FENS - Berlin 2018 - Day 1 07/07/18

Talk 1: "Trees and gates: Dopamine ~~axon~~ arbors as filters of dopamine output" - Stephanie Cragg - Oxford

- Dopamine transmission in forebrain → axons provide many functionalities → filtering / gating etc.
- Striatal dopamine → motor control ⇒ goal-directed behavior through basal ganglia
- low freq. tonic firing ⇒ 2-5 Hz || W. Schultz
  high freq. burst firing ⇒ 15-40 Hz
- Matsuda et al (2008) ⇒ striatal dopaminergic neurons ~ 3% - 5% volume striatum
  → arbor can form large regions
  → (energetic) ?? ⇒ high glucose consumption
- Wolfram Schultz → unexpected reward/value encoding
- striatal cholinergic interneurons ⇒ strategically placed ? to filter dopaminergic output (ChI)
  ↳ striatal ACh changes frequency dependence of dopamine release
  ⇒ low-pass to high-pass filtering
- cholinergic interneurons ⇒ DA activity driven by single AP synchronized in small populations

↳ can inputs also modulate DA transmission? ⇒ Yes!
↳ phasic more than critical inputs
↳ tested via optogenetics.

↳ ChI pause promotes outward in DA signal
deactivation ChI directly drives DA activity
⇒ ChI critical gatekeeper!

- Short-term plasticity in DA release ⇒ Release probability ✗
⇒ striatal excitability ✓
⇒ DAT (Opposite effects frequency)

↳ paired pulse studies → yes
↳ effects depends on how observed axon is!

- DAT filters output ⟷ sodium-gating
- striatal inputs govern DA output
↳ also striatal networks determine timing

- release dynamics
- strongly governed by excitability
- DATs limit release prob.

Talk: ' Modulators of sleep dependent memory consolidation ' – Lisa Marshall – Lübeck

- Coupling hippocampal spindle-ripples and SO-spindles
- Bidirectional changes in synaptic efficacy of cortical-hippocampal – PFC pathway → depression
- Targeted memory act. ↔ spindles of NREM sleep on decode stimulus-associated memory
- fixation of sleep → synaptic weakening / depression
- non-REM sleep (NREM): ⇒ direct cortical potential shifts
  ⇒ sleep associated hormone secretion
- Electrical stimulation ⇒ DCS – direct cortical stimulation
  → increased accumulation of sleep homeostasis (↳ SO-tDCS)
- Task dependent → influences post-task sleep
  ⇒ efficacy of stimulation // dependent on system state?
- SWA correlation? // Spindle density // activity / power (resting state?)
  ⇒ Role of different network state to SO-tDCS susceptibility!

- Ngo (2013) ⇒ auditory stimulation (closed loop)
  ↳ increase num of slow oscillations

⇒ EFFICACY of NEUROMODULATION

- stimulation parameters
- individual factors
- brain activity
- phase-dep. endogenous activity
- timing of stimulation

- Effects on neuromodulation ⇔ cortext-sensitivity!
- robust effects vs. relevant sub group effects

Talk 3: Tom Insel — Behavioral Phenotyping (Digital)
(Mindstrong Health)

- Social neuroscience! // Psychiatry // Finally the right scale
  - temporal // spatial
- optogenetics → STAR map
- Egnor and Branson (2016) — computational analysis of behavior
  - ↳ behavioural primitives → compositionality!
  - ↳ discovery of behavior using machine vision
- Robie et al (2017) — Mapping the neural substrates of behavior
  - ↳ GAL4 driver manipulation → grammars → language of behaviour
  - ↳ brain-behavior correlation maps!
- Markowitz et al (2018 - cell) → syllables
- thought experiment → handing phone to person next to us
  - ↳ awkwardness → privacy / vulnerability
- (we can't manage what we can't measure.)
- DIGITAL PHENOTYPING
  - → sensors → activity / location / sociality
  - → voice / speech → faster - manic, slower - depressed
    - → prosody / sentiment / coherence
  - → Human Computer Interaction (HCI) → Taps / Scrolls / Typing
    - ↳ ML → digital biomarkers
    - ↳ digital exhaust
    - ↳ manually constructed?

- 45 keyboard patterns → latency / sensitivity ⇒ BIOMARKERS
  - 45 TS of all patterns ⇒ How not what!
  - content-free! → no privacy problems
  - Depression (Digital Medicine, 2018) → Digital biomarkers and cognitive tasks

How constructed?

How did they get access to labelled data in first place?

- Hamilton Depression Score
- Neural correlates ⇔ Biomarkers
- Grünerbl et al (2017) → Diagnostic precision!

- Data Privacy ⇔ Open Mined – Trask
  Federated Learning / Homomorphic Encryption

- S. Brenner
  "Progress in science depends on new techniques, new discoveries, and new ideas, probably in that order."
- How does the algo actually work?!

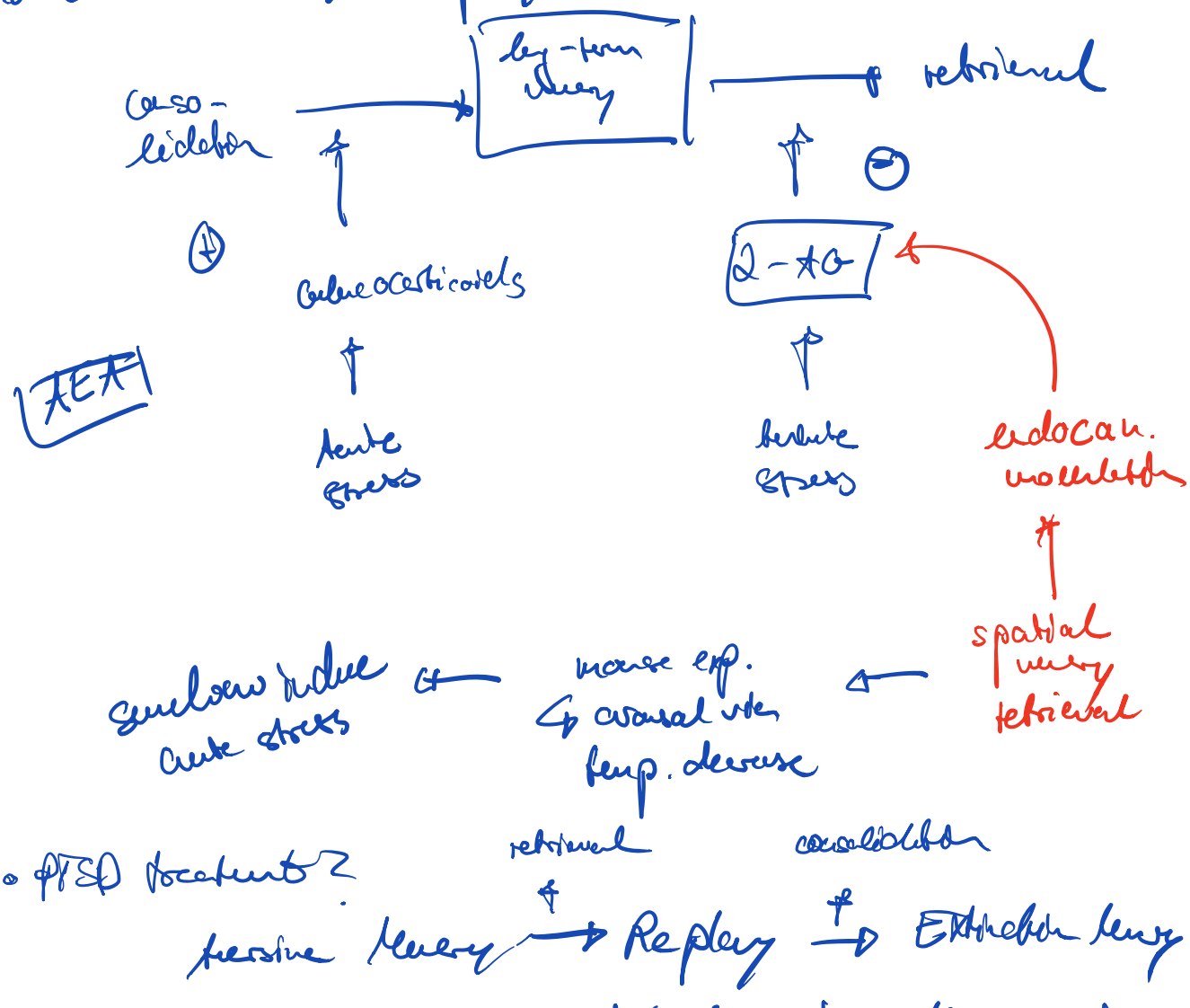
Symposium 1 – Cannabinoid Regulation of Stress, Emotion a. Memory

