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# Thinking with your brain and with your body:

*The neurobiology of decision making and  
implications for mental health and well  
being*

# Background

# Assumptions: Humans

- That we make decisions with our brain
- That the body was made to carry the brain around
- That the “best” (ie, the most advantageous, for the particular context) decisions are made without emotion
- That the best decisions are based on logic and conscious deliberation

**Does current neuroscience support these assumptions?**

# Propositions: The Law



- That emotion, or unconscious processes, should play a role in **legal decision making** is inimical to the **rule of law**
- That is, that the rule of law **protects** from the **arbitrary exercise of public power**, as well as from the “**deployment of purely personal legal power**”

# Propositions: The Law



- In this, it is envisaged that legal decisions are made, **based upon reason and logic**, in the absence any **personal “bias” or other unconscious processes, including emotion**
- **Does current neuroscience support these propositions?**

# Neurobiological Research



- In the past few decades, there has been an explosion of research investigating the **processes** involved in decision making, including its **neurobiological underpinnings**
- A major finding has been that unconscious processes, including biases (or predispositions) and emotions, are an important and integral part of **deliberation, reasoning and final decision making**

# Decision making



- For example, it is now well accepted in the **cognitive psychology** domain that there are two main systems that go to make up the decision-making process:
  - **Firstly**, what has been referred to as a “System 1”, which has been associated with “**Intuition**” and **fast** and **unconscious** mental processing
  - **Secondly**, a “System 2”, which has been associated with formal concepts of “**Reason**” and **slow** mental processing

# Decision making ...



- The **neurobiologists** for their part, have gone some way to identifying the **neurobiological networks** that underpin these two decision making systems
- **Additionally**, they have found that one of the networks that underpins one of the systems (System 1) has its own **rich network** through the brain - which also **extends to the outer reaches of the body**
- Through this connection, it is now well recognised that **visceral responses and bodily sensations** play an integral and **essential role** in cognition in general, and decision making in particular



# Decision making ...



- The aspects of decision making most likely to be associated with such **bodily responses** and **associated unconscious biases**, are those decisions that relate to **personal, social, or moral** issues
- Additionally, it is in decision making situations when these personal, social and moral issues are **considered**, that the decision maker is most likely to experience some degree of “**emotional**” response via **bodily sensations**

# Decision making ...



- In fact, **for these types** of decision, the role of **emotion** and **associated bodily responses** is said to be **essential** to the **integrity** of the decision making **process** itself

# Aims of presentation



- 1) Assist with understanding of the **neurobiology** of decision making
- 2) To understand how **bodily reactions and emotions** are essential to some forms of decision making
- 3) To raise the awareness that a **barrister's decision making**, both professionally and personally, will be enhanced where the **barrister's bodily state (and mental health)** have been given attention and care

# Bennett & Broe (2012)



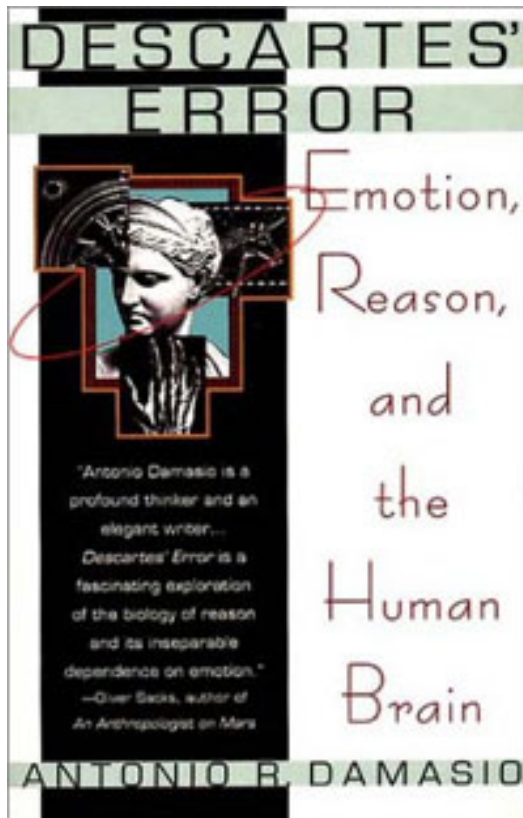
- Provides scientific references
- *The Australian Law Journal* (2012) Vol 86, p258

**The civil standard of proof and the “test” in *Briginshaw*:**

**Is there a neurobiological basis to being “comfortably satisfied”?**

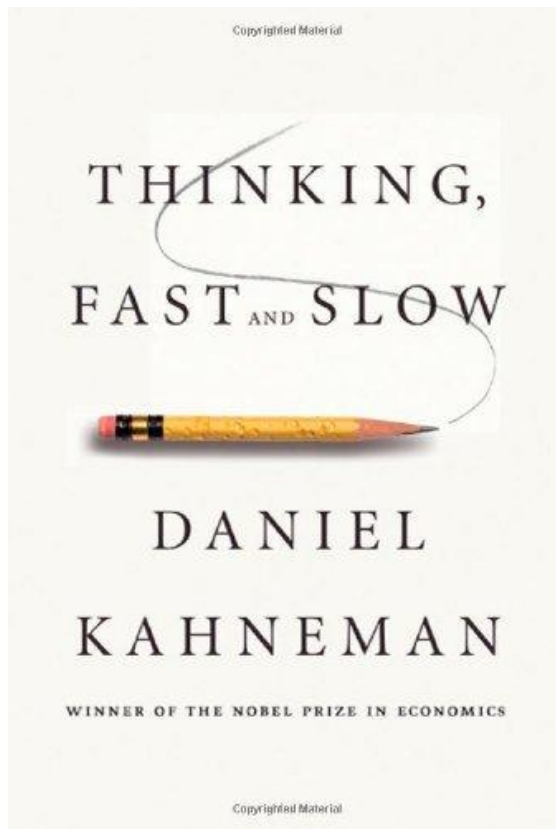
Hayley Bennett \* and G.A. (Tony) Broe \*\*

