

The Neural Basis of Decision-Making

- Cambridge Uni
- Jack O'Doherty

Phineas Gage

H Damasio (1994) - reverber area where lesions happened (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 maximize utility

- Utility can be subjective

Positive and negative reinforcers

Anything an animal will work to:
↓
Attain Avoid

→ Primary reinforcers → innate value
↳ Stereotyped actions (e.g. food, gain)

→ LEARNED REINFORCERS

Value through learning (money)

DECISION MAKING

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

↓
Internal representation in head effort 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

Discounts

↓
Past experience utility

→ How can we study fin-gre individual ≠ things

Measure -

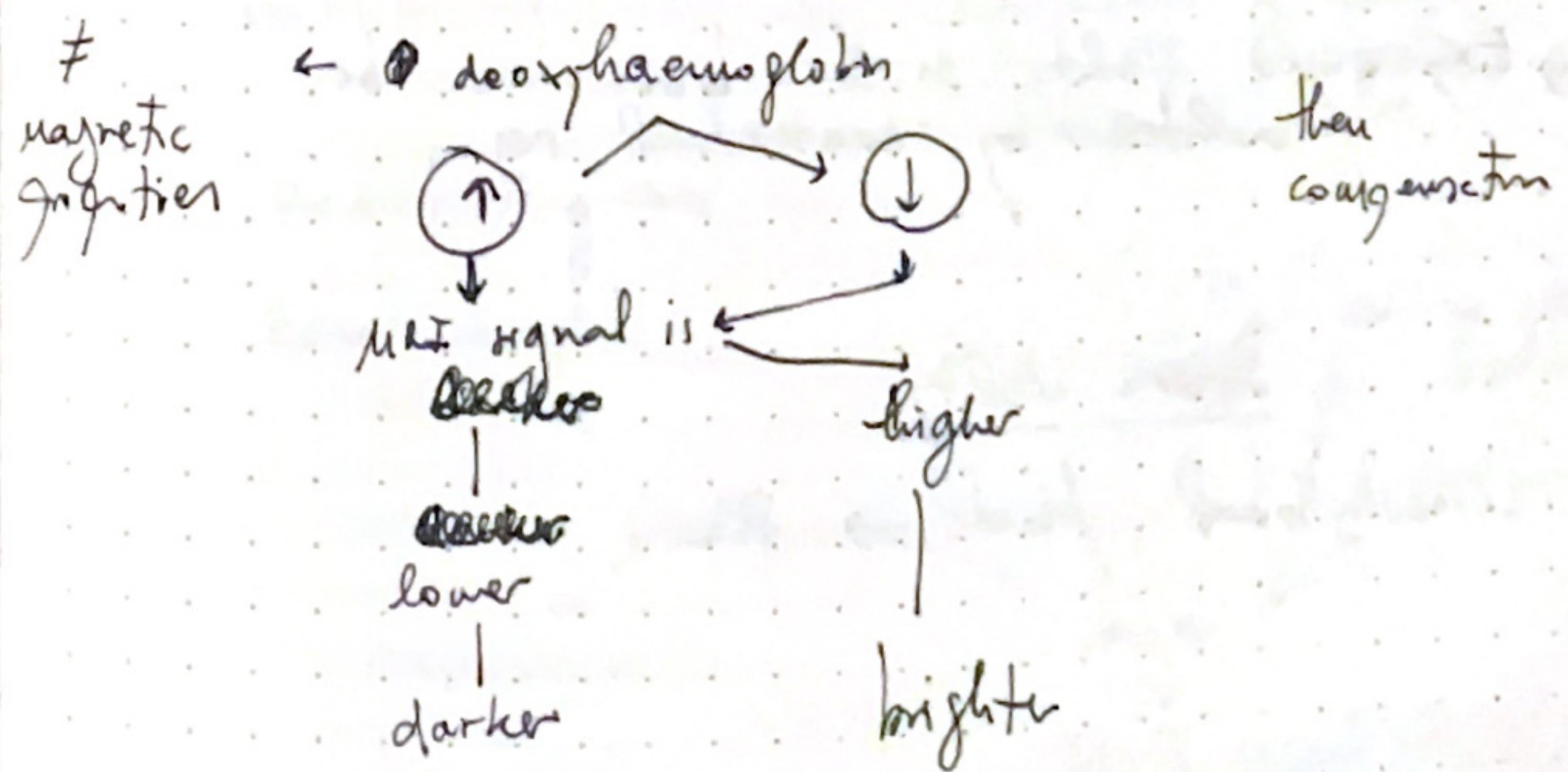
(direct)

→ Shell open (NA)
↓
electrical activity

(indirect)