Talk 1: CB1 receptor signaling in the brain – Giovanni Marsicano

- THC ⇔ endocannabinoid system: learning, memory, sleep
- CB1 ⇒ GPCR regulation
  ⇒ presynaptic → unique from receptor / not ionotropic
- Cannabinoids = lipids → easy movement through membranes
  ↳ regulation of mitochondria activity ← CB1 on plasma membrane (pan CB1)
- mt CB1 → mitochondrial respiration ⇒ modulated by!
  ↳ neuronal effects → object recognition
  intramitochondrial PKA activity
- CB1-KO (knockout) → injected GFP and have mice perform many tests ⇒ hippocampal mt CB1 needed for neuronal effects!
- astroglial mtCB1 receptors → astrocyte lactate production ← glucose
  ↳ reduction in lactate production ⇐ feed neurons
  ↳ Also: effect on sociability after THC →
  ↳ THC → mt CB1 → sociability! (astrocyte glucose metabolism)

Talk 2: Arousal and stress effects on memory — P. Campolongo

- Memory modulation by stress and modulation
  - → BLA-induced modulation ⇒ emotional memory consolidation
    - ↳ basolateral amygdala
  - → effects of THC depend on many factors!
- Eustress → Yerkes-Dodson law ⇒ which role does endocannabinoid system play?



- PTSD treatment?

chronic ⇒ diagnosis only possible 6 months after event

to treat: targets of psychiatric disorders linked to memory!

Talk 3: Endocannabinoids – Mechanism of comorbidity between inflammatory disease and anxiety – M. Hill

- Regulation of immune functions
- Relationship between inflammatory diseases and psychiatric disorders!
- cortical limbic networks → modulation / regulation emotion
  - ↳ prefrontal cortex ⊕ amygdala
- Global activation BLA → stress/anxiety experience
- Chronic stress ↔ CRH
- Inflammation = different type of stressor → same impact on behavior as psychological stressors!
  - ↳ gut colitis → TNBS model
  - ↳ same stress feature because CRH/CRF involved ⇒ anxiety-like phenotype!
  - ↳ gut damage ≠ proxy inflammation → then more damage the greater the FAAH activity
- Problem of identification ⇒ direct effect on inflammation vs. effect on brain (indirect)
- FAAH inhibitor is more efficient when animal is more stressed!
  - ↳ target FAAH or AEA

Talk 4: Corticolimbic control of fear extinction – A. Holmes

- Fear extinction
  - → equivalent procedures across species
  - → exposure therapy
  - → highly conserved brain circuits
- Pavlovian conditioning of fear stimulus ⇒ { can retard extinction / robust extinction }

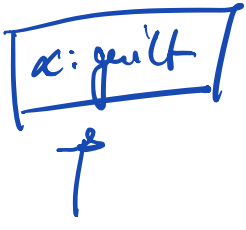
Anxiety disorders → translational symptom-b. → key anxiety – reactivity neural circuits

- Marsicano, Wotjak (2002) ⇒ CB1 deletion leads to impairment of fear extinction! → groundbreaking

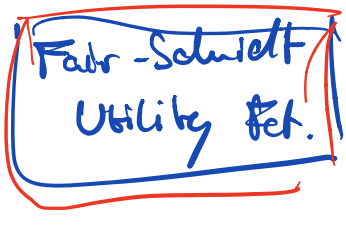
Brain Prize Lectures — Talk 1: Peter Dayan – Mind Games

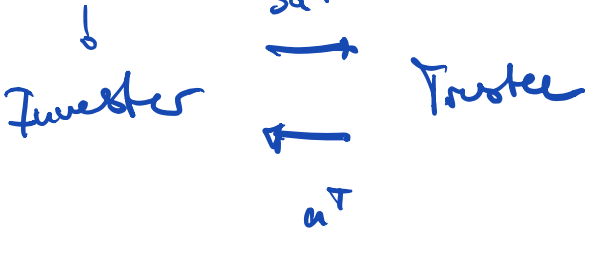
- Dayan, A. Hula, R. Montague, B. King-Casas
- phasic dopamine activity → TD PE → model-free / flawless
- Games with nature vs. games with others ⇒ social / interpersonal agents! → game theory
  - ↳ cooperation / competition ⇒ ambition / personality disorders
  - ↳ characteristics: * social propensity
    * recursive modeling → (your model of me depends on my model of you)

- Dictator game → empirically: people get more generous as they age
  - ↳ inequity aversion ⇒ guilt of *
- Ultimatum game → appearance of split
  - ↳ inequity aversion ⇒ envy of B
  - ↳ * has incentive to characterize envy of B



- p-beauty game ⇒ 2/3 of min between 100
  - ↳ discrete peaks ⇒ levels of recursion
- Multi-Round Trust Game → repeated game





$$X^1(a^1, a^T) = 20 - a^1 + a^T$$

reverse

$$X^T(a^1, a^T) = 3a^1 - a^T$$

$$- \alpha^T \max_{103} \{X^T(a^1, a^T) - X^1(a^1, a^T)$$

L_0 ∝ known but stochastic ⇒ MDP

L_0 ∝ unknown but stochastic ⇒ POMDP

L_0 ∝ unknown but unobserved ⇒ interactive POMDP (I-POMDP) → Gmytrasiewicz & Doshi (2005)

⇒ levels of recursive modeling

→ planning horizon // temperature // level of rationality

- BPD → trustees / investors ⇒ more investment / return by healthy
- Risk aversion — keep basic skills of money
- Fairness // reciprocation ↔ beliefs over trustworthiness of the other player
- Application of game theory experiments to psychiatric disease
  - → autism ⇒ Hasanyi
  - → policy ⇒ irritation

Brain Prize Laureates - Table 2: Ray Dolan — Dopamine and Reward

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- RPE → imaging: ventral striatal regions showed signed TD-related PE responses

↓

John O'Doherty et al (2004)

- Ventral striatum ⇒ value prediction → Actor ↑
  Dorsal striatum ⇒ reward learning → Critic ↓

  ↳ Levodopa ⇒ boosts dopamine → better learning
  Haloperidol ⇒ reduces dopamine → worse learning

- Aging → natural experiment ⇒ 5-10% dopamine decrease per decade!
  ↳ consequences cognition / learning

- learning effort to put in / expend on task
  → Multiattribute learning – Hauser et al (2017)
  ↳ adaptation of effort depending on previous success
  → reward prediction / effort prediction / effort ~ reward correlation

  ↳ effort PE and reward PE

- Reward and Mood
  → Rutledge et al (2014)
  → slow vs. fast learning systems
  - slow ↓ better memory
  - fast ↓ fast forgetting

  → simple mood predictors

> - Edward Thorndike
>   ↳ model-free
> - Edward Tolman
>   ↳ model-based
>   ⇒ cognitive maps

- Model-based RL
  → Neural replay ⇒ spatial navigation
  → replay ⇒ sequences in replay → forward / backwards

→ Resting state MEG studies

→ How does effort arise from? ⇒ hippocampus / ventral-medial PFC

→ reverse sequences

↳ solving long-term credit assignment problem!

Kording Prize Lecture — Talk 3: Wolfram Schultz — Behavioral/neural experiments

- Evolution → not only good reward ⇒ (best)
  ↳ curiosity, exploration
- DRPE → Rescorla-Wagner (1972) ⇒ 1 associable stimulus
  ↳ left after 10 min

Symposium 2 : Striatal Circuits

Talk 1 : C. Hellendoorn – (D2 Receptors – Motivation)

- Schizophrenia → increased occupancy of striatal D2 receptors
  - ↳ overexpression of D2R in striatum ⇒ deficits in cognition and motivation
    - → cogn. task dependent a prefrontal cortex
    - → non-reversible
  - ↳ Deficits in incentive motivation
    - → reversible ⇒ upregulation D2R → mice pass more often in food task

- 2 path-ways in striatum

Leslie Vosshall – Neurobiology of mosquito behaviour

- Malaria – Mosquitos were not eradicated → a lot of human community led to reemergence continuous invasion of pathogens!
- Try to control behaviour of mosquitos → only females hunt and bite! → bite ⊕ sensing underneath skin
  ↳ females have chemosensory neurons!
  ↳ mainly attracted by body temp and heat!
- CO_2 activates/stimulates heat seeking behavior!