# Antonio Damasio (2006)



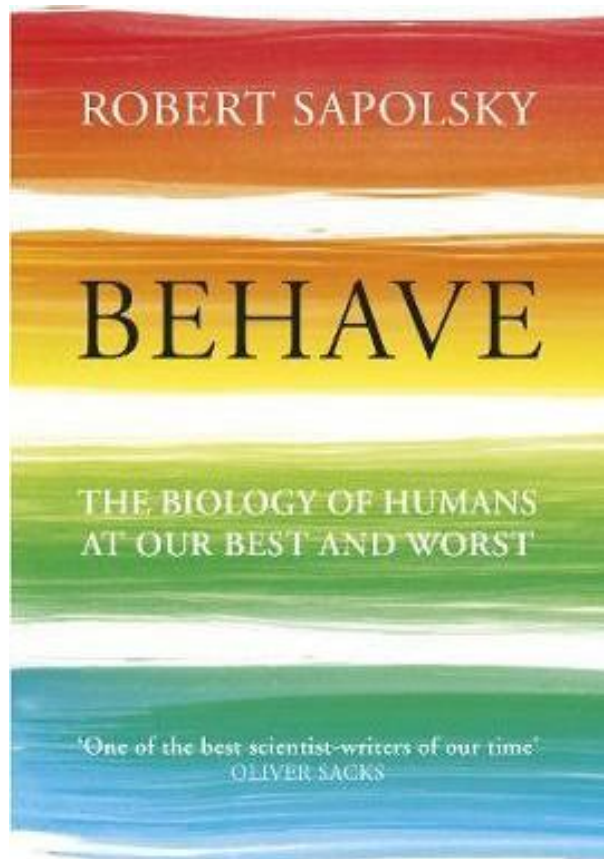
- Neurobiologist and neurologist
- World leader in research into the neurobiology of decision making

# Daniel Kahneman (2011)



- Nobel prize winning cognitive neuroscientist
- Uses cognitive, as opposed to biological references – but these graft onto neurobiological templates

# Robert Sapolsky (2017)

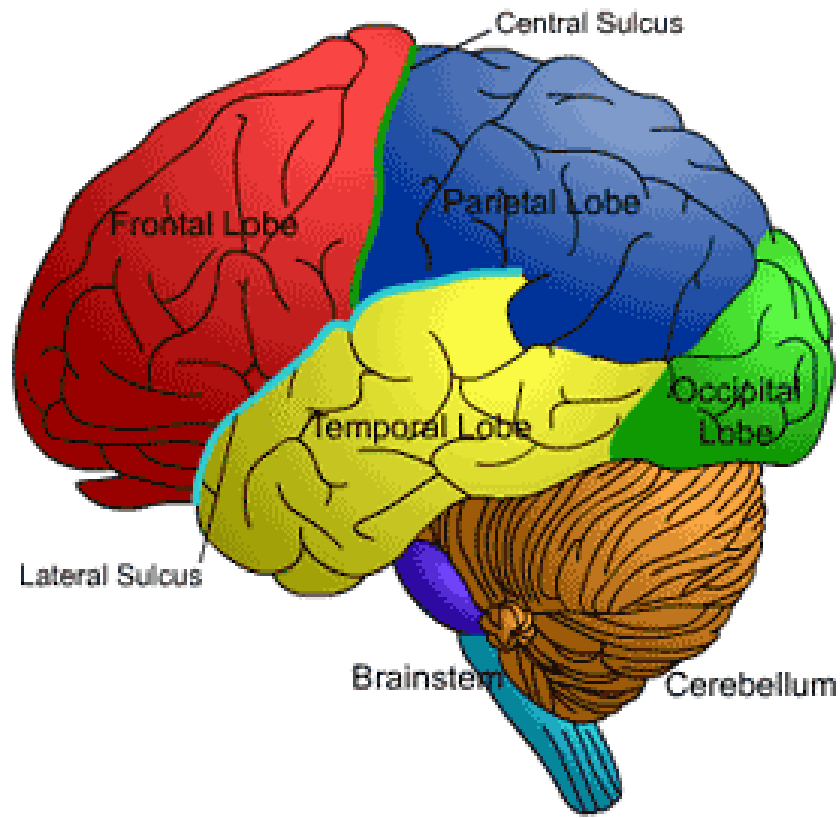


- Robert Sapolsky is an American neuro-endocrinologist
- He is currently a professor of biology, and professor of neurology and neurological sciences, and neurosurgery, at Stanford University

