

MAC-BRAIN

Developing a **Multiscale** account of **Attentional Control** as the constraining interface between vision and action: A cross-species investigation of relevant neural circuits in the human and macaque Brain

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Selective attention & control signals

Large number of inputs, but limited processing resources

=> **selective attention**

Sensory input / Saliency

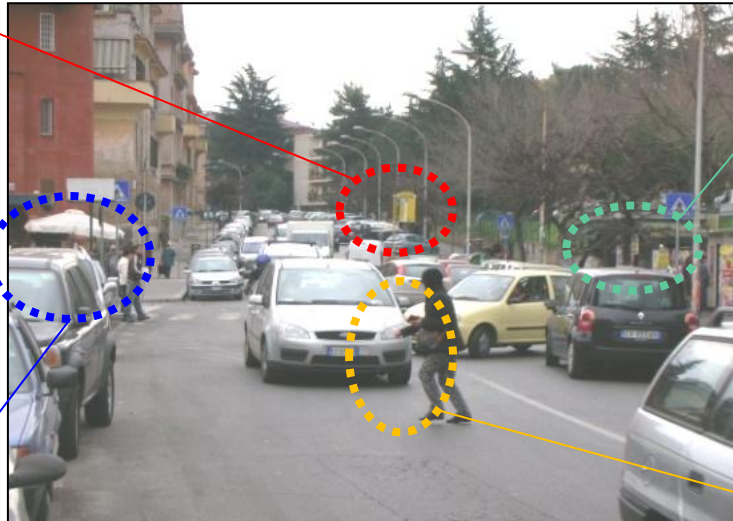
e.g. High contrast

=> Bus-stop sign

Goals

e.g. I want to buy a newspaper

=> Newsstand



Prior-knowledge / Memory

e.g. shops location

=> Joe's bar

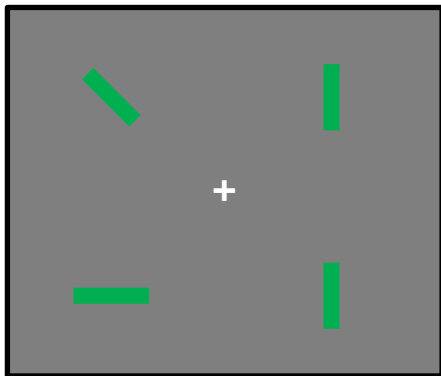
Danger / Reward

e.g. trafficked road

=> Person crossing

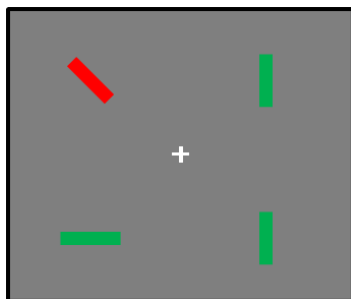
AIM: how are the many different sources of control combined?

MAC-Brain: a Multiscale account of Attentional Control

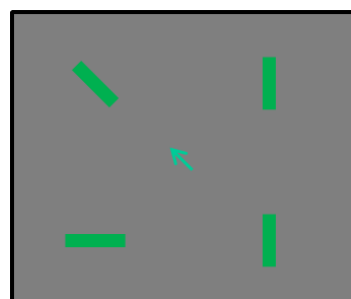


- Behaviour & TMS in humans (*Leonardo*)
- EEG-ERPs in humans (*Nico*)
- fMRI in humans (*Emiliano*)
- Electrophysiology in macaques (*Suliann*)

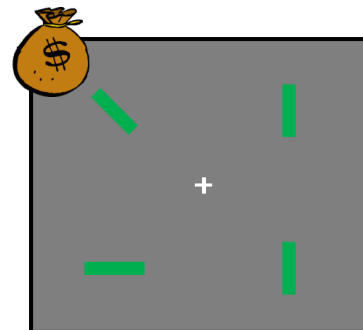
Saliency



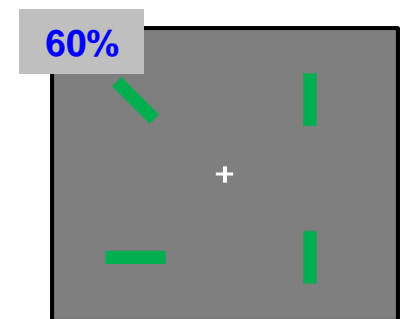
Goal-directed control



Reward



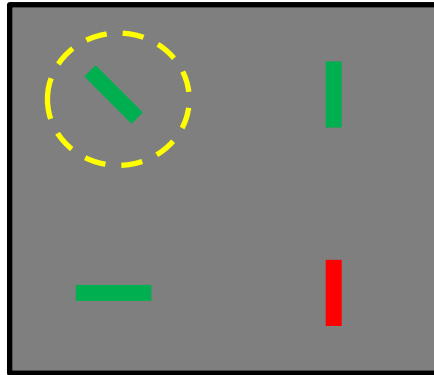
Statistical learning



... and combinations thereof !

