Dynocog

Thesis update V

13 April 2021

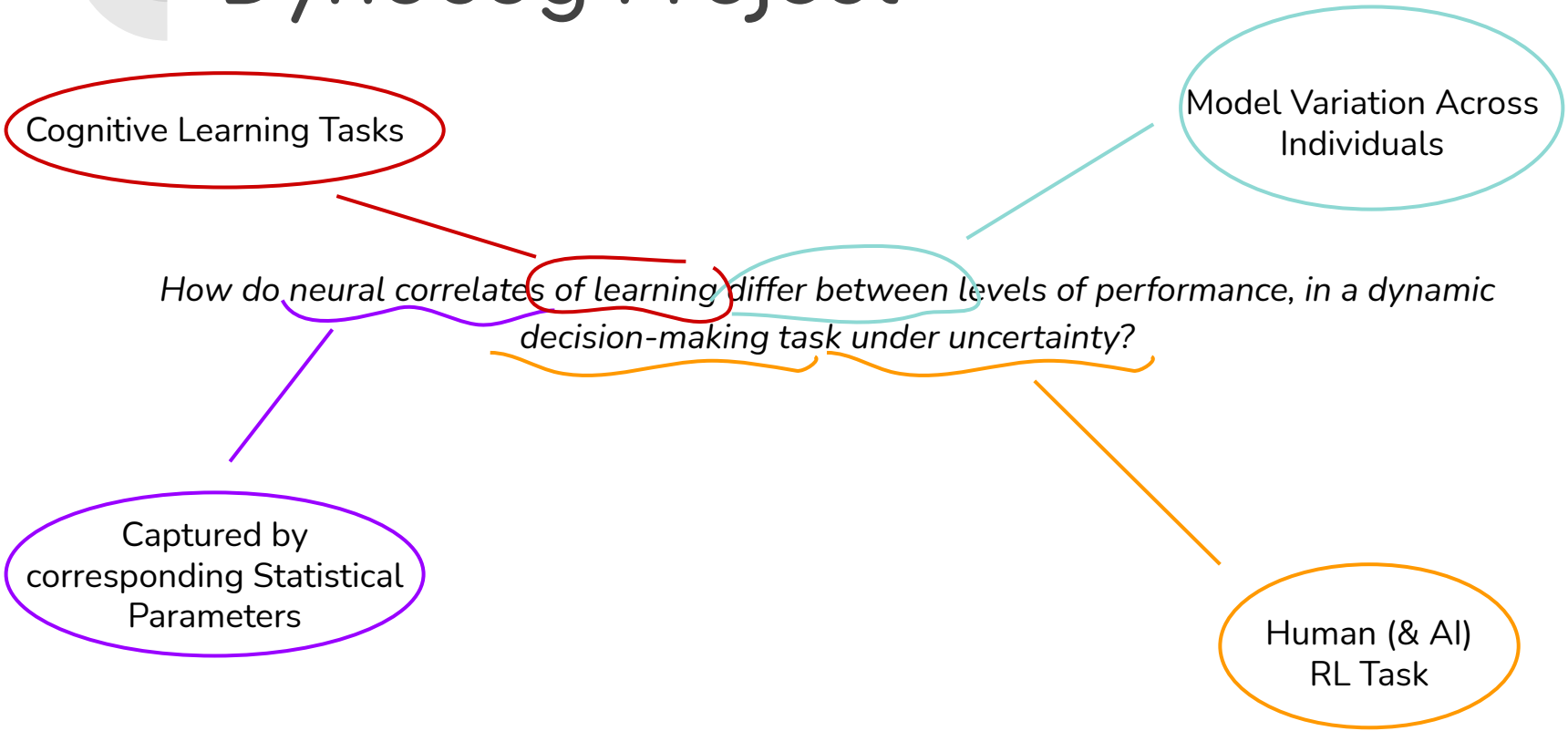
Project Overview

1. Project Background
2. Current Progress
3. Recent Updates
4. Next Step

Dynocog Project

How do neural correlates of learning differ between levels of performance, in a dynamic decision-making task under uncertainty?

Dynocog Project



Execution

Phase 1. Psychological Experiments

Phase 2. Design the Computational Framework

Phase 3. Fit & Perform Inference

Phase 1. Psychological Experimentation

Primary concerned with ***Dynamic Learning under Uncertainty***

Task Battery:

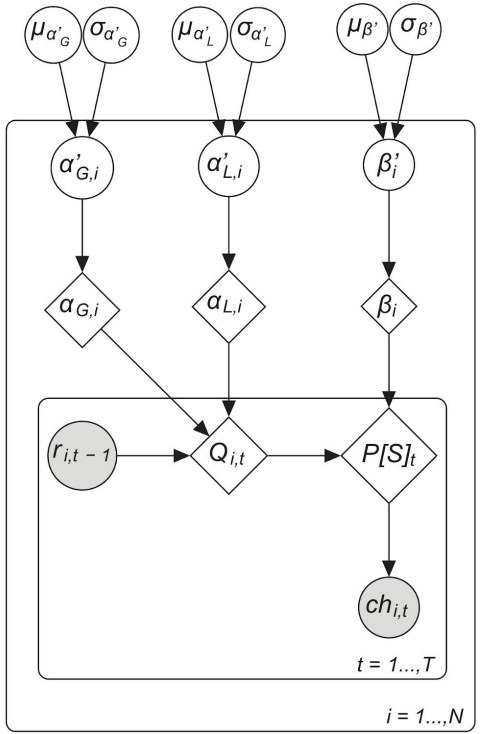
WCST	→	Dynamic Learning under Uncertainty
N-Back Task	→	Working Memory
Corsi	→	Working Memory
Navon	→	Complimentary: local/global attention
		(Relates to EEG data, Covariate to Corsi)
Fitts	→	Complimentary: (corroborate RL outcomes? @ Ben)

Phase 2. Mathematical Framework

Hierarchical Bayesian Reinforcement Learning

Inspired by the Slooten et. al.