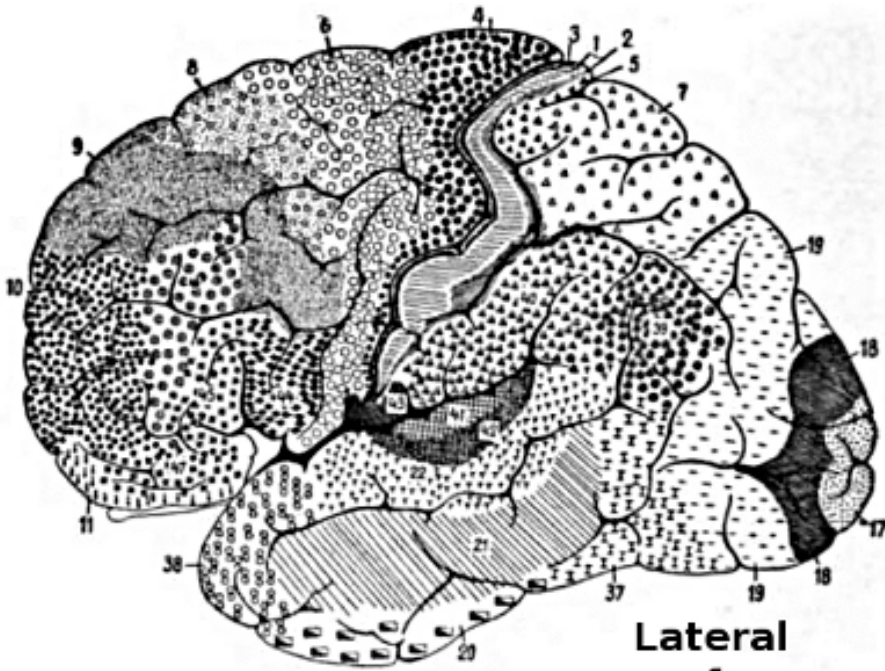
# Neurobiology of decision making



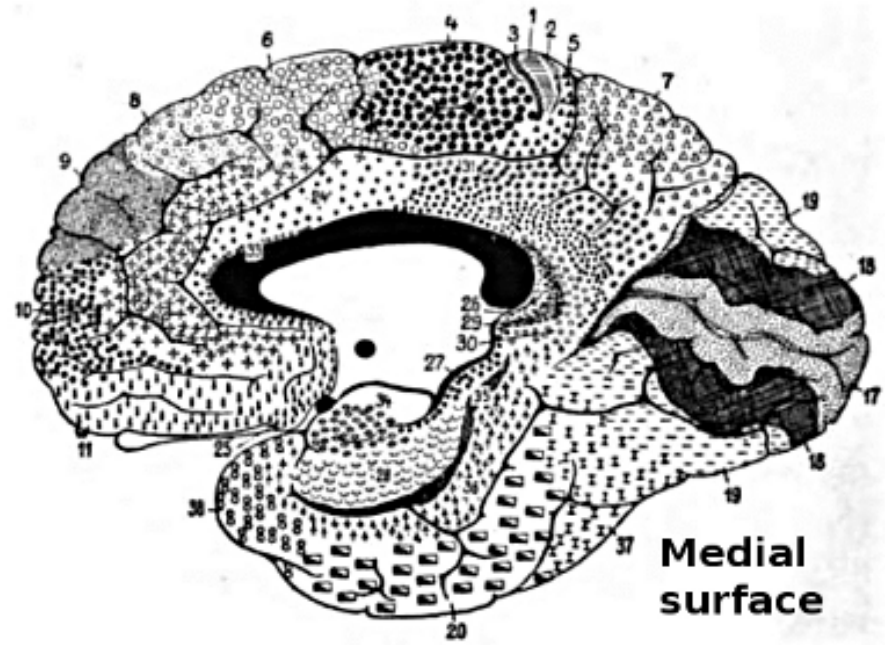
# Brain anatomy



# Brain anatomy: complex

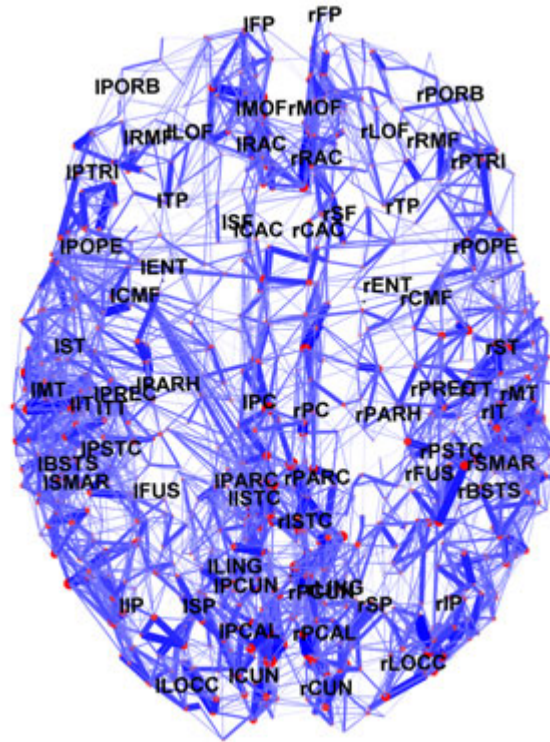


**Lateral surface**

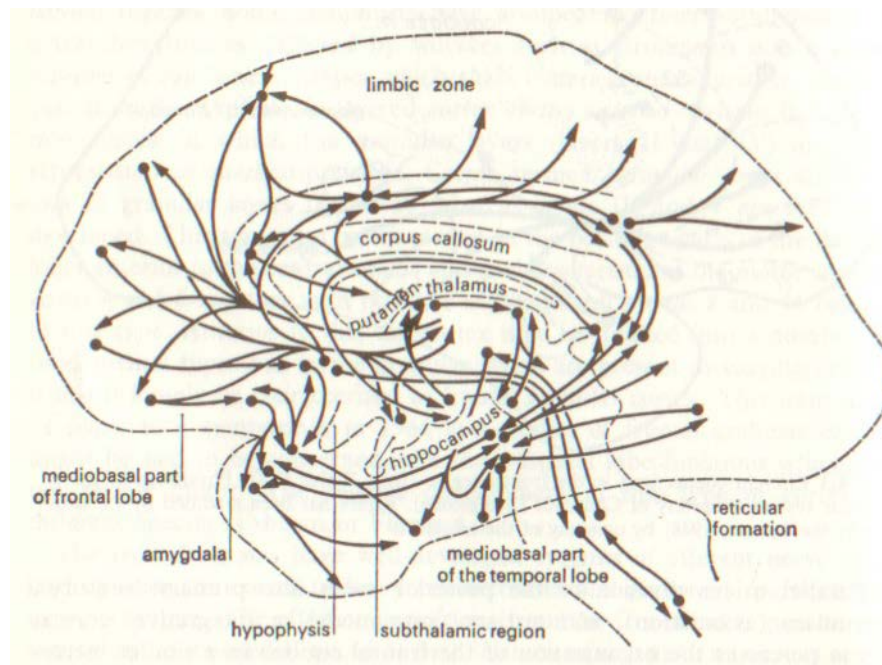


**Medial surface**

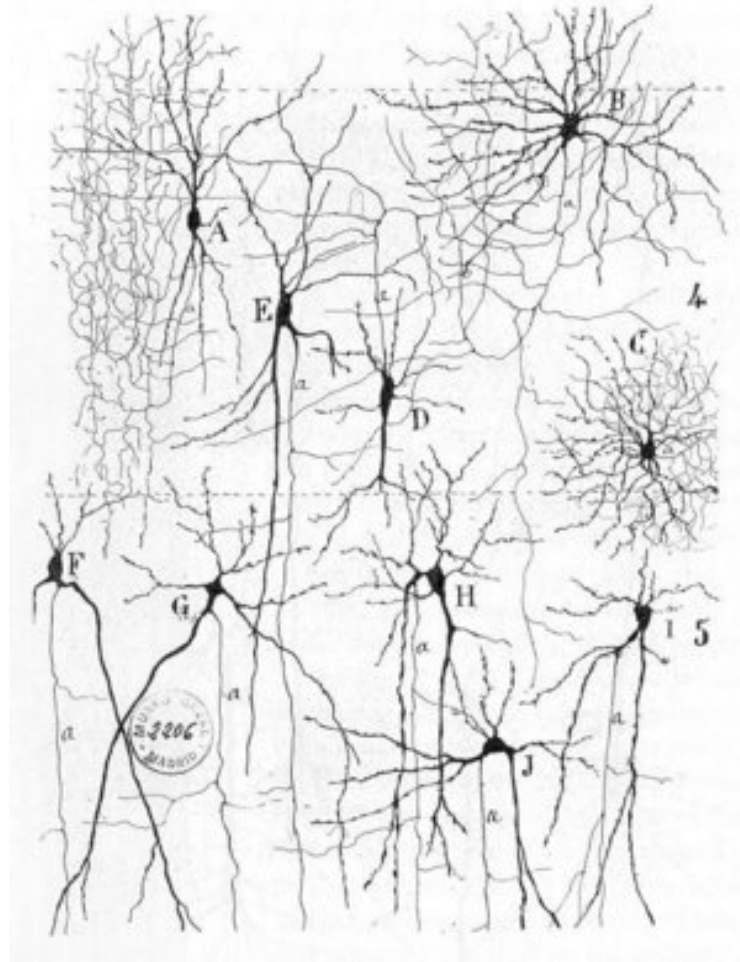
# Functional anatomy: complex



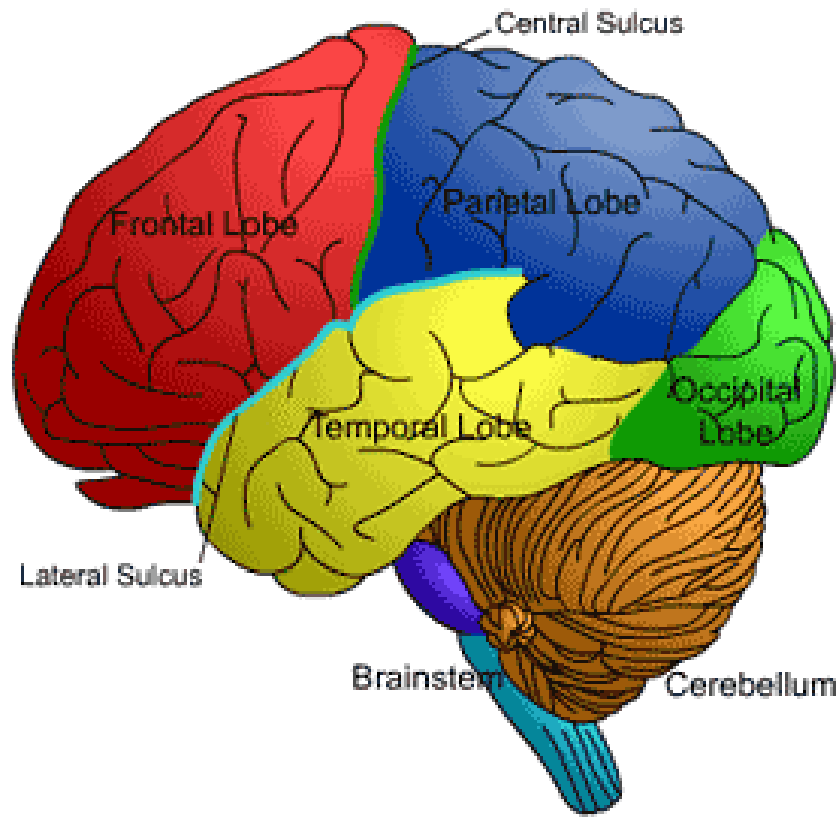
# Functional anatomy: complex



# Neuronal functional: complex

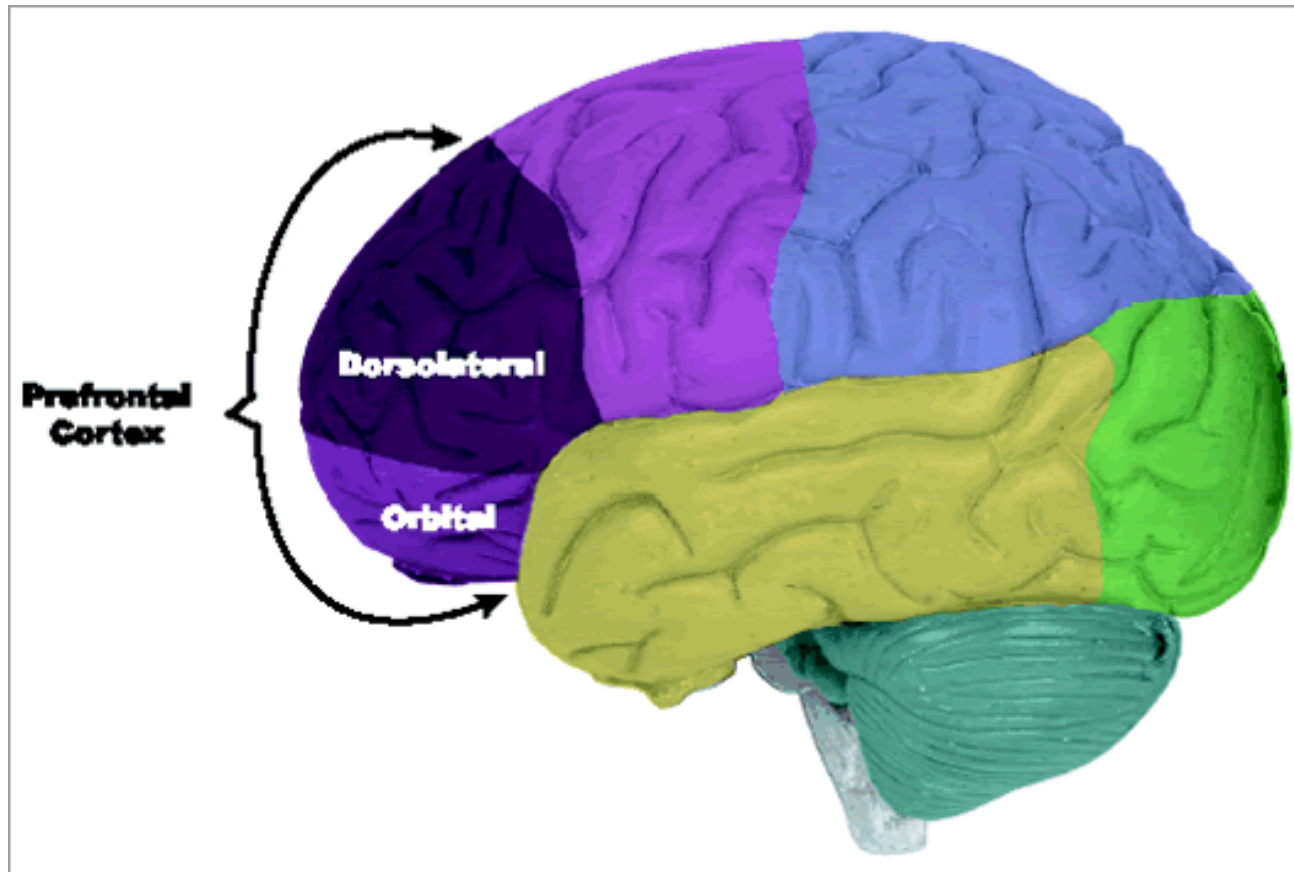


# Brain anatomy



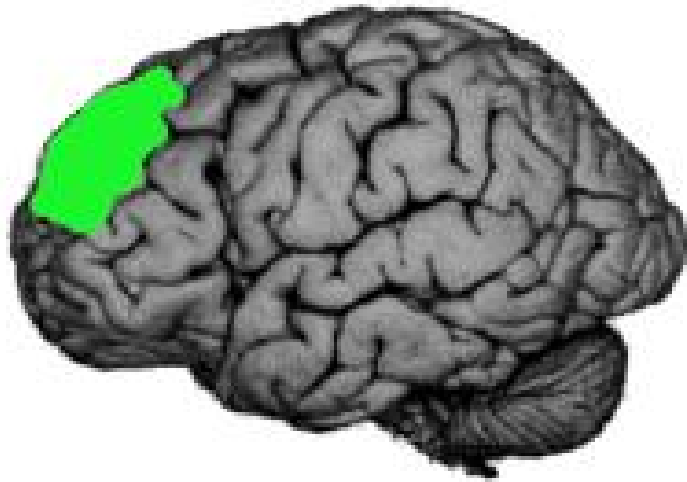


# Prefrontal region

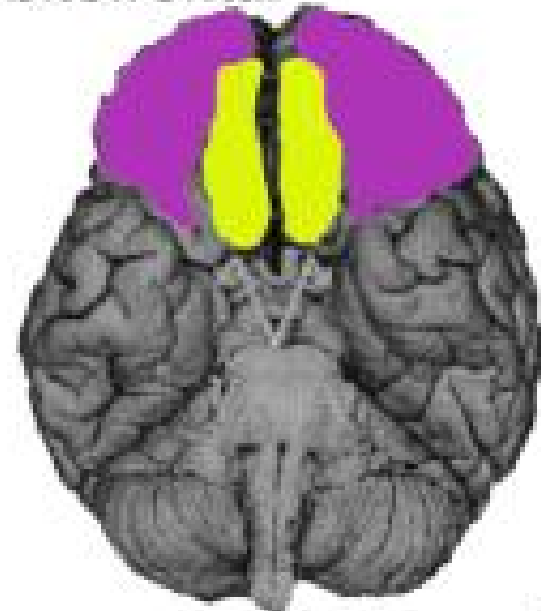


# Dorsolateral & ventromedial

**Dorsolateral**



**Orbitofrontal**



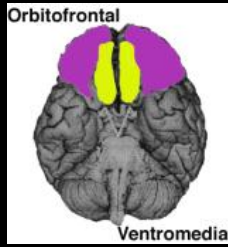
**Ventromedial**



# Frontal lobe & decision making

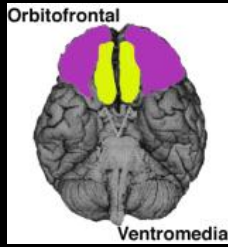
- Knowledge of **association** between frontal lobe and “executive” function has been available since the mid 1800’s
- At that time, **damage** to a person’s frontal lobe was found to result in impairments in “executive” function, that is, in judgment, reasoning, problem solving, abstraction, decision making, and for the regulation of emotion and behaviour