CO_2 ⊕ heat

- CRISR → knock out genes responsible for this behaviour!

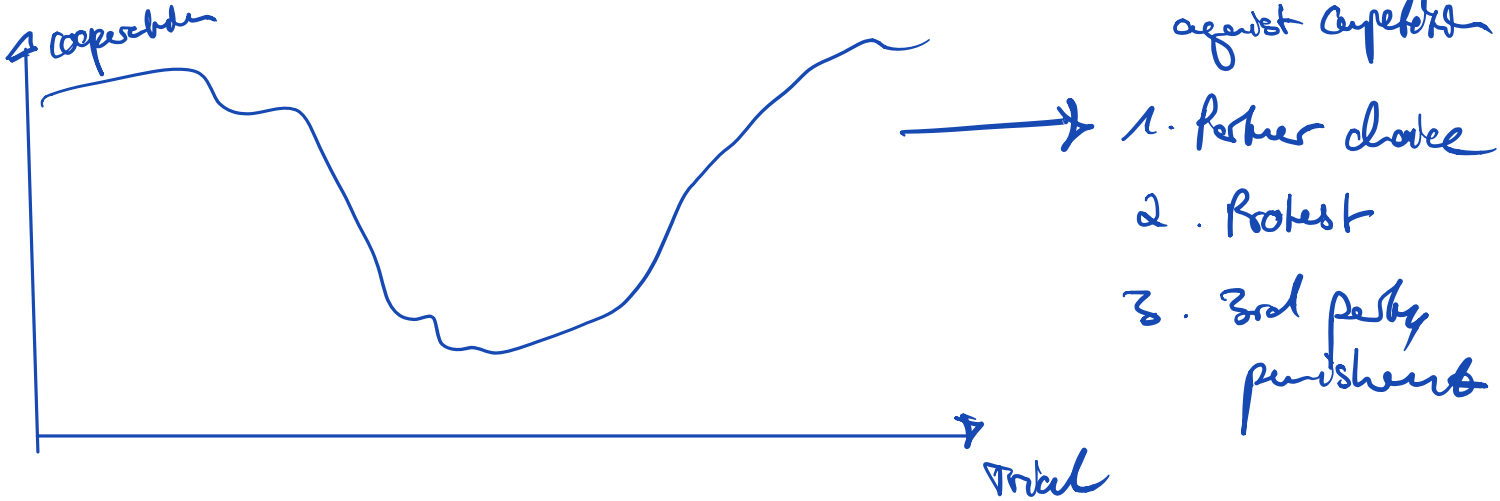
MULTISENSORY INTEGRATION ⇐ How do sensory cues come together?

- DEET → odor → unclear! ⇒ disgust vs. confusion ?!
  ↳ olfactory system → ORCO gene
  ⇒ does both → very complicated effect! many olfactory sensory neurons fire
  ↳ bitter taste ⇒ but does not explain effect why mosquitos are repelled
  ↳ legs are really key for repelling sensation
    ⇒ tarsal segments needed!
    ⇒ one of four legs is enough
  ↳ not only mosquitos affected but also others! → ADL activation
  ↳ interference with chemotaxis → increase prob. of passing!

START DAY 3
MO/09/07/18

Frans de Waal – "Prosocial Animals: Empathy and Cooperation"

- More behavior in behavioral area
- Darwin – facial expression ↔ emotion // human ↔ animals
- Heteromorphism: will never feel what any other feels
  ↳ misattribution of human-like exp. to non-human animals
- Analogy: similar traits despite independent evolution
- Homology: similar traits with shared ancestry
  ↳ have to have trait → humans don't want to be (compared) to humans
- Conflict Resolution → reconciliation
  ↳ aggression brings animals together → post-conflict attraction
- U.S. School kids – Verbeek & de Waal (2001)



↳ Chimpanzees have mechanisms just like humans!
⇒ task: pulling of buttons simultaneously to get food

- Empathy : Ability to understand / share feelings of other.

2 channels
- body → synchronization → emotional contagion
  - ↳ almost in every species
- cognitive → self-other distinction → perspective taking
  - ↳ needs identity awareness ⇒ more rare

- Clear sex differences throughout development
- Yawn contagion → social bias ⇒ empathy is triggered more easily by similarity / familiarity !
- Empathic concern → form of emotion regulation
- Studies on romanian orphans ← traumatization works against empathy
  - ↳ But Bonobo sanctuary study ⇒ orphans 'catch up' in terms of empathy

- 2 voles → separation → without stressor ⇒ no response
  - ↳ with stressor ⇒ strong emotional contagion when reunited !
    - ⇒ grooming behavior / consolation
  - ↳ only with familiar mates ⇒ siblings / partners
  - ↳ oxytocin levels increase in vole that has not experienced stressor ⇒ also in vision

- Targeted helping : Understanding of situation of another person and attempt to help / solve problem
  ↳ requires perspective taking ⇒ Yamamoto et al (2012)

- Mirror self-recognition ⟶ embodied cognition
  ↳ elephants pass test ⇒ more developed forms of empathy occur afterwards in development

- Russian doll model of empathy ↦ builds up from simple state matching

- Recommendation to get more behavior into mirror test
  ⇒ get rid of distinct / behaviorism ⇒ more biological view ↦ biological adaptation
  ⇒ all socio-emotional capacities of humans in animals
  ⇒ design replicable empirical def. of behavior under study

- Fairness / Morality ⇒ David Hume – Moral sentiments not logical necessity
  ↳ Brosnan & de Waal (2003) – Inequity aversion
  ⇒ relative perspective // effort plays a significant role!
  ↳ ultimatum game with chimpanzees ⇒ like humans they equalize

⇒ Some psychology / mechanism of human and animals behave similar ⟶ how to frame differences

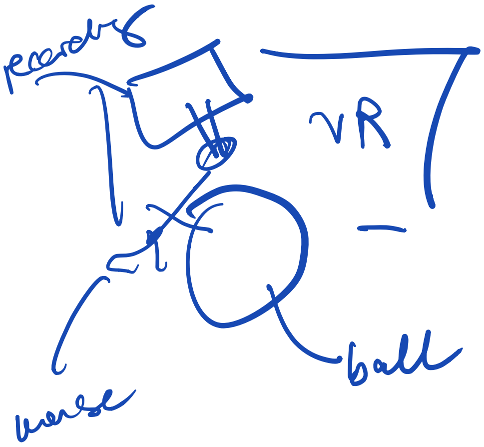
3rd Symposium – Decision, action and navigation in PC

Talk 1: Matteo Carandini – Decision and navigation in parietal cortex

- Harvey, Coen, Tank (2012) → cells in PC can be divided in left / right selective firing neurons. ↳ PPC cells exhibit simple position-heading fields
- Virtual reality mouse T-maze experiments

↳ position-heading field ⇒ predictor of stimulus responses

- Decision does not help as predictor of PPC activity!



→ decode PPC activity into trajectory of VR position

- Population activity reflects position and heading
- Better communication between researchers → train mice on more than one task!
- Task selectivity of neurons preserved throughout time
  ↳ strongly predicted by apparatus – wheel / ball → vague! Confounds across sessions → cannot be explained by many!
- PPC neurons highly selective for task. Task selectivity is consistent throughout days!
- Michael/Kremin et al (2017)

Talk 2: Douglas Nitz – PC encoding of embodied spatial relationships

- Topology – properties of geometric configs which are unaltered by elastic deformations ↔ homeomorphisms

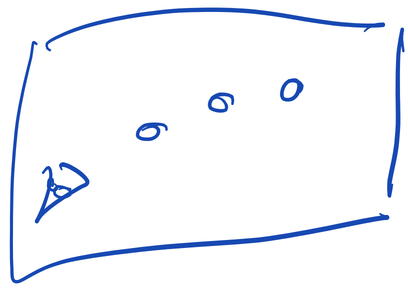
  Scheme – mental representation

- Hippocampus – subiculum – retrosplenial – posterior parietal cortex
  - hippocampus → place env
  - subiculum → place env
  - retrosplenial → position rate
  - posterior parietal cortex → target location
- PC maps progress through route very accurately!
  - ↳ maps space/position within route → topology of path
  - ↳ complementary to CA1 spatial mapping
- Spatial embedding
  - → ensembles of activation sequences map about location in env/route
  - → random vs. characteristic paths
  - → RSC – Retrosplenial Cortex ⇒ angular/linear velocity
  - → PPC and RSC encode egocentric location of a present target

Talk 3: J. Whitlock – Action representation PPC and frontal cortex 3D

- Damage to PC ⇒ deficits in targeted movements in hands/eyes
  - ↳ optic ataxia: misaligned coordination perception – action
- Mountcastle: Neural firing to spatially guided movements of hands and eye
- Nervous system evolved to generate 3D movement
  - → tracking via retro reflective tape
  - → Euler angles // heading vs head direction
  - → electrophy. recordings from parietal and frontal motor cortices
  - → self-motion maps ⇒ (right for all)

Recorded data



- GLM → head-position ⇒ 3D interactions → 80% of all units in PPC
  - → 10% PPC body
  - → 40% understood!

