and prefrontal cortex responsivity to reward
Good connectivity between different frontal areas in controls

Lateral frontal areas responded to reward in controls in the same way as orbitofrontal areas

This relationship ABSENT in cocaine users
The Right Brain Hypothesis for Obesity

Miguel Alonso-Alonso, MD, MPhil
Alvaro Pascual-Leone, MD, PhD

long-term effects on health or body shape. The human, cognitive dimension of eating may play insufficiently emphasized role in obesity.

- JAMA, April 25, 2007—Vol 297, No. 16 1819
- Very preliminary hypothesis
Obesity Hypothesis

• overeating and weight gain a common side effect in patients who underwent frontal lobotomy

• Damage to the right frontal lobe can cause a passion for eating and a specific preference for fine food, the so-called gourmand syndrome.

• In patients with degenerative dementia, the presence of hyperphagia correlates positively with right frontal atrophy and negatively with left frontal atrophy.

• hyperactivity of the right PFC can lead to anorexia–like symptoms, for example, in patients with right prefrontal focal epilepsy, in which the eating disorder can cease after initiation of anticonvulsant therapy.
Obesity Hypothesis

• Disrupting the activity of the right but not the left dorsolateral PFC induces a disregard for the long-term adverse consequences of choices, favoring risk-taking when subjects perform a gambling task.

• Successful weight-loss maintainers, who have a high degree of dietary restraint and body image awareness and monitoring, show more activation of the right dorsolateral PFC after consumption of a meal, as compared with nondieters.

• Epidemiologic and experimental data link obesity to a chronic activation of the HPA stress response.

• Cortisol modulates dopaminergic activity with remarkably lateralized effects.

• Dopaminergic projections to the right hemisphere display an enhanced sensitivity to stressors that are specifically perceived as severe and uncontrollable, such as those that arise from social conflict.
Self-awareness and Right Frontal Lobe: a prerequisite for self-control?

1. Self-monitoring is an important basis for insight.

2. Accurate self-monitoring requires adequate online attention to ongoing performance in the routines of everyday life.

3. A vigilant attention (VA) system contributes to this routine monitoring.

4. VA a network of two inter-related but independent systems –
   – a locus coeruleus, noradrenalin based arousal system.
   – a right dorsolateral prefrontal and parietal network
Self-rating: a foundation of psychology

1. Do I tend to talk too loudly?
2. Would people consider me brash and insensitive?
3. Am I clever?
4. Am I forgetful?
5. Would others consider me bad-tempered?
6. Am I nervous?
7. Am I reliable?
8. Do I tend to gabble when talking?

SUCH SELF-RATINGS CAN BE RELIABLE AND VALID
Offline self–referential thought versus online self–evaluation

1. Offline judgments pertaining to internal, emotional or ‘self’ states – medial prefrontal cortex

2. During demanding tasks with external focus, medial frontal regions typically inhibited – dorsolateral prefrontal areas, among others, show activations

3. ‘Offline judgement as to whether I am habitually careless may depend on different processes from the ‘online’ assessment, in the course of attentionally–demanding activities, as to whether in this instance I have been careless or not.
A RIGHT FRONTAL–LINKED VIGILANT ATTENTION (VA) SYSTEM CONTRIBUTES TO THIS ROUTINE MONITORING.
Poor vigilant attention – poor self-awareness in normals

- Self and close other ratings on FRSBE –
- eg I tend to speak only when spoken to”
- “I tend to mix up a sequence, getting confused when doing several things in a row.”
- Hoerold et al Exp Br Research. 2008
Correlates of error awareness

Vigilant attention
O’Keeffe et al, Brain Research 2004

A high ratio of slow/fast wave activity in the EEG spectrum (indicating decreased cortical arousal)
O’Connell .. Robertson, Eur J Neuroscience 2008

Skin Conductance Response to Aware Errors in TBI
O’Keeffe .. Robertson Brain Research 2004

SCR response to aware errors correlates 0.62 in TBI with error awareness

a) less awareness of one’s errors ($r = -0.661$, $P < 0.01$)
b) a smaller Pe amplitude ($r = -0.546$, $P < 0.05$)
Awareness of Error

O’Connell, Dockree, Robertson et al, 2007; EJN

O’Connell et al European Journal of Neuroscience, 2008
Conscious awareness of change linked to right fronto-parietal activity – change blindness

Beck et al, 2001
Awareness of error is diminished in:

- Traumatic brain injury
- Attention Deficit Disorder
- Fronto–temporal dementia
- Progressive supranuclear palsy
- Cortico–basal degeneration

O’Keeffe et al *Brain*, 2007; O’Connell et al in press *Neuropsychologia*. 
Impaired error processing in TBI and ADHD

O'Connell, Bellgrove and Robertson, 2004; O'Keeffe and Robertson 2004

Fig. 1. Mean skin conductance responses for each group to no-go targets as a function of no-go response (withhold vs commission error).

Fig. 2. The mean skin response amplitude (μS) for withholding a response and errors of commission on Fixed-Baseline for TBI and control participants.

Post-error SCR amplitude difference significantly correlated with total number of vigilant attention errors on SART.
Awareness of Error

O’Connell, Dockree, Robertson et al., 2007; EJN
Alertness & awareness

• A high ratio of slow/fast wave activity in the EEG spectrum (indicating decreased cortical arousal) was associated with:

  a) less awareness of one’s errors ($r = -0.661$, $P < 0.01$)
  b) a smaller Pe amplitude ($r = -0.546$, $P < 0.05$)
Insight and the damaged right frontal lobe

- Alzheimer’s Disease: ‘Inaccurate insight was correlated with glucose metabolic rate in the right lateral frontal cortex after controlling for global cognitive dysfunction’ (Harwood et al, 2005)
- Stroke – anosognosia for hemiplegia, right frontal regions strongly associated (Pia et al, 2004)
- Fronto–temporal dementia, ‘Loss of insight is associated with hypoperfusion/hypometabolism in the right hemisphere, particularly the frontal lobe. (Mendez and Shapiro, 2005)
Accuracy of self evaluation was significantly correlated with functional activation of the right dorsolateral prefrontal cortex (Schmitz, Rowley, Kawahara, & Johnson, 2006)
Current awareness of schizophrenic symptoms with right dorsolateral prefrontal cortex volume. Spearman's $R = -0.72$ (Shad et al, 2006)