- In recent decades, there has been an exponential increase in research demonstrating that within the frontal lobe, **ventromedial** and **dorsolateral** regions have particular importance in decision making processes

# Ventromedial cortex



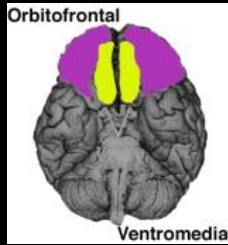
- Found that VM cortex is the:
  - Source of seemingly **unconscious**, “automatic”, and “intuitive” decision-making
  - Source of “hunches”
  - Source of “gut feelings”
  - Source of “alarm bells”
  - Source of the awareness of whether a particular decision “feels right”
  - Source of somatic (bodily) responses and brain-body associations

# Ventromedial cortex ...



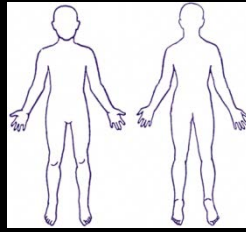
- VM is the source of access to **past experience** of decision maker quickly and automatically
- Studies have found that participation of the **ventromedial cortex** in decision making **assists** when there is:
  - Incomplete and uncertain factual basis
  - Uncertainty of consequences

# Ventromedial cortex ...



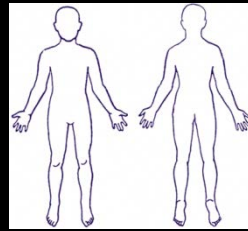
- VM is associated with the processing of **emotional information**
  - In particular, is **essential** when processing information of a **personal, social, or moral nature**
- VM is part of a **rich network** of connections to the other parts of the brain, as well as to the **farther reaches of the body**