PPC

↳ Frontal cortex → similar in terms of properties

- Isomap dim. reduction
- Efficient coding scheme → PPC and M2 of 3D posture
  - ↳ other sensory/motor systems

David Dupret – (Neural dynamics of a memory representation in the hippocampus, and beyond)

- Marr 3 levels of processing:
  - Computational theory
  - Representation and algorithm
  - Hardware implementation

- CA1 ⇒ theta-nested spectral components reflect mnemonic growths in dorsal hippocampus

- O'Keefe and Dostrovsky (1971) ⇒ place cells → hippocampus as spatial map
- Hebb → Cell Assembly Hypothesis
- Tolman's Maze

→ theta oscillations ⇒ window to functional physiology!

- spectrogram visualization of theta oscillations ⇒ 4 spectral components (tSC1 – 4)
  ↳ 4 profiles are not distinct clusters but present points in spectrum! → window to modelling!

- tSCs strength change in task-stage – selective manner at behaviorally – relevant locations! → have – learning – probe
  ↳ relation to CA1 spiking output ⇒ distinct firing output of ensembles!

- CA1 does not reach motor system directly!

- Nucleus accumbens (NAc) → nexus between neuronal representation and memory-guided behavior!

CA1 – stimulus light
Amy – stimulus sound
PFC – spatial navigation
NAc –
PFC – reward

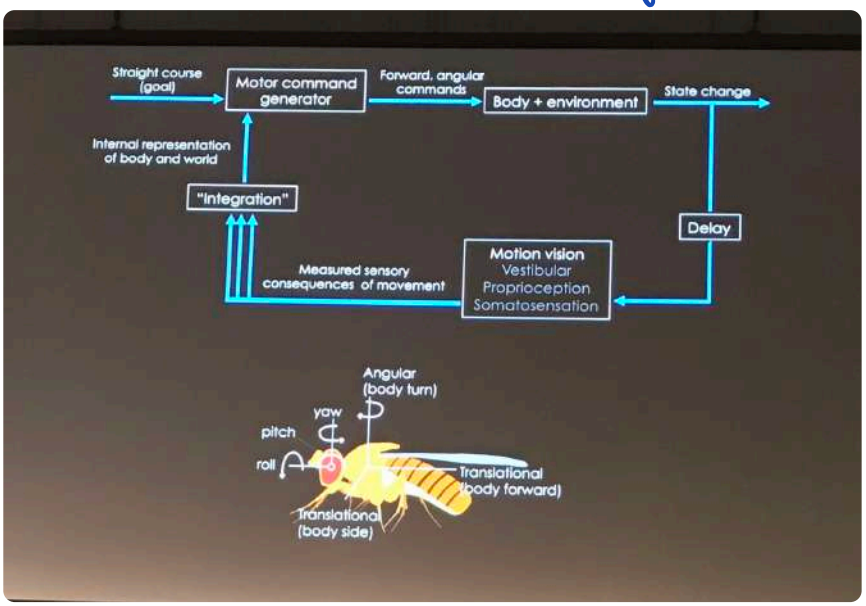
- dCA1 → NAc pathway functionally couples neuronal reinstatement of memory trace with behav. readout

4th Symposium — Computational Neuroethology for Neural Basis of Behavior

Talk 1 — E. Chiappe — Functional Representation of Walking Behaviors

- flies → locomotive paths → exploration → fixation saccades
  - ↳ straight movement lead to advance // fixed motion / heterogenous terrain
  - ↳ asymmetries in sensorimotor systems
  - ↳ saccadic turns ↔ velocity moments
  - ↳ self-generated visual feedbacks or amplified → motion vision!

control of steering behaviors



#2
HS cells
LPTC
IPS

- delineate #cells in specific. addons

Talk 2: Michael Orger — Zebrafish Swimming

- style all recordings of complete brain of fish
- freely moving at high frame rate of larval locomotion
  - ↳ tail traces
  - ↳ bouts feed to cluster kinematic space ⇒ Behavioral clustering

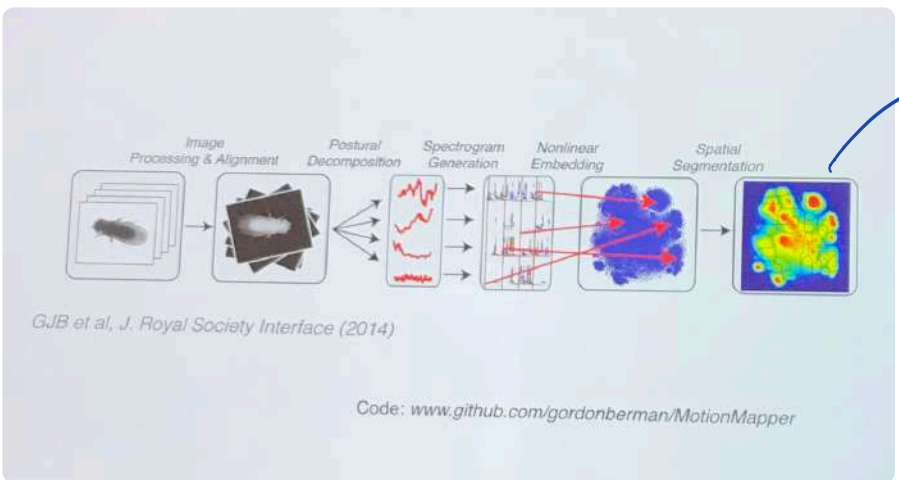
- social isolation impacts on behavior during development
  - ↳ isolation reduced fish have larger area of avoidance
  - ↳ clear effect on different forms of behavior that were identified
    - ⇒ faster / stronger / more displaced reactions
  - ↳ more visually responsive

- Champalimaud → Lisbon 23. - 26. October

Talk 3: G. Berman – Time Scales, Hierarchy and Neural Control of Behavior

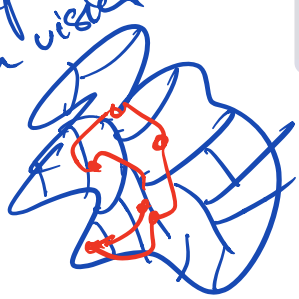
AMAZING

- N. Tinbergen – ('The Study of Instinct')
- R. Dawkins – ('Hierarchical organisation: a candidate for ethology') (1976)
- J. Tinbergen, F. Stilwell – Grammar of a Movement Sequence in Inbred Mice
- Unsupervised HMMs
  - ↳ What to measure? // How to account for segmentability?
    - ↳ Markovity / Memory!



↳ Behavioral maps / Space

capture motions via vision



↳ movement through space

↳ lives within: Markov transition probabilities

↳ Uncover Info Bottleneck

- Tolley → bottleneck ⇒ behavioral spaces ↔ predictability
- Mesh as information channel/bottleneck

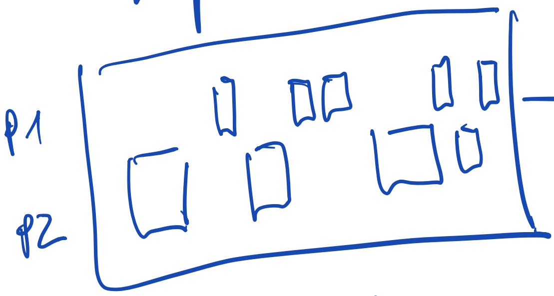
Table 4: G. Stephens — Continuous complexity of natural behavior

- Behavior to understand
- Single cell in gut ⇒ clinical brain → Howard Berg
  E coli
- Behavioral phase space ⇒ coordinates explorative dynamics and trajectories
  - equations of motion for living systems → C. elegans posture
  - SVD ⇒ an collection of forces → dynamic stable variables
  - embedding dimension → geometrically → false nearest neighbors
- Behavior = lower dimensionality than neural system!
  - still tons of variability in simple behavior

START DAY 4:
Die 10/07/18

Michael Long – Stability and Flexibility in Motor Networks

- Motor planning with sensory info → across individuals
  → speech ⇒ coordination of vocal sequences across individuals



→ (vocal exchange) at high frequency!

