Research Methods in Computational Psychiatry and Neuroscience

SPICE 2024

Neuroscience & Computational Psychiatry Module
Class IV

2nd of July 2024

Mount Sinai

Center for Computational Psychiatry

Methods to study the brain

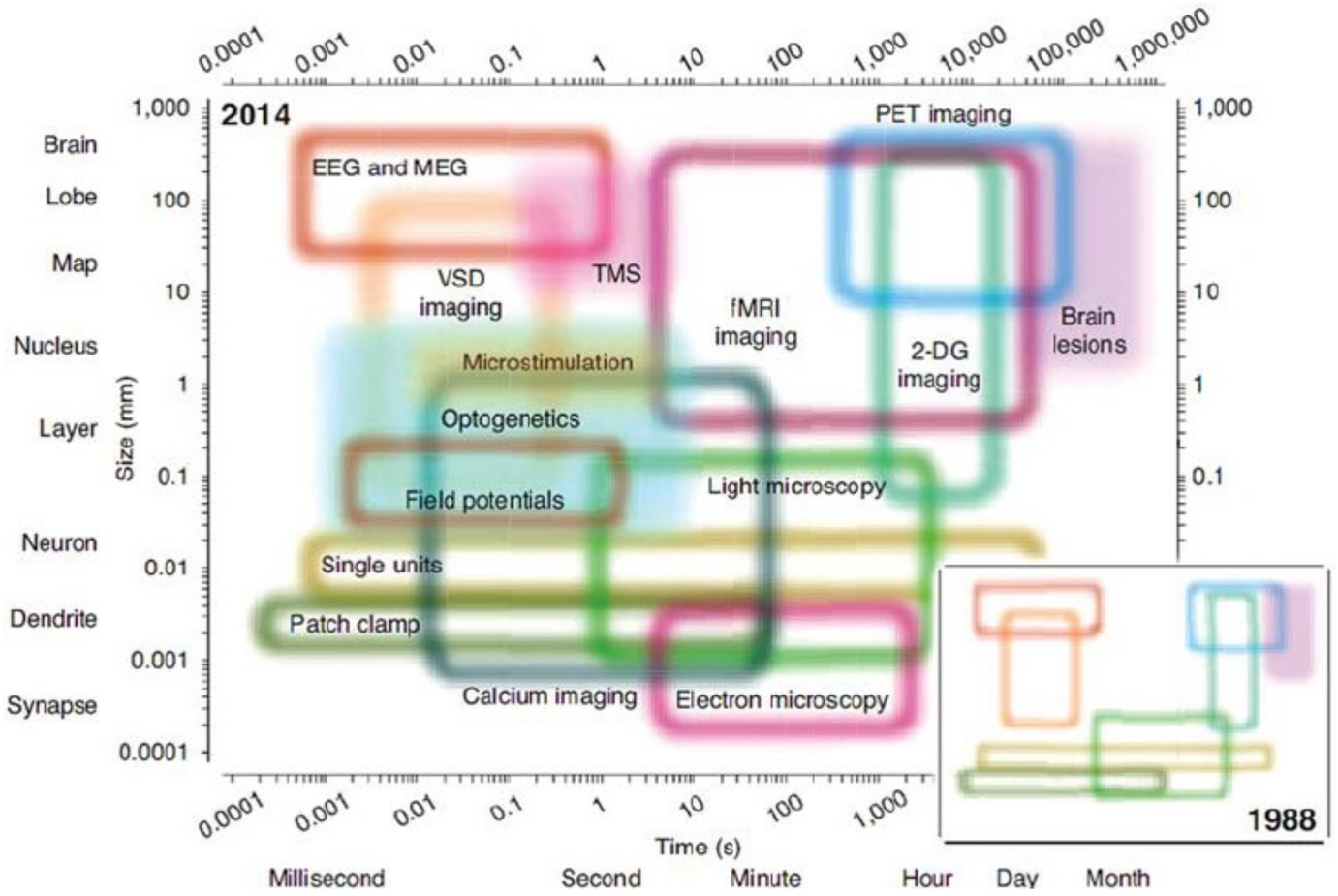


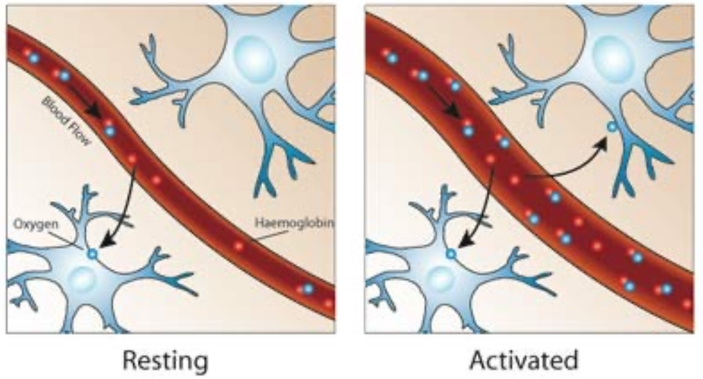
Image: Sejnowski et al. 2014

Methods to study the brain & psychiatric disorders

- Functional & structural magnetic resonance imaging (fMRI/ sMRI)
- Electroencephalogram (EEG)
- Magnetoencephalography (MEG)
- Behavioral testing
- Self-report
- Computational modeling
- Non-invasive brain stimulation (transcranial magnetic stimulation , etc.)
- Invasive brain stimulation/ recordings (deep-brain stimulation, voltammetry, iEEG, etc.)

Functional magnetic resonance imaging (fMRI)

- Indirect measure (blood oxygination)
- Good spatial, not-as-good temporal resolution