Working example

Processing of salient distractors



Behavior : Distractor interference under goal-directed attention vs. statistical learning

NHP : Preliminary training data

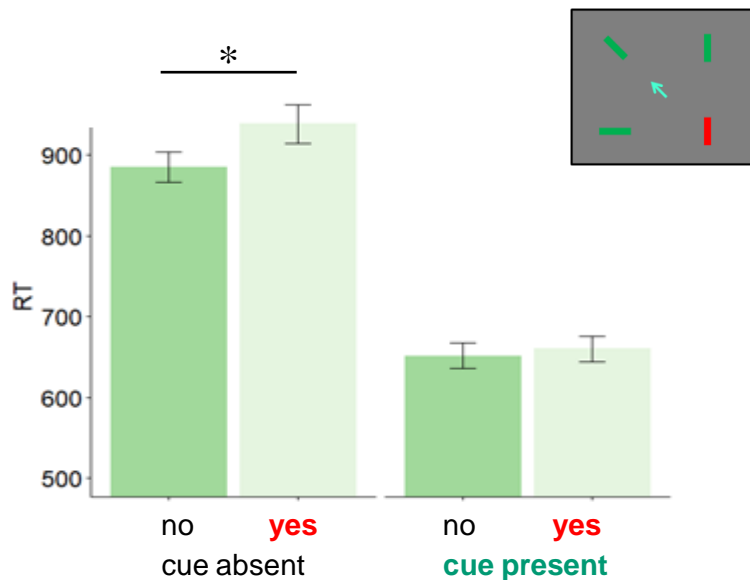
ERPs : Target selection ERPs (N2pc) in the presence of salient distractors

fMRI : Effective connectivity between occipital and parietal cortex

Behavior (humans)

Goal-directed control x salience

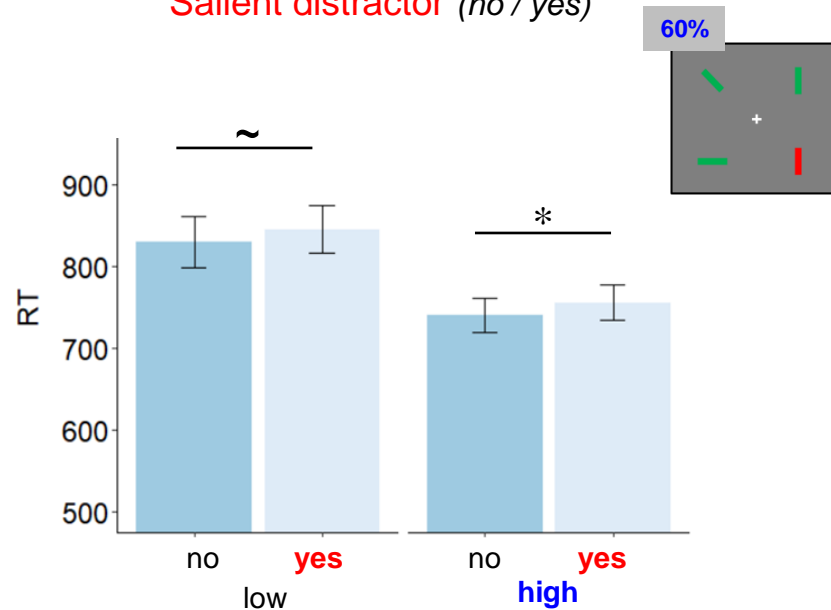
Central cue (absent / present)
Salient distractor (no / yes)



Cue x Salience ($p < 0.001$)

Statistical learning x salience

Target probability (low / high)
Salient distractor (no / yes)

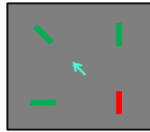


Statistical learning ($p < 0.001$)
Salience ($p < 0.011$)
No interaction ($p = 0.9$)

**Fully-predictive cues abolish distractor interference,
while implicit spatial biases remain vulnerable to salient distractors**