MOSTLY / ONLY LEFT HEMISPHERE

- speech production in the brain ↳ speech articulation, WM, cognitive control, sequentiability
  - Broca's area → precentral gyrus
  - speech motor cortex → pars triangularis and pars opercularis ⇒ HVC
    ↳ cooling 5–7 degrees
- ECoG: higher temporal resolution
- want perturbation for better define functions ⇒ temperature
  ↳ dependent circuit dynamics

↳ cooling introduces expansion in speech length //
  warming introduces compression → zebra finch and humans!

↳ Not only time changes but also quality!
  ↳ quality measure subjective via amazon mech. turk

- Functional Mapping ⇒ Broca's area → timing → sequence!
  Speech motor cortex → quality/articulation → not articulation

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- Receives: Dynamic vocal exchanges
  → S. teguina → coarse with vocalization
  → song trajectories ⇒ catersinging / vocal exchange!
    ↳ almost perfectly synchronized on-/off-sets
  → intracortical microstimulation

Motor Cortex → Robust Formation → Pharyngeal Motoneurons → Laryngeal Muscles (partially vag)

→ cooling agent ⇒ pred: cooling MI leads to dilation at all timescales
↳ MI ⇔ subcortical structures ⇒ shared dynamics

→ MI inactivation via muscimol ⇒ elimination post vocal responses
⇒ decreases variability

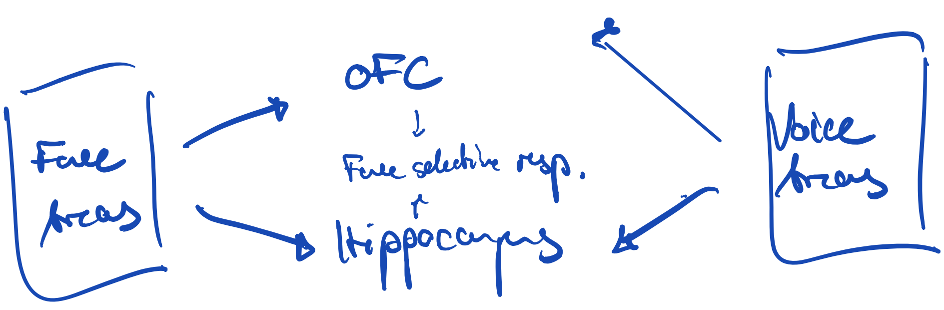
- Hierarchical control of vocalization [MI → birdy subcortex]
- Variability affected by MI inactivity

- Human speech dev.: ① Universal speech perception ⇒ Social Modulation
- Bird tutor replacement by robot singer → emergence of structure
  ↳ Tutoring really matters in development!
- HVC ← motor structure with noisy auditory inputs ⇒ Tutor exposure
  ↳ hearing tutor song can lead to precise singing for young birds
  ↳ drop in inhibition as age of bird happens
  ↳ local inhibitory blockade of gabazine ⇒ can block auditory responses
  ⇒ local inhomogeneous are sole source of inhibition to HVC
  ↳ stray connectivity with motor neurons

- Inhibition ≥ Maturity → Not all birds are good 'learners'?!
  ↳ different learning trajectories
  ↳ Inhibition increases in strength / precision with learning
  ↳ bird focuses learning on particular pieces of songs!
  ↳ targeted inhibition ⇒ interneuron activity accurately targets learned syllables!
  ↳ Long activation of motor seq. ⇒ premotor neurons can directly be driven by tutor song
- Who tells inhibitory network where to focus learning on?
  Enhance learning when manipulating interneurons?

Symposium 5 – Neural Mechanisms for social cognition in monkeys and humans

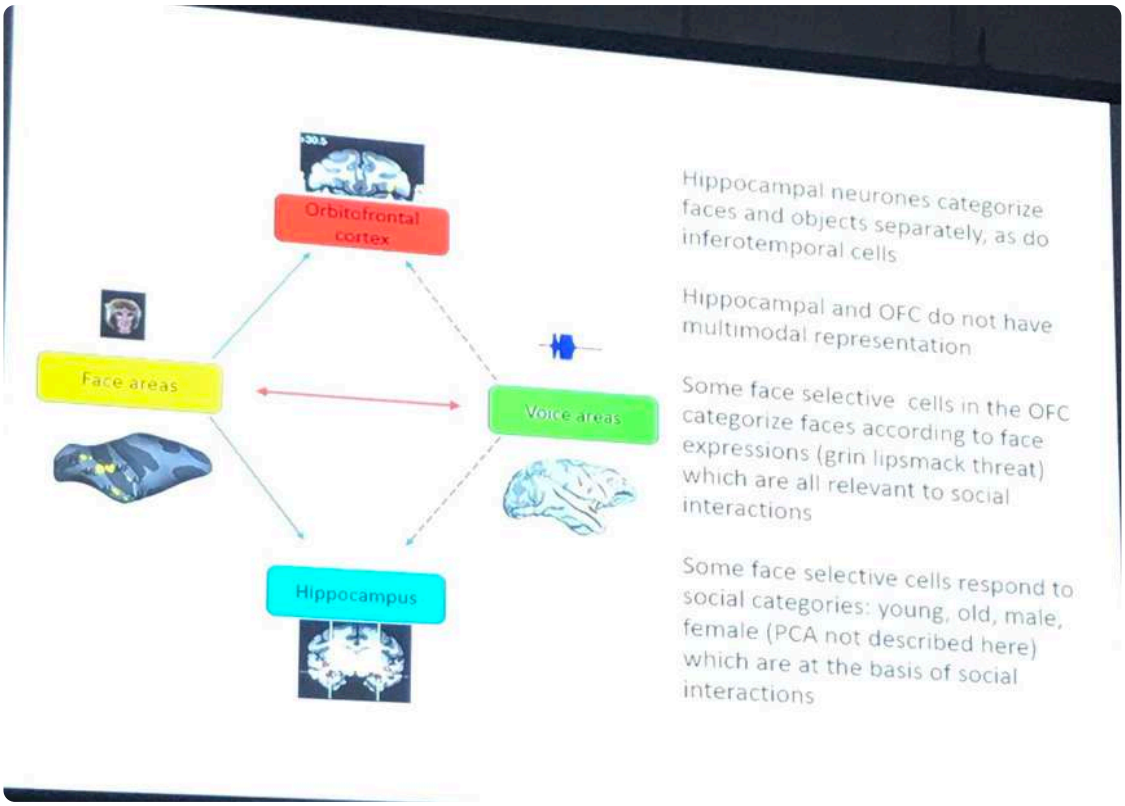
Talk 1: Sylvia Wirth – Neural coding of faces and voices



- Hippocampal cells encode knowledge of who person is
  ↳ identity in macaque hippocampus

- Monkey spent more time looking at face when preceded by its congruent voice → linking!
- Personally familiar vs not seen ⇒ no prior selection of cells
- Vocal stimuli represented distinctively represented from acoustic ones
- Faces represented apart from objects

- No representation of personally relevant objects (FIT or HPC)
- Inferotemporal cells were more sensitive to stimulus category (FIT)
- OFC → few selective cells
  - large diversity ⇒ response to social categories
  - Max. firing rate for pictures of young animal
  - modulated by vocal stimuli ⇒ No / little modulation
- Hippocampal cells analyze faces/objects separately!



Talk 2: Fabian Grabenhorst – Amygdala neurons simulate decision processes

- Amygdala → fear conditioning ⇒ responses visually driven
  ↳ also: face neurons // new approach: economic decisions

- Economic reward-saving tasks
  ① ↳ moment-by-moment choice coding in amygdala neurons
  ② ↳ planning activity for distant reward goals
  ③ ↳ progress-tracking toward planned reward goals

⇒ relation to social behavior! → observational learning

- Partners observe each others choices / rewards
  ↳ faster learning compared to standard self-observed learning
  ↳ also learn!