# Emotion and the body



- This **brain-body connection** of one of the main networks that allows for the **experiencing of emotion**
- Within this system, the experience of “**emotion**” is associated with **changes** to the visceral and musculo-skeletal states of the body
- These changes can be measured experimentally by changes in **heart rate** (pulse), **blood pressure**, **respiration rate**, **skin conductance** (sweating), etc
  - Examples: anger, disgust, fear

# Emotion and the body ...



- These somatic changes may be experienced (or not)
- In this, when the emotions and their physiological changes are of a **sufficient magnitude**, the emotions may be “felt” (ie, consciously perceived)
- When **not** of a **sufficient magnitude**, ventromedial function and its associated physiological changes to the body, may **not be consciously** recognised, but **will still occur** and may still participate in cognition (at a non-conscious level)

# Definitions

- **“Emotion”**
  - A collection of changes occurring in both brain and body, usually prompted by a particular mental context
- **“Feeling”**
  - The perception of those changes

# Iowa Gambling Task:

Experimental task illustrating role of ventromedial cortex in decision making





# Iowa Gambling Task



- **Bechara A, Damasio H, Tranel D, and Damasio A**
- *Results first published in **Cerebral Cortex, 1997** – but have since been replicated*
- **Accepted wisdom:** “Deciding advantageously in a complex situation is thought to require **overt reasoning** on declarative knowledge, namely, on facts pertaining to premises, options for action, and outcomes of actions that embody the pertinent previous experience”
- **Study hypothesis:** “Overt reasoning is **preceded** by a **nonconscious biasing** step that uses neural systems other than those that support declarative knowledge”

# Iowa Gambling Task



- 4 decks of cards: A, B, C, and D
- Each card in each deck either wins the subject a sum of money or costs them some
- **Task:**
- Subjects told:
  - *Play so that you lose the least amount of money, and win the most*
  - *Turn over one card at a time, from any deck*

# Iowa Gambling Task



- **Experimental condition:**
- **Cards stacked:**
- A and B decks are disadvantageous:
  - Rewards high, but losses higher
- C and D are advantageous:
  - Rewards not so high, but losses less

# Iowa Gambling Task



- **Experimental conditions:**
- Two groups: “Normal” control subjects and
- “Ventromedial” impaired subjects
- Subjects are monitored for skin conductance response (SCR): sweaty palms
- Subjects asked at various intervals: *Tell me all you know about what is going on in this game*

