The Neural Basis of Decision-Making

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Phineas Gage
|
H Damasio (1994) - reverten area white brain
damaged (most impacted)
↓
Ventromedial prefrontal Cortex

Bechara (1994-2000)
patients with ventromedial prefrontal cortex lesion
↓
Iowa Gambling Task
↓
patients were bad in choosing advantageous decks as opposed to control group
↓
no lesion
lesion elsewhere
↓

In economics (central idea): learn by trial-error

- A rational agent with make choices to maximise utility

- Utility can be subjective

- Positive and negative reinforcers

Anything an animal will work to:
- Attain
- Avoid

→ Primary reinforcers → innate value
Stereotyped aims (ex food, pain)

→ LEARNED REINFORCERS

Value through learning (money) ex.

DECISION MAKING

→ 3 armed bandit problem → try sequentially through trial and error 3 Machines

↓

Internal representation in head about average reward I'm winning on ≠ Machine

↓

based on past experience

↓

use this to predict future

Representation of ≠ Utilities

I need to understand that
Some things are rewarding / some things aren't

↓

Dimension

↓

Given experience utility

→ How can we study this —
give individual ≠ things

Measure — (direct) | (indirect)

→ Skull open | 3 markers of ↑ Brain Activity
(NA) | ↑ blood Ø
↓ | ↑ glucose consumption
electrical activity | ↑ O_2 "

↓

fMRI

≠ magnetic properties ← deoxyhaemoglobin → then congregation

↑ ↓

MRI signal is

lower → darker

higher → brighter

experiments → ① w/ food
↘ ② w/ money

Reward and Punishment

fMRI → Correlation Reward value — Correlation punishment

Brighter is when ↑ money

(ventro medial orbito frontal region) — Ortal

③ Attractive faces

④ Music → Nature 1999

Experienced Utility

wine → Experienced Utility in the brain can be modulated by contextual region

Decision Utility

Computational Model → RL

how do we learn to make a prediction of the utility for a particular action —

Computational model → RL

We make a prediction and then it's confirmed or NOT → by experience utility

We encode a degree of surprise → ~~dat~~ ~~dat~~ expectation − reality

Prof Wolfram Schultz — linked to dopamine neurons

DECISION UTILITY

how → people represent expectation of future rewards
↘ evidence of learning

vm PFC → codes for expectation of rewards — expected Value

Prediction error → Basal ganglia

Utility → experienced → value of thing I got
Utility → decision → what I expect to get

decision → can be taught, can be learned trial-error (RL), VMP cortex

how does the brain make choices to ≠ types of rewards —

Valuation

Sensory decoding < food / trinket / money — common valuation area → Decision

measure willingness to pay

overlapping areas
- with WTP across all items
- with WTP for all items

we code things in the same utility scale —

↑ activity in vmPFC → ↑ risk seeking

↑ activity in lateral regions —when→ ↑ risk averse

MDP — Markov Decision Process

mathematical framework to make decisions under uncertainty

MDPs maximize future reward

possible ← action to execute / future states / probability of happening / reward

MDPs what to do in every state

→ Solution → Policy

↓

* Value iteration → Utility of State (potential future reward)

iterative utility computation

* Policy iteration — which to do