- Gives us insight into activity patterns



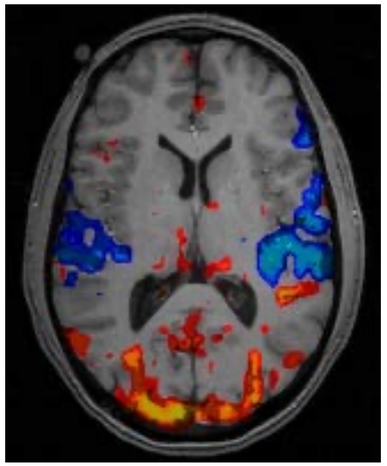


Image: Open University; Nuffield Department of Clinical Neuroscience

EEG & MEG

Singh, S P (2014). Magnetoencephalography: Basic principles. Ann Indian Acad Neurol 2014:17 (Supplement 1):S107-12

Papadelis & Perry (2021). *Semin Pediatr Neurol*. October;39: 100919
doi:10.1016/j.spen.2021.100919

- Direct readout of electrical/ magnetic neuronal currents
- Worse spatial, better temporal resolution
- Sensitive to large, synchronized firing of pyramidal neurons

EEG & MEG

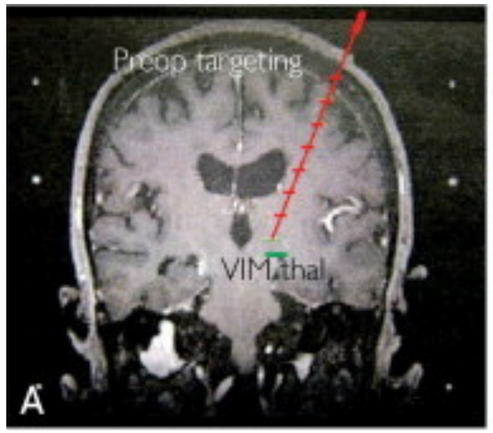
Singh, S P (2014). Magnetoencephalography: Basic principles. Ann Indian Acad Neurol 2014:17 (Supplement 1):S107-12

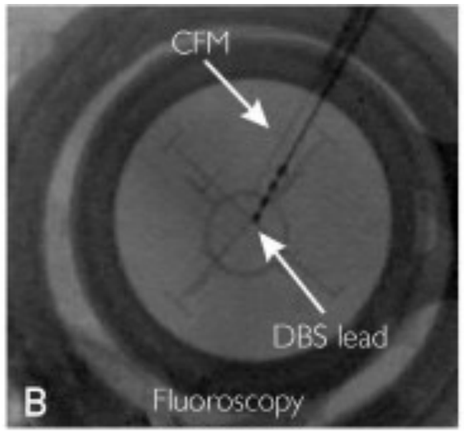
Papadelis & Perry (2021). *Semin Pediatr Neurol*. October;39: 100919
doi:10.1016/j.spen.2021.100919