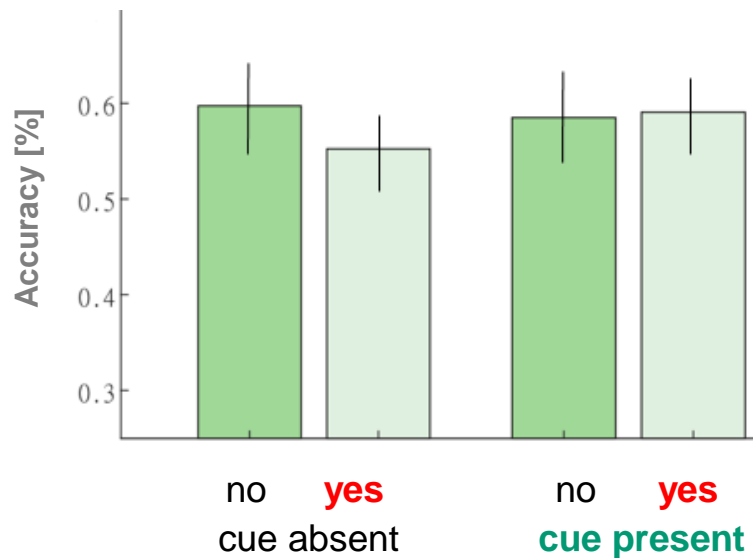
Preliminary training data (*macaque*)

Goal-directed control x salience



Central cue (*absent / present*)

Salient distractor (*no / yes*)



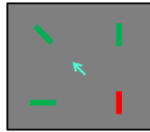
No sig. effects (yet)

Two monkeys in training, one fully implanted with recording chambers

Difficult task to learn for the animals, but promising pattern with fully-predictive cues reducing distractor interference

Temporally-resolved data: ERPs (humans)

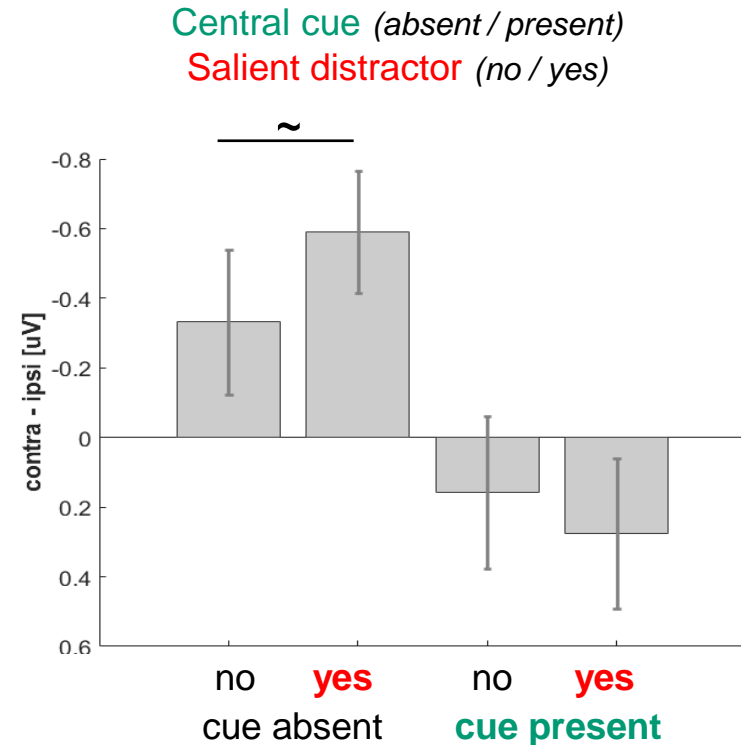
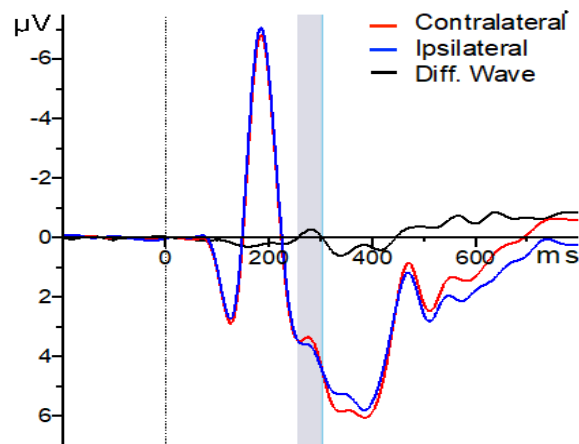
Goal-directed control x salience