# Iowa Gambling Task



- **Results: Normal** subjects began to choose advantageously before they realised what strategy worked best, whereas **ventromedial** subjects continued to choose disadvantageously even after they knew the correct strategy
- **Moreover: Normal** subjects began to generate “anticipatory” SCRs whenever they **pondered** a choice that turned out to be risky, before they knew explicitly that it was a risky choice

# Iowa Gambling Task



- **Experimental observations:**
- All subjects commenced by sampling cards from all decks
- Usually by **card 10:**
- Normal subjects began to generate anticipatory SCRs to decks A and B
  - All indicated they had no idea of what was going on: **“Pre-hunch” period**

# Iowa Gambling Task



- By about **card 50**:
- All normals began to express a “hunch” that decks A and B were riskier, and generated anticipatory SCRs whenever they pondered a choice from decks A or B
  - “Hunch” period

# Iowa Gambling Task



- By card 80:
- Many normal subjects expressed knowledge about why, in the long run, decks A and B were bad, and C and D were good:
  - “Conceptual” period (70%)



# Iowa Gambling Task



- **Ventromedial subjects:**
- Subjects with **ventromedial lesions** did not develop the anticipatory SCRs, although some eventually articulated the observation that the choices they were making were risky

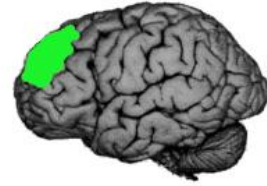
# Iowa Gambling Task



- **Experimenters concluded:**
- *"In normal individuals, nonconscious biases guide behaviour before conscious knowledge does. Without the help of such biases, overt knowledge may be insufficient to ensure advantageous behaviour"*

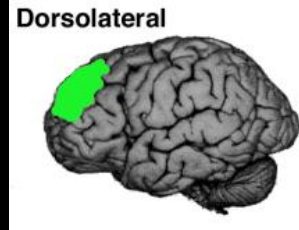
# Dorsolateral Cortex

Dorsolateral



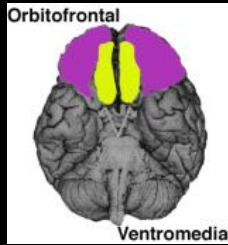
- Primary neural substrate for **attention** and “**working memory**”
- Working memory is the “**short term**” memory system that allows **attention** to be paid to a **number of pieces** of information **at once**, for a limited amount of time
- Whilst in working memory, this information may then be **evaluated, compared and contrasted**, and **manipulated**
- May hold and integrate information from **multiple sources**, as well as incorporating and orchestrating this **new knowledge** with **previously learned and stored** information

# Dorsolateral ...



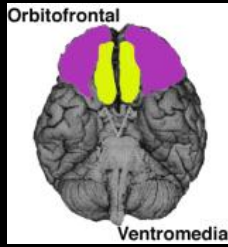
- Dorsolateral function is typically a **conscious** process, and can **actively draw on** information from a wide variety of sources
- Dorsolateral function more **classically related** to traditional concepts of **deliberation and judgment**
- Operation may appear **technical and mechanical**

# Stages of decision making



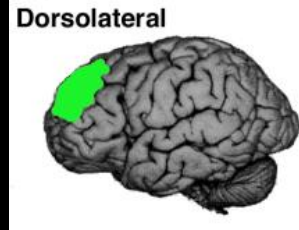
- **Earliest processing mediated by ventromedial cortex**
- May be **conscious or non-conscious**
- Processing will operate **rapidly** and apparently **automatically**
- Is able to, consciously or non-consciously, access **relevant and related past experience**
- Is able to process and access **emotional** information as it relates to **personal, social, and moral** issues – which tends to have **high emotional salience**

# Stages of decision making



- **On its own**, ventromedial is:
- Able to arrive at a **preliminary “decision”** which may be felt as a “hunch” or “gut feeling”
- Preferences **towards or against** particular options will be linked to particular **bodily reactions**, via the somatic and emotional connections from the ventromedial cortex **to the body**
- In doing this, information is sorted and prioritised for later processing by the dorsolateral cortex

# Stages of decision making



- Later processing by the dorsolateral cortex
- Information **becomes available** for **conscious** dorsolateral deliberation
- Information from a **variety of sources** may be accessed:
  - Conscious access to **past experience**
  - **New information** recently acquired
  - Conscious awareness of **emotion**

# Without ventromedial

- Decision making in relation to **personal, social, and moral issues**:
  - “acquired sociopathy”
  - lack **empathy** and **compassion**
  - “dispassionate”, “uninvolved”, detached”, “cold-blooded”
- **NOTE: General intelligence** and knowledge of social and moral rules intact



# Without ventromedial

- Decisions **slow and effortful**
- Need to **actively** interrogate memory systems for relevant experience
- Decisions **technical and mechanical**
- Decisions **unemotional**
- No *feelings* of being “right” or “wrong”
- As no **preliminary** “bias”, all alternative choices may appear of **equal weight** thus unable to make a decision

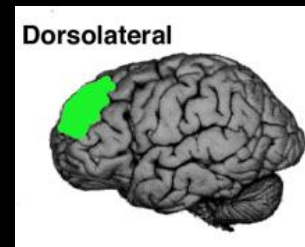
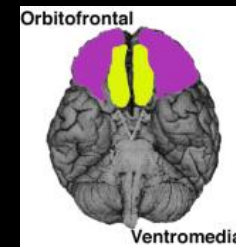
# Without dorsolateral