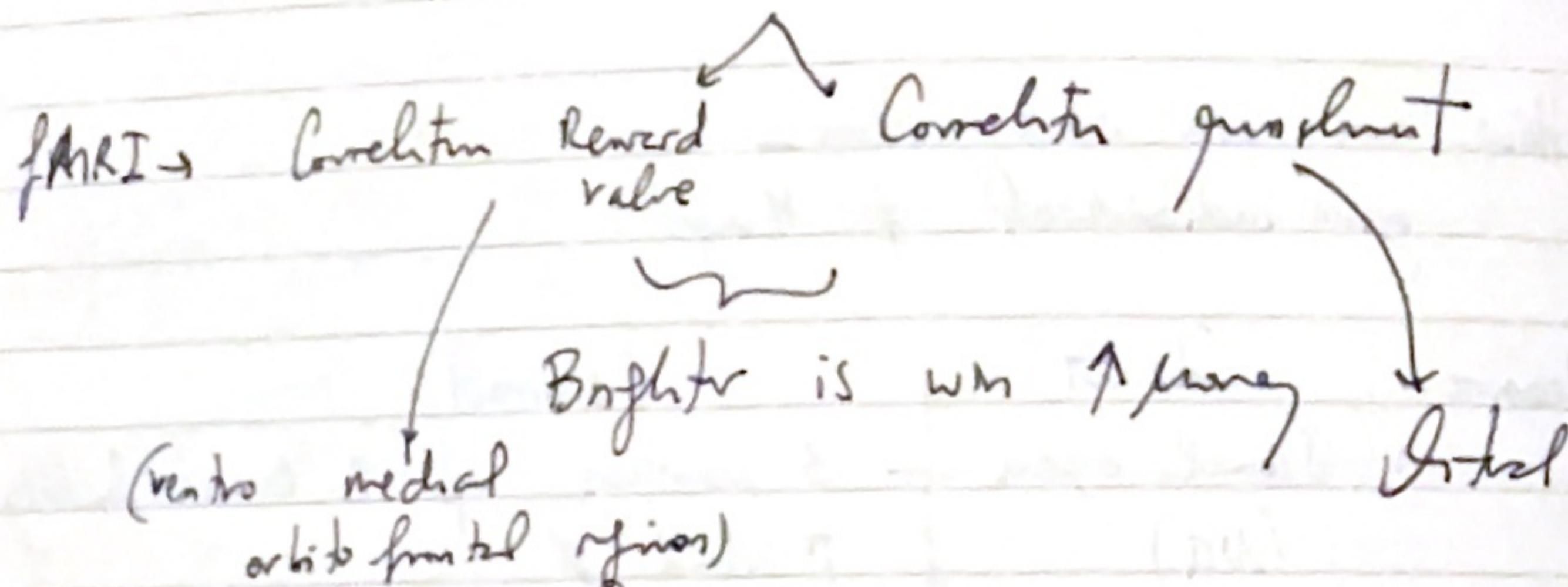
3 markers of ↑ Brain Activity
↑ blood p
↑ glucose consumption
↑ O₂ "