ERP index of target selection: N2pc

Posterior electrodes: PO7-PO8

Time window: 256-304 ms post target

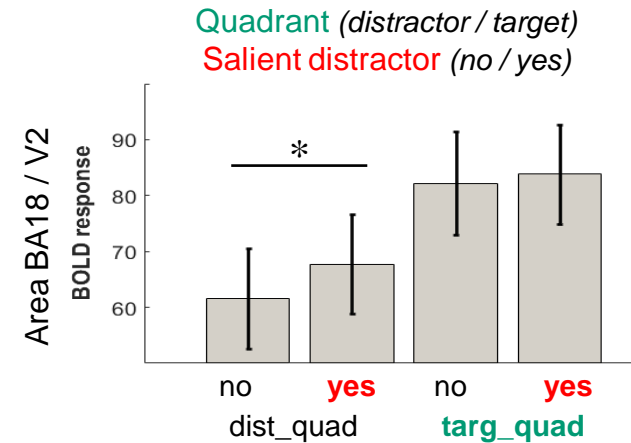
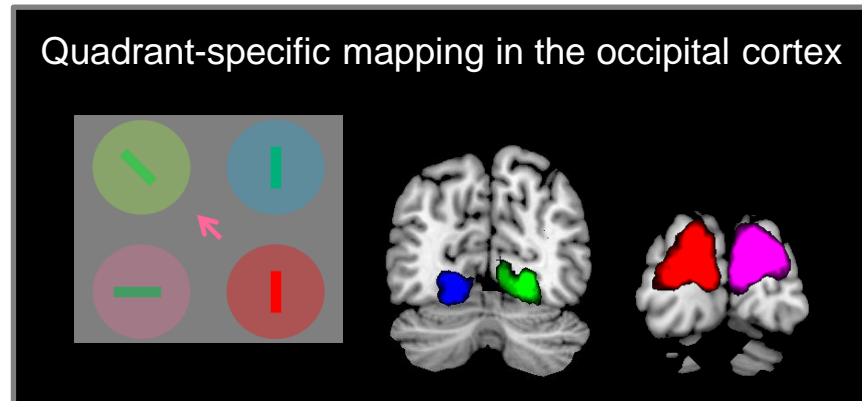


Cue x Salience (trend: $p < 0.1$)

**Salient distractors result in larger target-selection N2pc,
but no N2pc under fully-predictive cues**

Spatially-resolved data: fMRI (*humans*)

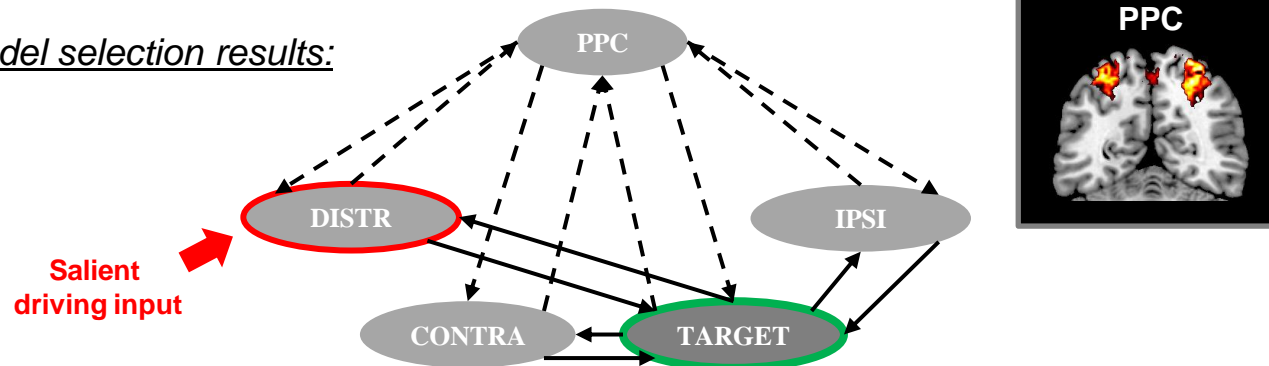
Goal-directed control x salience [fully-predictive cues]



Quadrant x Salience ($p < 0.001$)

Effective connectivity

Model selection results:



Both connectivity within visual cortex & interactions with PPC contribute to filtering salient distractors under fully-predictive cues

What next & cooperation with the Flagship

Current Covid-19 crisis strongly impacted both research
and co-operation activities

Main objectives for 2021:

- Finalize data acquisition and analyses
- Strengthen interactions within the consortium (*meetings and data-sharing*)
- Data availability to the HBP project
- Activate collaboration with HBP core (*computational modeling*)

Responsible Research Innovation



Society

Clinical relevance : stroke/neglect, development/ADHD

Valorization : *sensory analysis, product evaluation*

Ethics

Highest possible standards

in particular related to experimentation in awake macaques



Open-science

Commitment to open-access and data-availability

Protocols and data sharing in the context of HBP

Science education and training

Students exchanges within the MAC-Brain consortium

UNIVR phd student currently in Ghent



Gender-balance

PIs and management: 3F + 3M

PhD and post-docs: 4F + 3M