- “Biased” decisions **based only** on previous experience
- **Not able to integrate** new information into factors to be considered
- Not able to **hold complex information** in mind, nor information from a number of sources, at once, to compare and consider
- Wholly emotional decisions may be **unchecked** for inappropriate bias and relevance

# Without dorsolateral

- No “**testing**” against **reason and logic**
- Inability for the “testing” to **over-ride** a pre-set (based on ventromedial selection) **emotionally and somatically** favoured decision

# Both VM and DL



- The **ideal** decision making context is with participation of **both** the ventromedial and dorsolateral cortices
- In situations where personal, social, or moral issues are **paramount**, then ventromedial participation **is required**
- In other situations however, a decision made on a **technical basis** with only dorsolateral processing may be **sufficient**

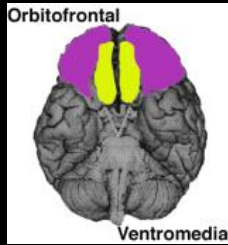
*Implications for barristers  
making decisions*

# Decision making process



- **Stages of decision making**
  - 1) **Ventromedial**
  - 2) **Dorsolateral**
  - **The decision itself**

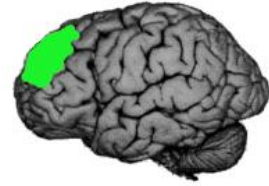
# Stage 1: Ventromedial



- **Rapid**, automatic, “intuitive”, **unconscious**
- Relies on previous learning: **past experience**
- **Emotional** responses
- Related **bodily** sensations
- Legitimate **preliminary “bias”** or **“prejudice”**
- Potential source of **inappropriate bias**
  
- Gut feelings, **hunches**, alarm bells
  - *Internal voice: “I’ve got a bad feeling about this”*

# Stage 2: Dorsolateral

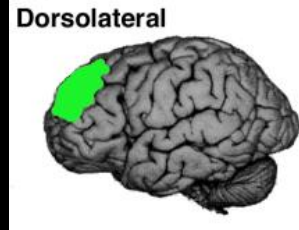
Dorsolateral



- Slow, **deliberative**, conscious
- Able to take in **new information** from a variety of sources
- Scrutinise and “**test**” the results of ventromedial processes
- Able to assess for **emotion and inappropriate bias**, unsubstantiated suspicion, guesswork, hunches
- Able to **over-ride** a decision from the ventromedial



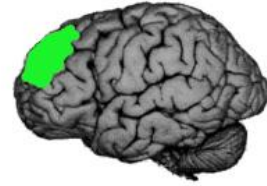
# The decision itself



- The process moves from ventromedial (**unconscious**) processing, to, dorsolateral (**conscious**) processing
- The final decision will be based upon input from, and a balancing of that input, these two systems
- In this, need to enable and allow input from the ventromedial system: that is: not to block, or otherwise compromise access to that bodily information

# The decision itself

Dorsolateral



- If access is blocked, or otherwise compromised, impaired decision making will result:
  - *(see earlier, decisions made based only on dorsolateral information)*
- **The decision maker needs to address:**
  - 1) Be aware this is an issue
  - 2) Do something about it: raise their awareness of bodily sensations, emotions, and hunches: *making the unconscious conscious, and available for participation in the decision making process*

**Conclusion: Extension of  
neurobiological findings**

# Neuroscience Findings

- In order to make a decision, the brain takes in information from:
  - 1. the environment (via the senses)
  - 2. the body proper (via the ventromedial cortex)
- In this, the body proper has been described as a “sensing instrument”

# Extend findings

- Must be mindful: that we need to give the body – this “sensing instrument” – appropriate attention and care: that is, so as it can do the job it is built to do
- 1. The senses: It is uncontroversial, that the quality of information from the environment is maximised, if people “support” sense where needed: glasses, hearing aids
- 2. The body proper ???

# Extend findings

- 2. The body proper
- **Homeostasis** refers to stability, balance, or equilibrium within a cell or the **body**. ... **Homeostasis** can be thought of as a **dynamic equilibrium** rather than a constant, unchanging state
- What we need to do is to:
  - Be aware that there are factors that may that **derail** homeostasis:
  - That is, factors that dampen or numb bodily sensations, as they will also dampen or numb those sensations that assist decision making

# Extend findings: negative

- What are these “factors”?
- The following factors have the capacity to **derail homeostasis** (and numb sensation, and thus block access to valuable information) and thus have the potential to compromise decision making:
  - *Stress, anxiety, depression, other mental disorders*
  - *Insomnia*
  - *“Medications” used to deal with stress: Alcohol, drugs, food (over eating), etc*
- This is an uncontroversial list (I hope): most people will be aware of the physiological sequaele of these issues

# Extend findings: positive

- Research findings have shown the following to **support and enhance** the integrity of the body proper, including being shown to be associated with **better cognition and mental health**:
  - Appropriate diet
  - Regular exercise
  - Adequate sleep
- In maximising the integrity of the body proper, its function as a “sensing instrument” for decision making is maximised: cognition is improved, as is mental health more generally



# Extend findings ... final

- Other research finding: only one third of people who have mental health problems seek advice from a professional
- Take home message:
- If struggling with stress, anxiety, and any other mental health issue (including any addiction), get help:
  - Find a therapist or other specialist
  - See a dietitian
  - Get a personal trainer
  - Join a gym, yoga class, etc
- This will **enhance decision making**, and more importantly, will **enhance mental well being** more broadly

# One of my favourites is



- But each of us need to identify our own “blocks” to sensations, and find our own ways to remedy this



The End