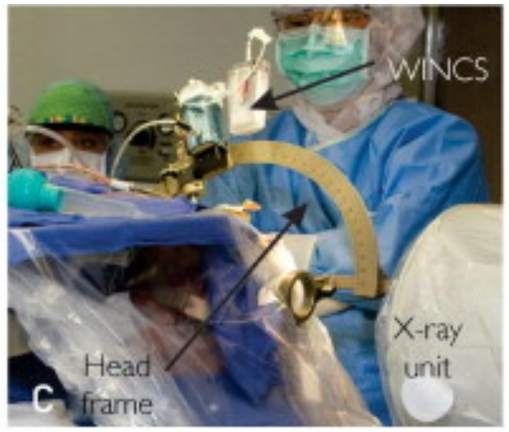
- Direct readout of electrical/ magnetic neuronal currents
- Worse spatial, better temporal resolution
- Sensitive to large, synchronized firing of pyramidal neurons

Deep brain stimulation and voltammetry

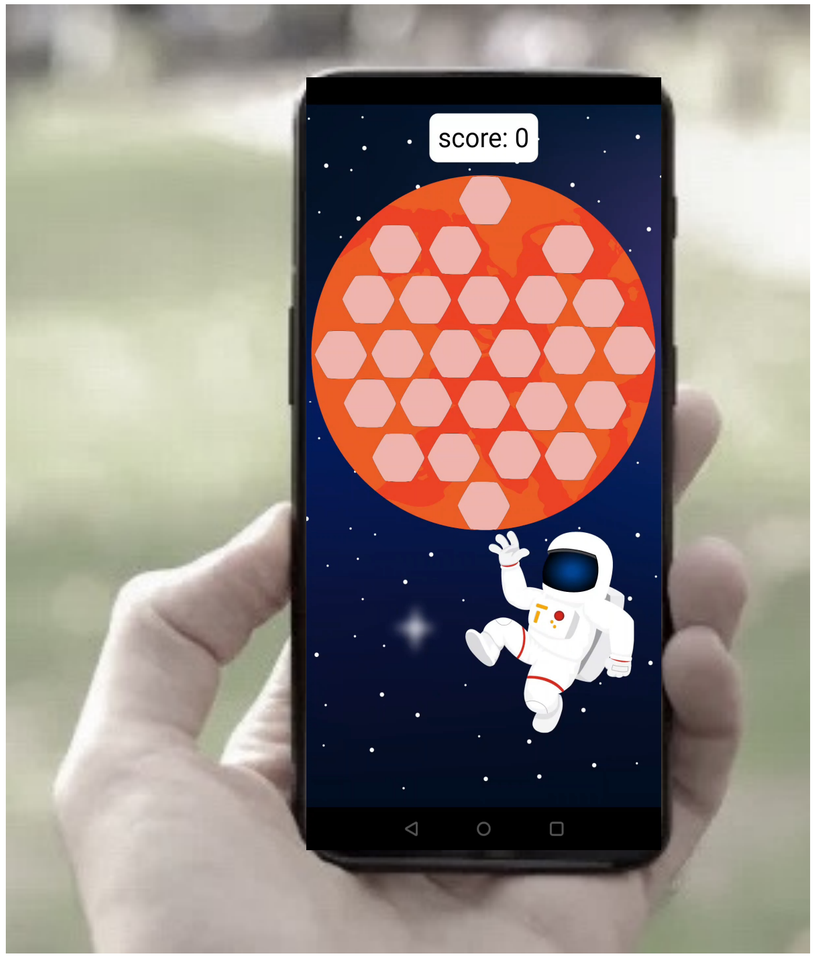
- **DBS**: Surgical therapy using electrical stimulation to treat movement & psychiatric disorders.
- Mechanism: Alters brain activity, likely through neurotransmitter modulation.
- **Fast-Scan Cyclic Voltammetry** (FSCV): Real-time measurement of neurotransmitters (dopamine, etc.) during DBS surgery.
- Direct observation of DBS's impact on brain chemistry
- Correlation of neurotransmitter changes with clinical outcomes
- Personalization of stimulation parameters
- Insight into task-related neurotransmitter dynamics