To be Implemented in Pyro (scalable, universal probabilistic programming)



$\mu_{z'} \sim Normal(0,1)$
$\sigma_{z'} \sim Cauchy(0,5)$
$z' \sim Normal(\mu_{z'}, \sigma_{z'})$
$\alpha_{G,i} = \Phi(\alpha'_{G,i})$
$\alpha_{L,i} = \Phi(\alpha'_{L,i})$
$\beta_i = \Phi(\beta'_i)$

Hierarchical Bayesian == Pooled Variation

RL == Dynamic Learning Task

Phase 3. Fit + Inference

Model Specification ~ Neural Correlates

Statistical Parameterisation ~ Neuropsychological Theoretical Model

$$Q_i(t+1) = Q_i(t) + \begin{cases} \alpha_{Gain}[r_i(t) - Q_i(t)] & if\ r = 1 \\ \alpha_{Loss}[r_i(t) - Q_i(t)] & if\ r = 0 \end{cases}$$

$$P_A(t) = \frac{exp(\beta Q_A(t))}{exp(\beta Q_B(t)) + exp(\beta Q_A(t))}$$

Current Progress

Phase 1. Psytoolkit Instance

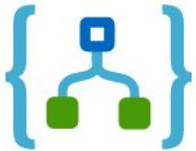
- Psytoolkit fully implemented
- Awaiting perusal & MTurk

Phase 2. Model Design

- Thoroughly decomposed comparable model (Slooten)
- Not yet begun our instance

Phase 3. Model Instance

- Theoretically studied
- Implemented other Pyro instances
- Not yet configured data structure



Recent Updates

Psytoolkit

Notion + Git == Project Structuring

Psytoolkit

All iterative changes made:

1. Instruction sets
2. Game Implementation changes
3. WCST rule generation Python script

Instruction sets

Custom vector images

Figma

Psytoolkit

- WCST Python Instance
- Some functional (programming) changes in Psytoolkit (e.g. ‘GO’ or ‘z’, ‘x’ keys)
- @ Ben to peruse

WCST Python Instance

cross1blue	1	0	1	"number"	"cross1blue"
star2yellow	2	0	2	"number"	"star2yellow"
cross4blue	4	0	3	"number"	"cross4blue"
star3yellow	3	0	4	"number"	"star3yellow"
circle4green	4	0	5	"number"	"circle4green"
triangle3yellow	3	0	6	"number"	"triangle3yellow"
star2blue	2	0	7	"number"	"star2blue"
cross4red	4	0	8	"number"	"cross4red"
star3yellow	3	0	9	"number"	"star3yellow"
circle4green	4	0	10	"number"	"circle4green"
star3red	1	3	1	"color"	"star3red"
triangle1blue	3	1	2	"color"	"triangle1blue"
circle3green	2	3	3	"color"	"circle3green"

Instructions:
H or *O* = ‘z’
no *H* or *O* = ‘x’

GO!

3. Recent Updates

Notion

- Notion: Project migration
- Integrate Git (outdated)
- Taskboard & Calendar

Dynocog Research Unit

A mathematical paradigm to comprehend human cognition.

Workflow

Task Board — Board view

Not started 4

Update Calendar on Google doc
Collaboration
Apr 11, 2021

Cleanup Dynocog Repo
Collaboration
Apr 11, 2021
Zach Wolpe

Find datasets
Superflous work
Apr 30, 2021
Zach Wolpe

Prep Recap + Trajectory Presentation
Collaboration
Apr 13, 2021
Zach Wolpe

+ New

In progress 3

Psytoolkit Adjustments
Psytoolkit
Apr 11, 2021
Zach Wolpe

Automate WCST generation
Python
Apr 11, 2021
Zach Wolpe

WCST task generator. 2
Psytoolkit
Apr 10, 2021
Zach Wolpe

+ New

Completed 1

Progress Update
Collaboration
Zach Wolpe

+ New

Task Board — Calendar view

No date (1) | Search | New

April 2021 — Today

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	31	Apr 1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	May 1

10: **WCST task ...** Psytoolkit Zach Wolpe

11: **Automate ...** Python Zach Wolpe; **Cleanup Dy...** Collaboration Zach Wolpe; **Psytoolk...** Psytoolkit Zach Wolpe; **Update Cal...** Collaboration

13: **Prep Recap ...** Collaboration Zach Wolpe

30: **Find dat...** Superflous wor Zach Wolpe

Project Details

Github Link

ZachWolpe/Dynocog

How do neural correlates of learning differ between levels of performance, in a dynamic decision-making task under uncertainty? We're a cognitive neuroscience

https://github.com/ZachWolpe/Dynocog

Project Overview

Wisconsin Card Sorting Task Models

BACKGROUND Main research question (RQ):

> *How do neural correlates of learning differ between levels of performance, in a dynamic decision-making task under uncertainty?*

We aim to depart from more traditional ideas of comparing dichotomised average neural data,

What's Next?

Next Step

1. Final round check Psytoolkit (@ Ben)
2. Psytoolkit data structure (@ Zach)
3. MTurk Implementation (@ Ben @ Jussi @ Zach)
4. Theoretical Model Design (@ Zach @ Jonathan @ Allan)
    a. RL + graphical architecture
    b. Bayes sense check
5. Clean up write up structure (@ Zach, Provided by @ Jonathan Shock)
6. Incorporate write up plan (@ Zach)

Thoughts?