Cognitive and Neural foundations of decision making



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Foundations of human behaviour



- Learn about the workings of the mind
- How thoughts and emotions shape perception and behaviour

How do we Understand the Other ?

 Theory of Mind (TOM) & Mentalizing refers to our ability to understand mental states such as intentions, desires and believes of others.

Empathy

refers to our ability to share the feelings of others, be it a particular emotion or sensory state of the other.



Altruism

When we act to promote someone else's welfare, even at a risk or cost to ourselves



Fundamental Human traits

Moral Sense

some capacity to distinguish between kind and cruel actions Empathy and Compassion

suffering at the pain of those around us and the wish to make this pain go away

Sense of Fairness

a tendency to favor equal divisions of resources

Sense of Justice

a desire to see good actions rewarded and bad actions punished

Sharing

- 18 & 25 month old babies behave randomly when given the choice to share treats with strangers
- When prompted by the adult, the older children shared with them
- 18 month olds when played with a forbidden toy, blushed when spotted.



Fair distribution of resources

- Children prefer an even distribution of resources, no matter the conditions
- 19 month olds stared longer, a sign of surprise, when shown equal division of prize for unequal work
- Younger children consider absolute distribution more important; a person sharing 3 out of 10 candies is deemed kinder than 2 out of 3

Adult brain scanned during the ultimatum game: unfairness aversion



Responders reject the offer

Responders accept the offer

Empathy - emotions

- Mirror neuron network in human involves and activates the amygdala (emotions)
- A mirror neuron is a neuron that fires both when an animal acts and when the animal observes the same action performed by another
- We do not accomplish understanding of other's feelings by mere analogy or thinking processes.
- Rather, the other's emotion is experienced by ourselves and therefore directly understood. It is a shared body state.

Empathy



Individual or collective effort

 What are the challenges and implications of "volitional cognition" – where our brains choose how our brains are to work?

 What of "transformative cognition" – where the marketplace, social forces, competition, and their embedded values "influence" how our brains are to work?

All economic activity involves the human brain

- Behaviour may reflect an interaction of cognitive and emotional factors
- Opening the "black box" of the mind ___Inp
 - Neuroscience makes this possible
 - It gives a way to open the "black box" which is the building block of economic systems — the human mind.
- Knowledge about brain mechanisms can be helpful to inform economic theory



The study of decision making

 Perhaps the most rapid progress in neuroeconomics will be made in the study of "risky decision making"

 In most economic analyses risk is related to choice outcomes. But for most people, risk has more dimensions, particularly emotional ones

Is economic behaviour "rational"?

- Economists emphasize rationality
- Psychologists emphasize cognitive limits and sensitivity of choices to contexts
- Context is external (like major economic crises > poverty > poor health etc)
- But context is also internal: what does this external context do to our emotions
- In turn, emotions influence our behaviour

Do animals make rational decisions?

Harper's duck experiment (1982)





throws bread-ball every 10 seconds

Animals do make rational choices!

Ducks achieve optimal solution within 90 sec.



The Financial Crisis – Lessons for Europe from Psychology (Henry Montgomery, 2011)

 Economic behaviour is a psychological microcosm, to which all fields of psychology could be applied

- It is people who invest, speculate, borrow/lend, buy/sell.

- People who act in the economic world understand the world around them with general psychological principles (cognitive psychology), driven by certain motives and emotions (motivational and emotion psychology)
- A two-systems view of how the human mind works two types of adaption and maladaption to economic realities

Affective vs. Analytical Cognition



Fast and slow systems

Affective system

- fast
- unconscious
- Reflexive
- short-term

Analytic system

- slow
- conscious
- Reflective
- longer term projections



Neuroeconomics

- About a decade old
- About 200 neuroscientists and economists are active
- In contrast with behavioral economics (with mostly economists), neuroeconomics - is a mix of neuroscientists, psychologists and economists
- Roughly a 2:1 mix of neuroscientists and economists
- Annual conference and a "society"



Society for NeuroEconomics NEUROSCIENCE • PSYCHOLOGY • ECONOMICS

Neuroeconomics: methods

- Animal behavioral studies (e.g., addicting rats to cocaine, loss aversion in monkeys)
- Studies of children with and without autism
- External physiological measurement (e.g., pupil dilation, voice tone, facial expression, skin conductance, heart rate)
- Cognitive load (e.g., remember this seven digit number and do a task)

Lesions, localized damage, gene knockout...

- Experimental destruction of amygdala in an animal tames the animal, makes it sexually inactive and indifferent to danger like snakes or other aggressive members of its own species
- Knocking out the gene that makes a key protein for amygdala function makes rats relatively fearless
- Humans with lesions of the amygdala lose emotional meaning
- Hippocampus removal prevents experiences from being encoded in long-term memory

Brain mapping using non-invasive techniques



Functional Magnetic Resonance Imaging (fMRI)

Electro-Encephalography (EEG)

Transcranial Magnetic Stimulation (TMS)



Psychophysical measurements

- Behavioural technique
 - Motion capture, eye movements

- Physiological indicators like:
 - Heart rate
 - Blood pressure
 - Galvanic skin response
 - Pupil dilation



Cognitive load decreases self-regulation

- Load manipulated by having people keep either a 2-digit or 7-digit number in mind during experiment
- Subjects choose between cake or fruit-salad

Shiv and Fedorikhin (1999)

Processing burden	% choosing cake
Low (remember only 2 digits)	41%
High (remember 7 digits)	63%