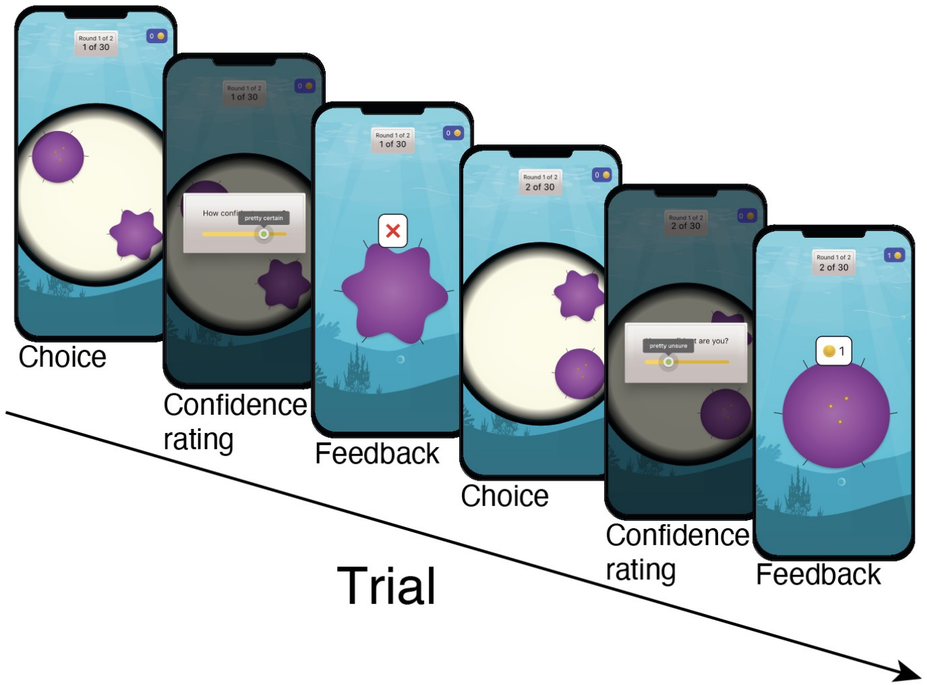






Cognitive-behavioral tasks





BrainExplorer.net

Loosen et al., (in preparation)

Self-report

Obsessive-Compulsive Inventory - Revised (OCI-R) (OCI-R)

Instructions:

The following statements refer to experiences that many people have in their everyday lives. Select the option that best describes how much that experience has distressed or bothered you during the PAST MONTH.

		Not at all	A little	Moderately	A lot	Extremely
1	I have saved up so many things that they get in the way.	0	1	2	3	4
2	I check things more often than necessary.	0	1	2	3	4
3	I get upset if objects are not arranged properly.	0	1	2	3	4
4	I feel compelled to count while I am doing things.	0	1	2	3	4
5	I find it difficult to touch an object when I know it has been touched by strangers or certain people.	0	1	2	3	4
6	I find it difficult to control my own thoughts.	0	1	2	3	4
7	I collect things I don't need.	0	1	2	3	4
8	I repeatedly check doors, windows, drawers, etc.	0	1	2	3	4
9	I get upset if others change the way I have arranged things.	0	1	2	3	4
10	I feel I have to repeat certain numbers.	0	1	2	3	4
11	I sometimes have to wash or clean myself simply because I feel contaminated.	0	1	2	3	4
12	I am upset by unpleasant thoughts that come into my mind against my will.	0	1	2	3	4
13	I avoid throwing things away because I am afraid I might need them later.	0	1	2	3	4
14	I repeatedly check gas and water taps and light switches after turning them off.	0	1	2	3	4
15	I need things to be arranged in a particular way.	0	1	2	3	4
16	I feel that there are good and bad numbers.	0	1	2	3	4

QUESTIONARIO S.T.A.I.
FORM Y – 2

Nome e Cognome .....

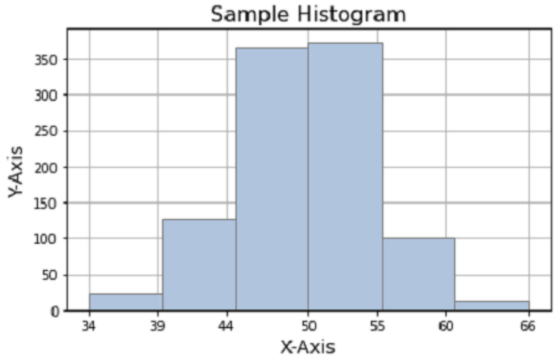
ISTRUZIONI: Sono qui di seguito riportate alcune frasi che le persone spesso usano per descriversi. Legga ciascuna frase e poi contrassegni con una crocetta il numero che indica come lei *abitualmente* si sente. Non ci sono risposte giuste o sbagliate. Non impieghi troppo tempo per rispondere alle domande e dia la risposta che le sembra descrivere meglio **COME LEI SI SENTE ABITUALMENTE**.