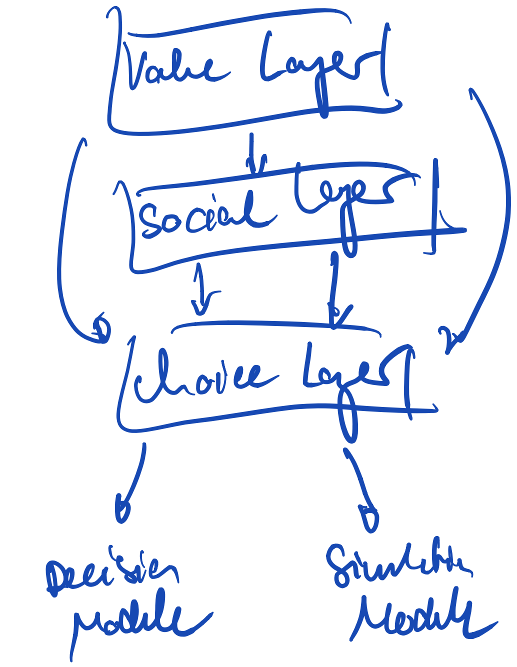
↳ gaze data ⇒ monkeys can predict behavior of partner
↳ lateral nucleus ⇒ value coding for both types of learning

- Neurons simulate partner's decision making
  ↳ value comparison process
  ↳ sensitivity for decision difficulty

↳ SVM decoding?

① object-value neurons
② Social neurons
③ Decision / Simulation neurons

} Two decision process in primate amygdala
↳ Artificial amygdala



• Gustavo Deco (UPF)

Talk 3: M. Rushworth –

• Object – Action – Self value

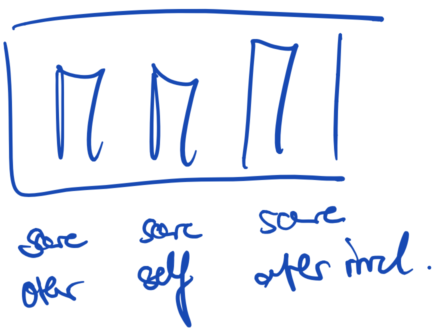
• Grey areas → affected by social environment

↳ STS // LOS

• Self value estimation

↳ time / history dependent and social neighborhood!

→ look how people evaluate behavior and fMRI signal



→ cooperative and competitive behavior allowed!

↳ exceeding of threshold!

→ self-evaluation is based on both the performance of the team and the personal

Talk 4: P. Tobler – Group effects on neural mechanisms for learning

• learning via prediction learning → social

↳ observed outcome pred. error in ventromedial PFC

observed action pred. error lateral dm medial PFC

• Multi-player prisoner's dilemma

↳ individual learning can have unintended social group effects!

↳ choice to play with partners → social exclusion ⇒ ostracism

↳ punishment of free-riders ⇒ No path-dependency:

↳ fast & frontal predict better outcome of exclusion than defecting behavior!

- Combat problem by forced interaction → use learning to reduce!
- Ingroup bias → empathy ⇒ Insular shows reliable!
  ↳ can empathy be learned?! ⇒ increase for outgroup?!
  ↳ left anterior insular ⇒ learning being helped by outgroup leads to strong dehumanization with outgroup!

PE coding
↳ Research-Paper

→ intervention effect on PE

- pain responses affected by learning intervention!
- pain relief learning effect from anterior insular predicts behavioral pain response

Eleanor Maguire — High Resolution Studies of the Hippocampus

• Autobiographical memories (AM)
→ ventromedial PFC interaction with hippocampus
↳ experience replay!

HC <-> vm PFC

→ Hippocampus stores nothing in longer term
but critical for AM retrieval in longer term
→ vm PFC orchestrating role for enabling AM

CONTINUOUS FLUX

• Hippocampus (HC)
→ Encoding → Not involved in retrieval AM
↓
traces? ⇒ No AM traces are in hippocampus in longer term
↳ still crucial for recall

→ long-term potentiation / long-term depression ⇒ principal forms of plasticity
↳ under naturalistic conditions ⇒ higher turn-over
↳ over-writing in hippocampus!
↳ life span of dendritic spines in hippocampus too small!
→ anterior ⇒ recently formed || posterior ⇒ 2 years later

• Hassabis et al (2007) → remembering is imagining!
↳ counterfactual thinking ⇒ mental 'time travelling' to choice point
⇒ Kahneman & Tversky (1982)
↳ damaged patients ⇒ fight against imaging alternatives!

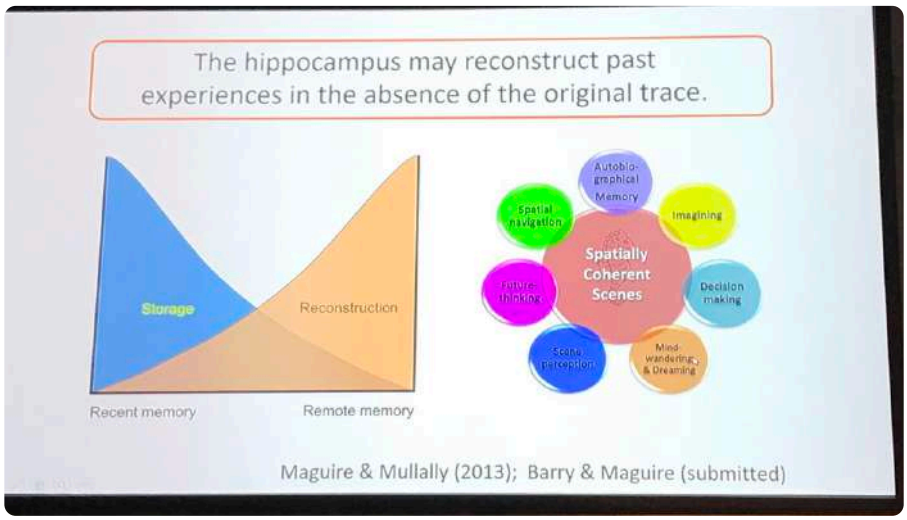
• Scenes — hippocampus involved in processing!
↳ 'Boundary extension' ⇒ give scenes way more detail than carefully presented

seen closer?

- HC patients ⇒ know what is likely beyond view but don't have scene visualization?

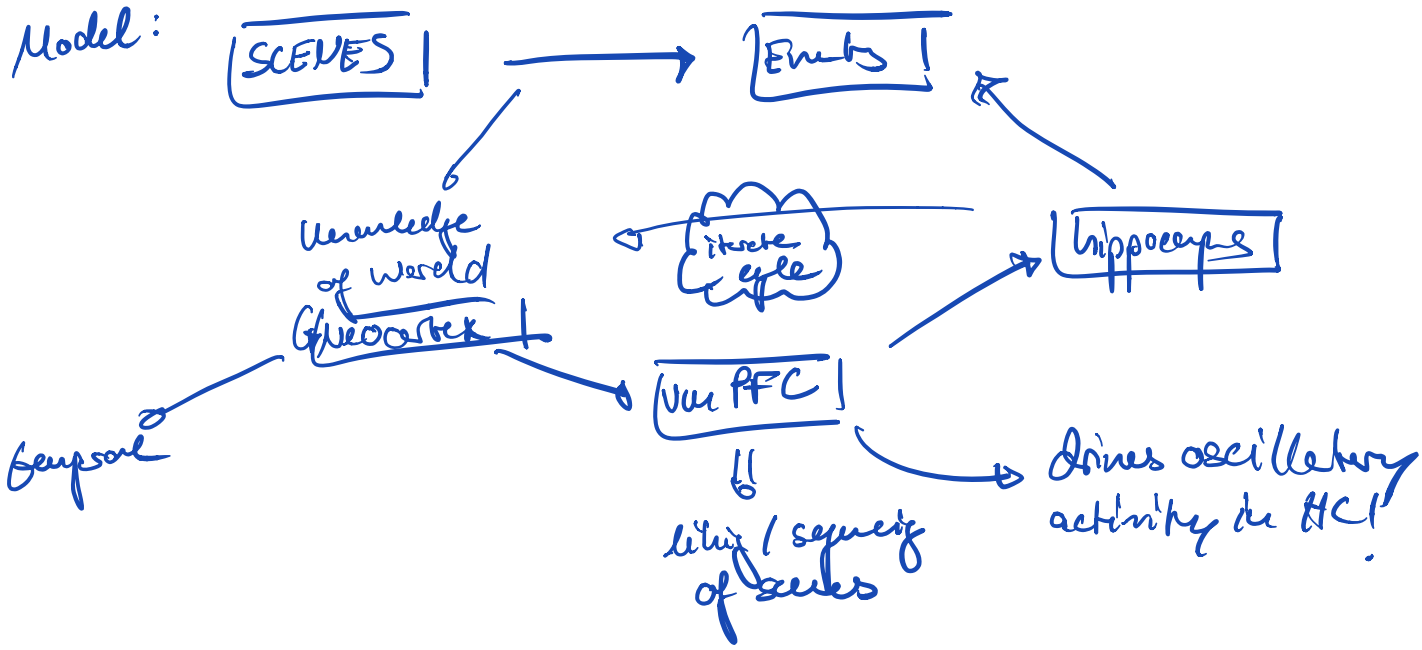
⇒ mind-wandering → control do much of thinking about past
↳ patients are "stuck" with present!
↳ control have episodic thoughts while patients are more semantic

- Hippocampal reconstruction in absence of original trace



- Anterior medial part of hippocampus!
- Comparison vmPFC patients on HC task and v.v.
↳ confabulation ⇒ (worst type)

- Model:



- Event segmentation theory: parse/segment events where boundaries change!
↳ smallest subunit of event = scene
- DCM → activity flow direction ⇒ vmPFC precedes HC during AM retrieval

better model fits

EPP in vmPFC

free energy

- Can't examine formation of MM with fixed scanner setup
  - ↳ Mobile MEG → optically-pumped magnetometers (OPMs)
  - ↳ allows for head movement OPM-MEG
  - ↳ combine with interactive virtual reality ⇒ capture inception of MMs → follow neural signatures

In conclusion

- Autobiographical memory recall is orchestrated by the vmPFC.
- The hippocampus plays a subordinate, but still critical, role.
- Scenes are the smallest unit of autobiographical memories.
- Implications beyond autobiographical memory.
- A need for high temporal resolution MEG (iEEG, OPM-MEG) studies and ultra-high 7T MRI spatial resolution studies of autobiographical memory.
- A need to examine and track neural signatures of autobiographical memories from the point of their very inception.

Symposium 6 – Prefrontal Mechanisms underlying Working Memory

Talk 1: Albert Compte – Spatial WM in the PFC

- Oculomotor delayed-response tasks
  - → PFC = spatial WM ⇒ neurons encode correct location
  - → Bump attractor dynamics → noise spreads ⇒ Forensic Habits
  - → PFC activity is consistent with diffusing bump attractor dynamics
    - ↳ bump travels frontal trials

    pooled through trials

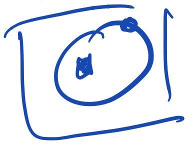
- Latent Memory? ⇒ Attractive and repulsive serial biases in ODR
  - → Again bump? ⇒ inter-trial memory → Nb! ☐
    - ↳ sudden reappearance of bump
    - ↳ inter-trial interval

- Add short-term facilitation
  - → Simulations now explain data
  - → Internal representation during fixation period
  - → TMS in PFC/PPC reduces serial biases

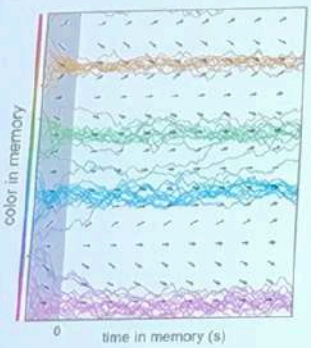
Prefrontal mechanisms in ODR

- **Bump attractor dynamics** for active spatial working memory during trial
- Bump-accummulated, **subthreshold short-term mechanisms** (STP?) for passive, across-trial memory traces

Talk 2: T. Buschman — Attractor Dynamics determine WM precision

- Sources of errors in WM ⇒ DYNAMIC!
  - →  ⇒ angular distance → metric for error in WM
  - → errors in WM increase with memory load and over time!
  - → stochasticity of neural activity accumulates over time
    - ↳ over time causes memories to drift away
    - ↳ but errors are clustered ⇒ non-uniform → attractor dynamics?
  - → dynamical system: $d\theta = \beta_{load}\, G(\theta) + \sigma_{load}\, N(0, dt)$
    - ↳ Brownian Motion ⇒ vector field
    - $d\theta$ → change in memory; β_{load} → drift ↳ attractor dynamics; σ_{load} → diffusive noise
    - ↳ explains clustering in memory
    - ↳ systematic bias in memory representation! → predict how active memory should be in specific states → attractors were active!
- Advantage of attractor dynamics
  - → diffusion is unbounded ⇒ attractor bounds! → mitigate
  - → adaptation of attractor dynamics?!
  - → adaptation of attractor dynamics ↑ as load increases (no. of things kept in mem.)
    - ↳ σ_{load} ↑ ⇒ attractor dynamics offset! → β_{load} ↑ ⇒ auto-act → mitigate
      - auto-act → more bias in short-term → rescue long-term
    - ↳ shifting of attractors adaptive
      - ↳ according to understanding of the environment!

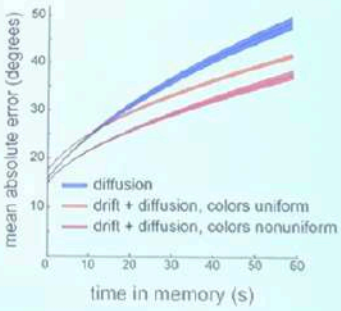
Attractors provide a mechanistic explanation for the frequency, bias, and accuracy of memory reports



Working memory is a dynamic process, with memories evolving over time.

Attractor dynamics provide a mechanistic explanation for:

- Distribution of working memory reports.
- Bias in working memory.
- Accuracy of working memory.



Attractor dynamics mitigate the impact of neural noise, improving memory performance.

- Attractors optimally adapt to the context; compensating for load-dependent increases in diffusion and moving to reflect the statistics of the environment.

Implement Bayesian inference over time.

Talk 3: Joni Wallis - Prefrontal Mechanisms contributing to WM

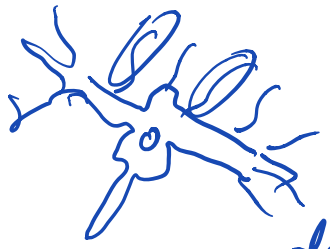
- Many different stimuli can be encoded in WM (auditory / visual / etc.)
  → PFC neurons can encode a lot of different info
  → can't learn everything! Space is special.
- Covert attention ⇔ microsaccades interact with WM
- Spatial selectivity ⇒ almost 2/3 of neuron's activities variance can be explained by spatial info!

to even simple task, were color-tuned neurons encoded spatial position

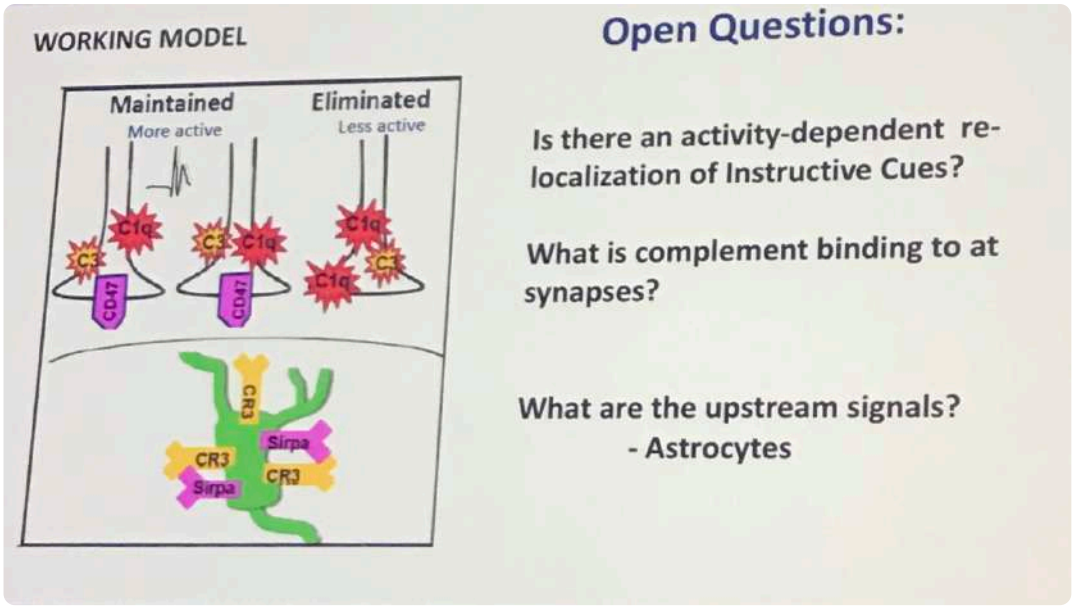
- Our results support the idea that the prefrontal cortex is responsible for the high-level control of behavior.
- This is accomplished on a framework of spatiotemporal tuning, whereby individual neurons are tuned for organizing behaviors at a particular time and location.
- As behaviors become more automatic, the involvement of PFC declines, evidenced by reduced spatiotemporal tuning.

Beth Stevens – Immune Mechanisms of Synapse Loss in Disease

- Brain has its own immune system → microglia ⇒ prune and remodel synapses
  - ↳ precise wiring
  - ↳ today: mechanisms! ⇒ [ ]
- CNS synapse elimination → development ⇒ "Use it or lose it"
- Which synapses are targeted?
  - → neural activity: inputs compete
  - → astrocytes ⇒ formation/plasticity
  - → microglial cells ⇒ 10% of brain → very dynamic!
    - ↳ constant surveillance of spines/dendrites
    - ↳ [ ] vs. pruning
    - ⇒ preferably engulf less active inputs!
    - ↳ instructed by complement proteins! ⇒ C3 microglia



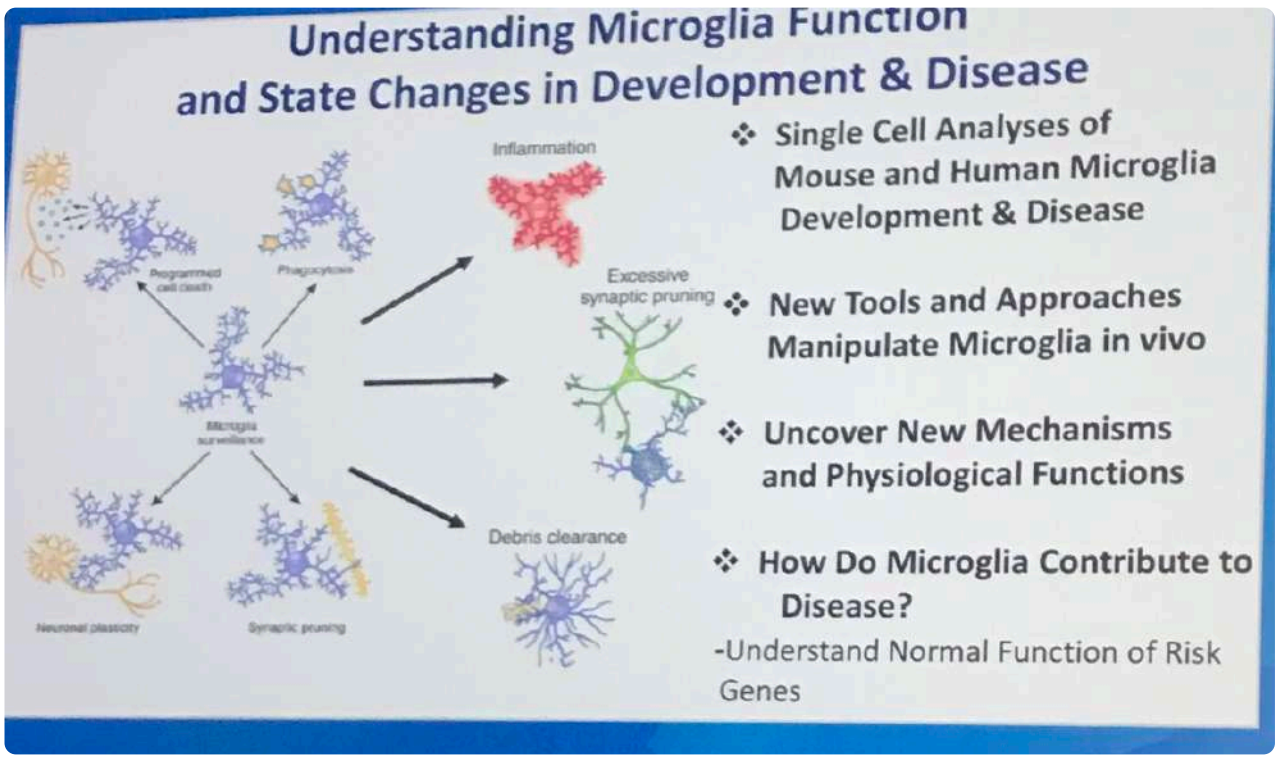
- specificity ↔ protective molecules prevent microglia from engulfing
  - ↳ stop signals ⇒ prevent inappropriate removal
    - ⇒ microglia have many receptors to identify!



- dynamic cross talk!
- disorders
  - ↳ pruning mechanisms is turned back on in adults for ex.!

Alzheimer's / Schizophrenia

- Microglia also clear plaques & dead neurons!
  - ↳ activation ⇒ hallmark of AD
- Diverse roles → context dependence ⇒ HETEROGENEITY in development
  - to study cell profiling RNA seq
  - to CRISPR destroy → 3 different microglia states
    - ↳ during intelligent development!
    - ↳ use as new markers ⇒ localization in brain
- Disease and injury ⇒ Microglia state changes
  - ↳ demyelination ⇒ state change ⇒ gene change



DTGS:
11/07/18

Silvia Arber → Organization and Function of Descending Motor Circuits

- Action diversification ↔ circuit organization

Motor Cortex
↓
Basal Ganglia → Thalamus
↓
Action Sequence
↓
Lower motor system

- Motor system spans over full CNS
- Forelimb → precise
- Hindlimb → locomotion

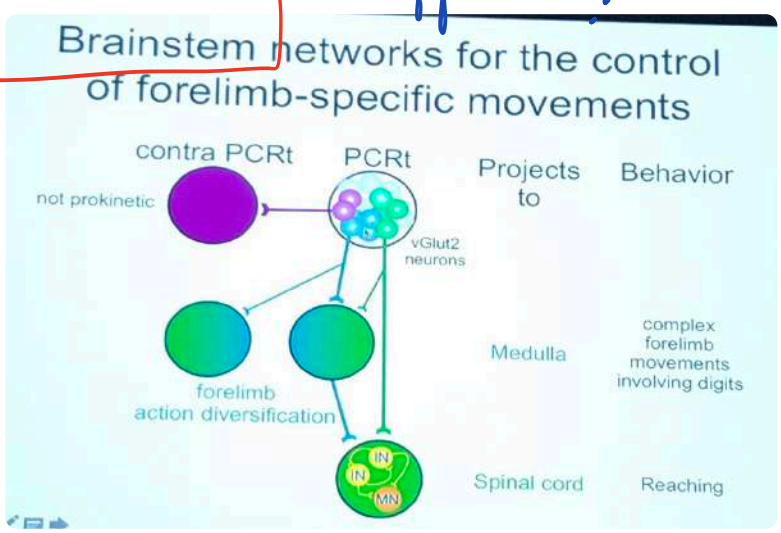
→ Full body movement: Mc, Pn, Gi

- skilled forelimb movement
  - subcortical structures
    - ⇒ RdV → grasping
    - ⇒ PCRt → ready
      - direct but differential access to spinal cord
      - activation of 200 neurons leads to ready

HLR
↓
Upstream motor areas
↓
Reticular formation
↓
MC
↓
Spinal Cord

Precise subpopulations
↓
Stimulation/inhibition neurons
↓
Need to study SPECIFIC populations?

- General – optogenetics problem: Artificial activation leads to behavior but are neurons actually active in naturalistic behavior?!



Botond Roska – Neuronal circuits Based Medicine ⇒ VISION

- Retina does not receive feedback → "brain is clever to retina" → can't correct
- Cell types → not only different morphology but also genetic coding
  - ↳ understanding diseases → all type specific !
- Retinal circuit
  - → photo-receptor ⇒ from circuit mosaic to extract features !
    output
  - → retinal cells types have quite barcodes
- FRMD7 – shortest cells ⇒ in mice and human → idiopathic congenital nystagmus
  - gaze stabilization → lack of horizontal optokinetic reflex
- motion direction ganglion cells ⇒ mechanism for selectivity ?!
- symmetric connectivity is missing !
- Set of brain regions that connects visual input with motor output ?!
  - → functional ultrasound imagery ⇒ higher resolution than fMRI
    - ↳ whole-brain activity map ⇒ models of brain regions
    - ↳ overcome bias of studying regions that supervisor prepares
    - ↳ fMRI: bad resolution in humans
- Duplex fovea for smartphone usage !!
  - → eye is growing : problem of focus !
- Skin biopsy → iPS cells ⇒ development optic cups
  - ↳ human organoids from stem cells ! ⇒ why for missing: optic nerve
  - ↳ build organoids for all genetic diseases

- Disease: Retinitis pigmentosa
- Near infra-red image (NIR) ⇒ supplement human near-blind vision
- Can fake blood? human retina and body it back fully functioning