Emotional augmentation/reduction predictably changes patience

- Task: Children *try* to wait 15 minutes, to exchange a smaller immediate reward for a larger delayed reward.
- Manipulations:
 - Control
 - Affect augmentation: exposure to rewards
 - Affect reduction: represent the delayed reward abstractly (pretzels are logs, marshmallows are clouds)
- Results:
 - Ability to wait goes down after affect augmentation
 - Ability to wait goes up after affect reduction

Chronic stress, cortisol and market instability

- Many influential models in economics, finance, and neurobiology assume risk preferences are a stable trait
- A study examined the effects of chronic stress on financial risk taking by raising cortisol levels in volunteers over an 8-d period using individually tailored hydrocortisone regimens (Kandasamy, PNAS 2014)

 Results reveal that participants become more risk-averse and that the overweighting of small probabilities becomes more exaggerated among men relative to women

Cortisol shifts financial risk preferences

 The increase in cortisol among participants – similar to that observed in real traders when faced with uncertainty and market volatility

 Physiology-induced shifts in risk preferences may thus be a cause of market instability that has been hitherto overlooked by economists, risk managers, and central bankers The orbitofrontal cortex plays a central role in choice and decision making

 Clinical studies indicate that the orbitofrontal cortex (OFC) is necessary for economic choice behavior

• Lesion studies lend further support to these data

 Neurons in this area appear to encode for factors related to goods (i.e. value, choice outcome) (Xie & Padoa-Schioppa, *Nature Neuroscience*, 2016)

No OFC → No Ambiguity/Risk Aversion



Social influence and persuasion

Brain mechanisms of persuasion: how 'expert power' modulates memory and attitudes

- persuasive effect of high expertise/fame of the communicator - expert power
- persuasive effect mediated by modulation of caudate activity resulting in a re-evaluation of the object in terms of its perceived value



Social influence and persuasion

- Experts enhanced subsequent memory effects in the medial temporal lobe - involved in memory formation
- Experts induced a semantic or social context for the objects, for conceptual and associative processing
- People adjust their opinions to the perceived opinions of large group



Social conformity

✓ deviation from social norms triggers an immediate neural error response

- ✓ social conformity complies with the principles of the reinforcement learning
- ✓ individual differences in conformity based on a variable reward prediction error signal

Social conformity and conflict



Conformity

Conflict

Sheer information on others' behavior can be very influencing

Re-use of towels in hotel rooms

(field experiment; Goldstein and Cialdini, 2007)

- 'Help save the environment' 34%
- '75% of guests who stayed in this room used their towel more than once' 49%

Why should economists study the brain?

- Because we hope to improve our measurements of utility?
- Because the study of the brain will direct and catalyze the development of new models, speeding up the rate of progress in model development.
- Because neuroscience will provide new empirical methods that will sometimes provide new empirical tests.
- Because we will eventually be able to use neuroscience measurements to help people better understand and manage themselves.

Utility Maximization?

Standard economics :

Neuroscience:

- The pleasure from food or cocaine and the "pleasure" from obtaining money are two totally different
 phenomena
- The same dopaminergic
 reward circuitry of the brain in
 the midbrain is activated for a
 wide variety of reinforces,
 including attractive faces,
 funny cartoons, cultural
 objects like sports cars,
 drugs, and money!

Preceptual and cognitive limits

- Visual short term memory ~ 4 items
- Attentional bottleneck
 - Inattentional blindness (Invisible Gorilla),
 - Attention blink
- Memory: Reconstruction and re-consolidation
- Cognitive load- emotional interference

Applications

Research areas for specific topics in economics:

- Intertemporal choice & Self control
- Decision making under risk & uncertainty
- Individual and collective effort in social change
- Neuroscience approach to fine-tune messages to

help people make healthy choices

Intertemporal choice & Self control

- Trade-off utility at different points in time
- Humans appear to be unique among animals in terms of caring about future consequences
- Affective system
 - Choosing earlier rewards more often
- Lateral prefrontal cortex
 - Later rewards
 - More cognitive actions



- 1 chocolate today or 2 chocolates tomorrow?
- Brain imaging study: stimulation of limbic system associated with the midbrain dopamine system
 - Low serotonin, high cortisol
 - > immediate reward



Humans value the present at the expense of the future?

Brain activity in the fronto-parietal system and mesolimbic dopamine reward system predict behavior



Applications

- Science of learning and moral cognition can be leveraged to encourage real-world prosocial behavior
- Prosocial behavior in the context of public goods such as education, energy, health care, natural resources, and social welfare
- Integrate various methodologies- machine learning, agent-based simulations, social network analysis, behavioral experiments, and field experiments

Linking Behavioural insights to public ethics

PUBLIC POLICY IMPLEMENTATION involves influencing or changing behaviour via legislation, regulations, taxes and incentives.

• RECOGNISES THAT PEOPLE ARE COMPLEX, AND OFTEN TIMES IRRATIONAL. BE/BI: AN INVALUABLE TOOL

• Key insights into the psychology of behaviour motivations

• Low cost/ low pain option for motivating ethical behaviour

RESULTING IN REDUCTION OF INEFFICIENCIES AND INCREASEd trust

Behavioural Insights help in public policy?

- Information DOES NOT always lead to behaviour change
- Behavioural Insights provide an understanding of how to best present information
- Persuade rather than enforce
- Manage stress healthy and unhealthy stress
- Humility into policy making and focus on what works

Thank you

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"Heavier-than-air flying machines are impossible."

The Lord Kelvin - 1895 Physicist & Engineer