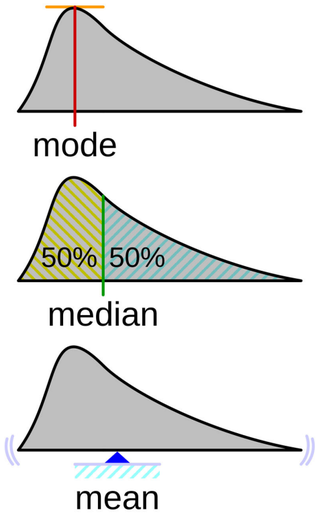
1 = Quasi mai 2 = Qualche volta 3 = Spesso 4 = Quasi sempre

1. Mi sento bene	1	2	3	4
2. Mi sento tesa e irrequieta	1	2	3	4
3. Sono soddisfatta di me stessa	1	2	3	4
4. Vorrei poter essere felice come sembrano gli altri	1	2	3	4
5. Mi sento una fallita	1	2	3	4
6. Mi sento riposata	1	2	3	4
7. Io sono calma, tranquilla e padrone di me	1	2	3	4
8. Sento che le difficoltà si accumulano tanto da non poterle superare	1	2	3	4
9. Mi preoccupo troppo di cose che in realtà non hanno importanza	1	2	3	4
10. Sono felice	1	2	3	4
11. Mi vengono pensieri negativi	1	2	3	4
12. Manco di fiducia in me stessa	1	2	3	4
13. Mi sento sicura	1	2	3	4
14. Prendo decisioni facilmente	1	2	3	4
15. Mi sento inadeguata	1	2	3	4
16. Sono contenta	1	2	3	4
17. Pensieri di scarsa importanza mi passano per la mente e mi infastidiscono	1	2	3	4
18. Vivo le delusioni con tanta partecipazione da non poter togliermele dalla testa	1	2	3	4
19. Sono una persona costante	1	2	3	4
20. Divento tesa e turbata quando penso alle mie attuali preoccupazioni	1	2	3	4

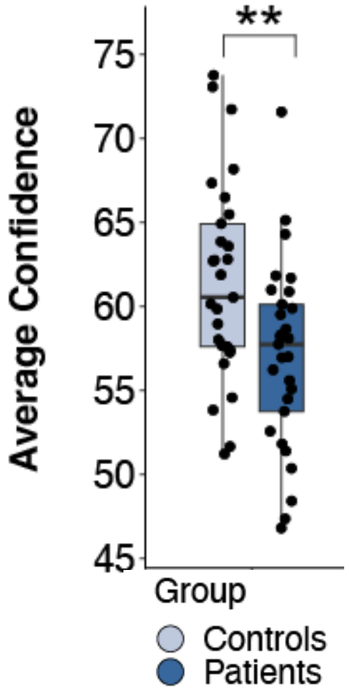
Statistics

Descriptive Statistics

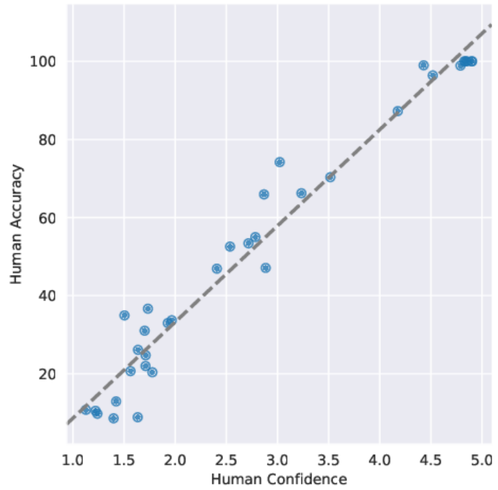




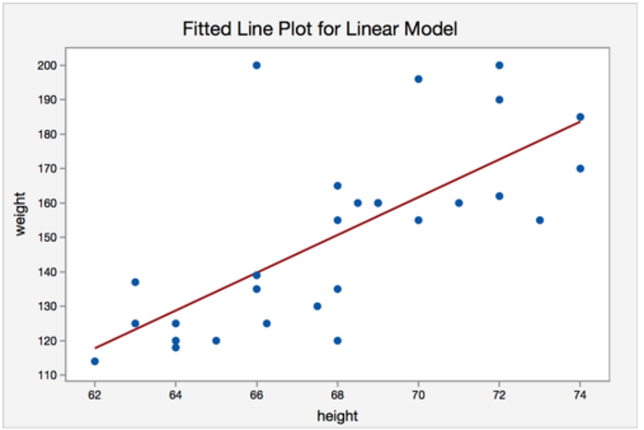
Inferential Statistics



Correlation



Regression



Images: Malik, Crowder & Mingolla (2022); Loosen et al, (in preparation); StatOnline.com