↓
fMRI



- ① experiments → w/ food
 ② w/ money

Reward and Punishment



③ attractive faces

④ Music → Nature 1999

Experienced Utility

wine

→ Experienced Utility in the brain can be modulated by contextual regions

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 only

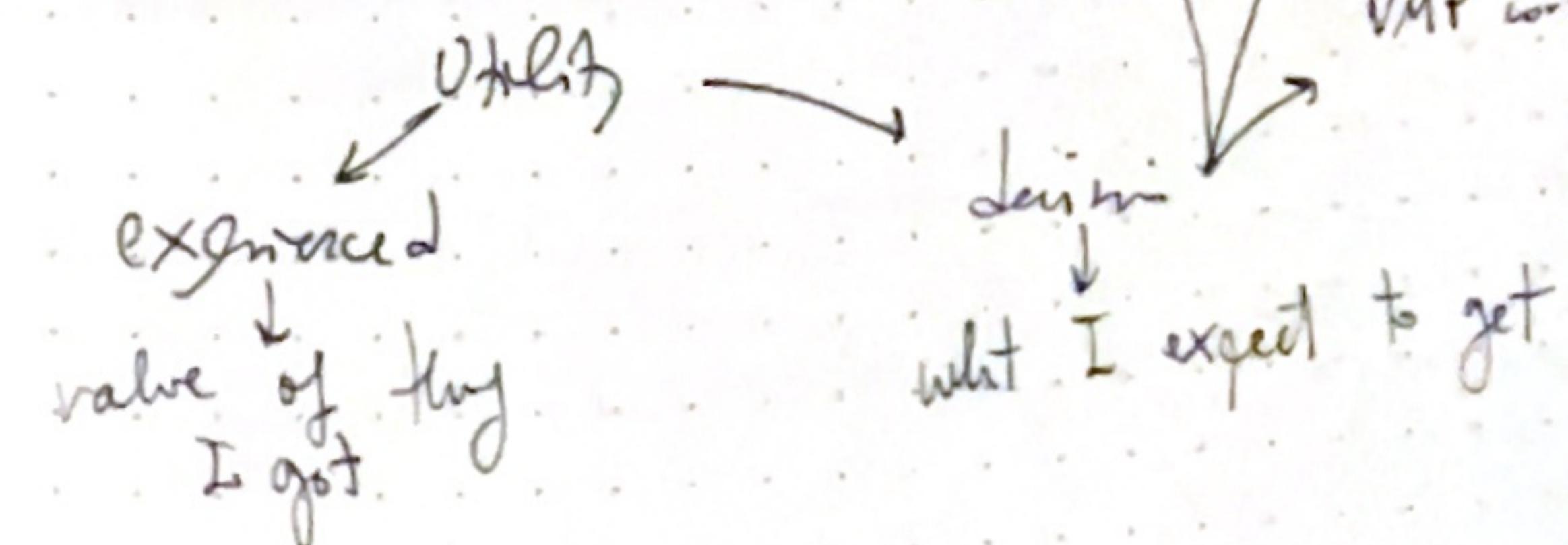
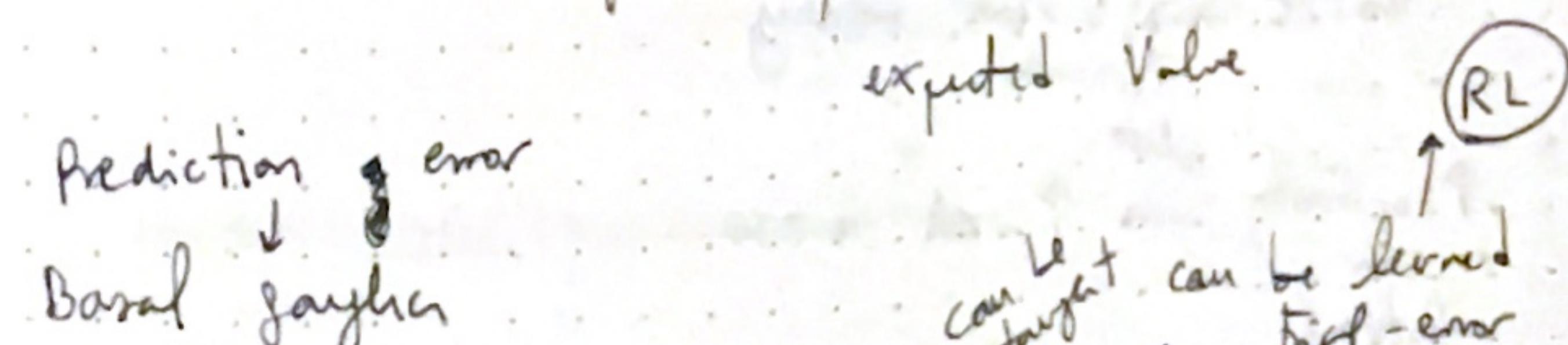
We encode a degree of surprise
 → # test expectation - reality

Prof Wolfram Schultz - linked to dopamine neurons

DECISION UTILITY

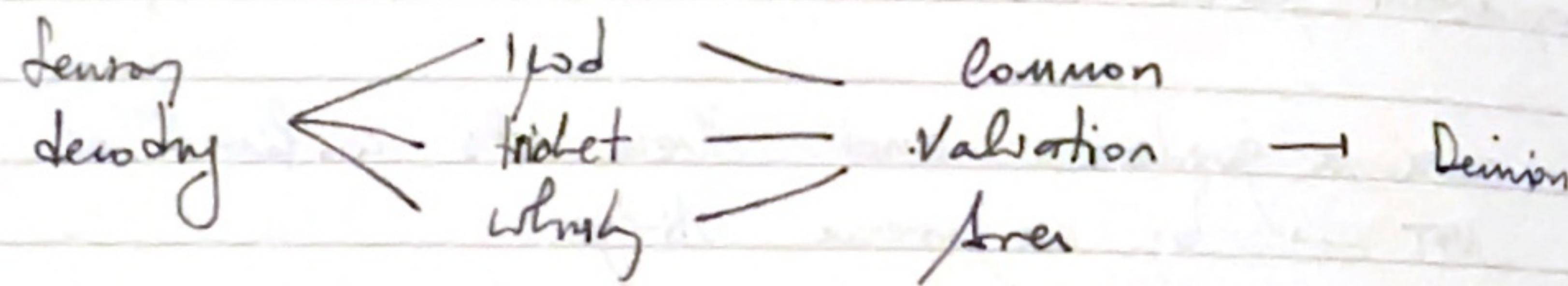
how → weigh against expectation of future rewards
 evidence of learning

vm.PFC → codes for expectation of rewards



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

Valuation



means willingness to pay

or haggling over [with WTP across all item
with WTP for all items

we code things in the same utility scale -

↑ activity
in
vmPFC → ↑ risk seeking

↑ activity when
in
lateral regions → ↑ risk averse

MDP - Markov Decision Process

mathematical framework to make decisions under uncertainty

MDPs maximize future reward

gamble ↗ action to execute
future states
probability of haggling
reward

MDPs what to do in every state

→ Solution → Policy

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

iterative utility computations

* Policy iteration - Which to do