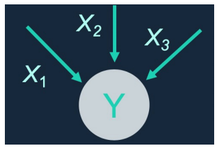
Statistical and computational modeling

$y = f(x)$

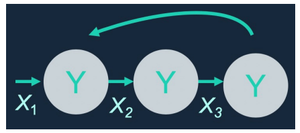
Regression models

- requires explicit formulation of task variables
- receives one or more parallel inputs

Parallel Inputs



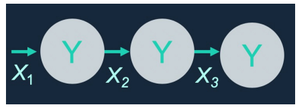
Feedback



Computational models

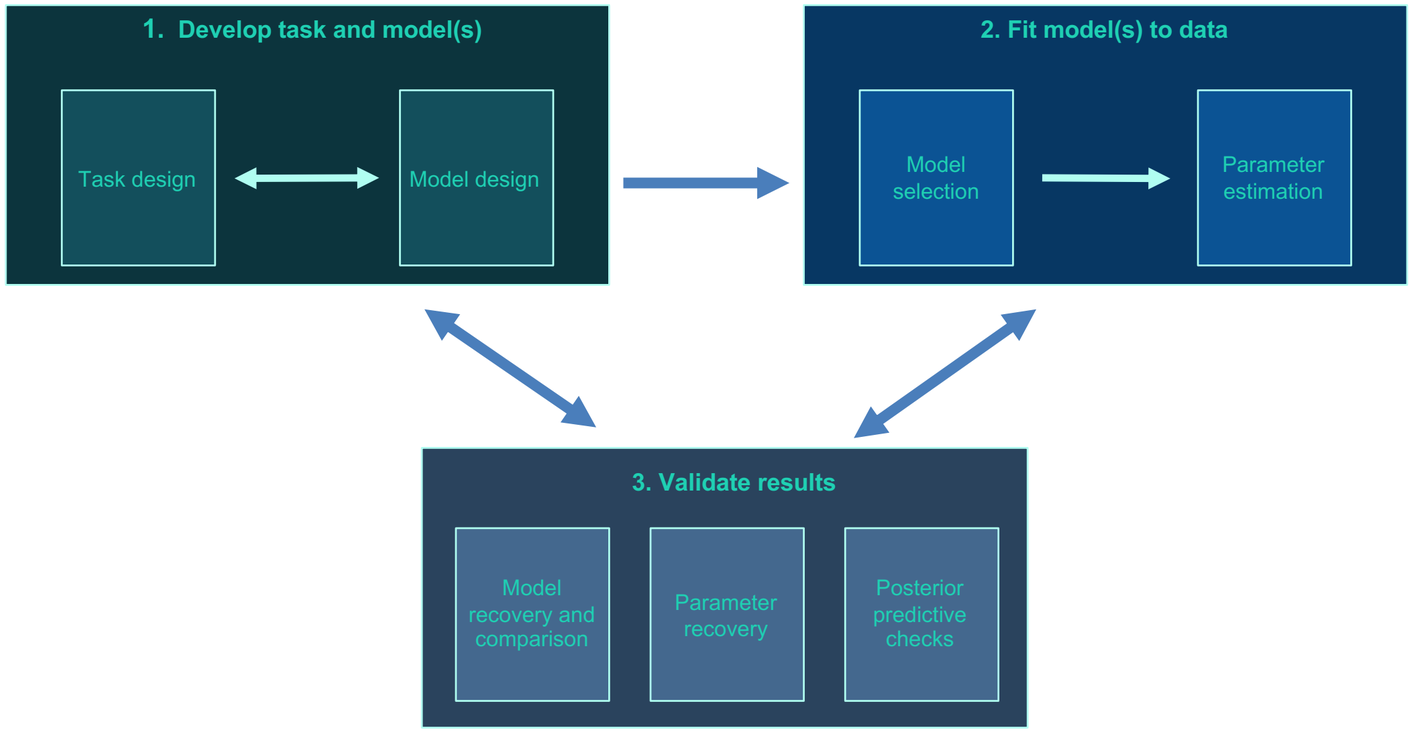
- can infer latent (hidden) processes (e.g., beliefs,…)
- predict data of nonlinear systems, that involve series pathways, feedback processes etc.

Serial Input



Mujica-Parodi & Strey, 2020

Computational modeling



- What are the relevant variables to predict the data?
- Are there multiple models that can explain the data?
- How can we select between them?

Thank you!

Any Questions?

Thank you!

Any Questions?

Next Class:

Wednesday the 3rd

9:30am-10:30am

Next Week: