Caltech simian MRI

III-59

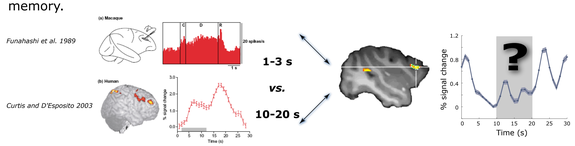
#288

Event-related fMRI of goal-directed behavior in alert monkeys and humans: spatially-specific and nonspecific signals during delayed response tasks

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introduction

Functional MRI in alert monkeys is a new powerful tool for studying multiple brain areas and elucidating the neural basis of the BOLD signal, and linking human imaging and monkey electrophysiology. We used this technique to study brain activity during delayed response paradigms, which allow to separate sensory, motor, and preparatory processes, and introduce cognitive demands such as inhibition of reflexive responses and working memory.



The goals of the current work were:

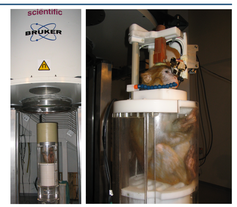
1) To develop **event-related fMRI** approach in behaving monkeys

2) To compare monkeys and humans with **same tasks, timing and techniques**

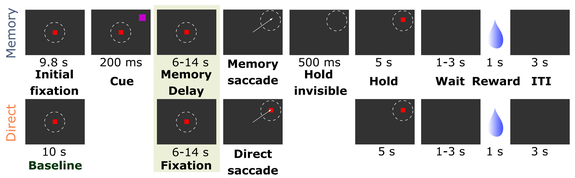
methods

Imaging

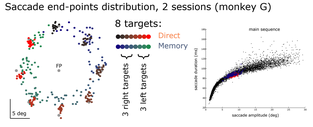
Bruker Biospec 4.7T/60cm vertical bore dedicated primate scanner, ParaVision 3.0.2/4.0. Birdcage "transceiver" RF coil.
Functional: GE-EPI, single-shot, TR 1s, 128x128 12.8 cm FoV, 1x1x2 mm voxel, 10-14 oblique slices.
Structural: T1-weighted IR-RARE in-plane during session; high-resolution (0.5/1 mm voxel) T1-weighted 3D-MDEFT or MDEFT-RAGE in separate session.



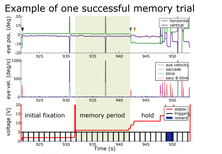
Paradigm: randomized memory vs. direct saccades



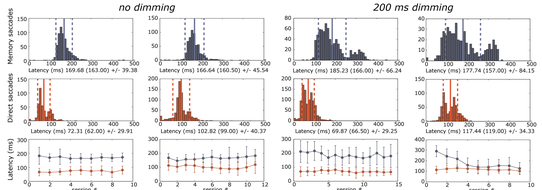
Saccade end-points distribution, 2 sessions (monkey G)



Example of one successful memory trial

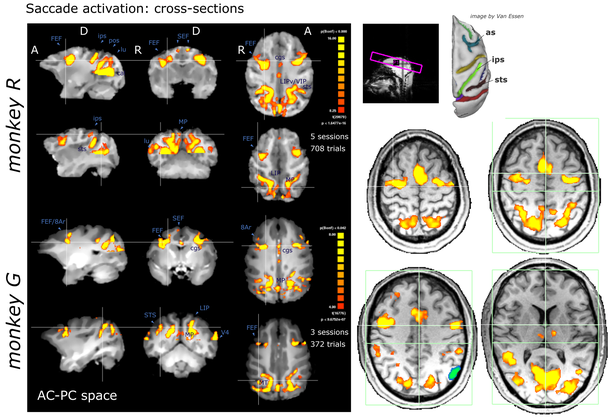


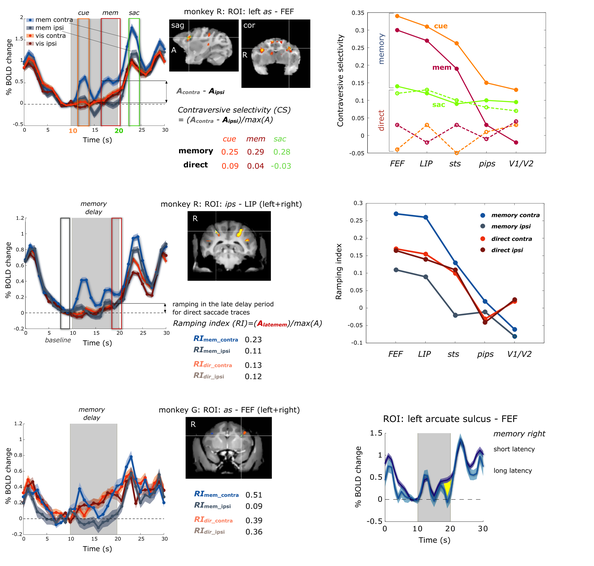
no dimming *200 ms dimming*



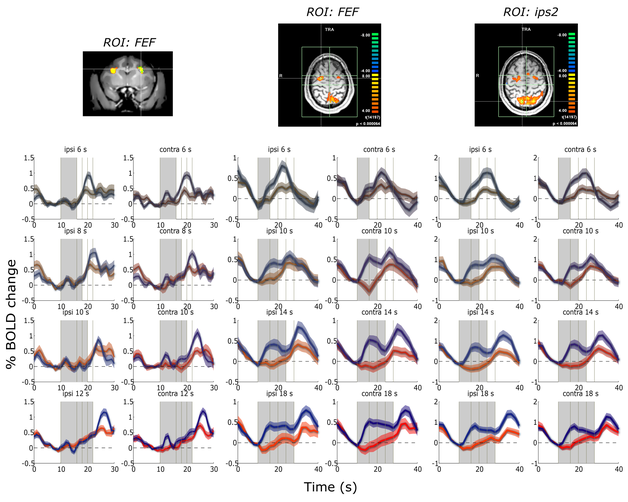
results

Saccade activation: cross-sections





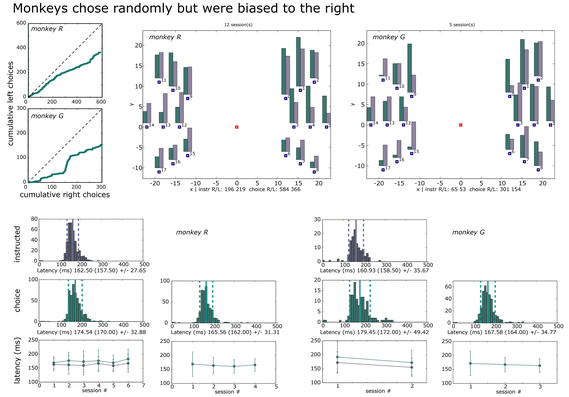
Time-courses during variable delay periods



Decision-making: "free-choice" task with equal reward

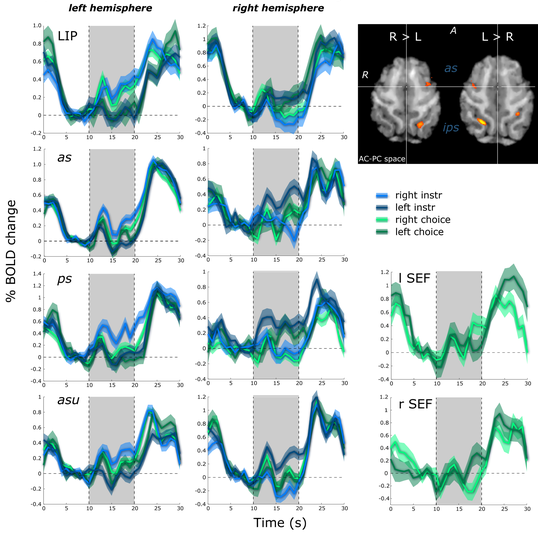


Monkeys chose randomly but were biased to the right



BOLD signals during free-choice and instructed trials

Activity in frontal and parietal areas reflect upcoming decision



summary

- We developed and applied event-related fMRI in behaving monkeys, demonstrating that dynamics of visual, motor and "higher-order" cognitive signals can be resolved.
- In monkeys, spatially-specific contralateral memory/motor planning signals were found in frontal and parietal areas such as FEF, SEF, LIP and in superior temporal sulcus (MT/MST).
- Non-specific preparatory signals were also detected in same areas, exhibited as ramp-up of activity towards the end of delay period in visually-guided trials.
- In humans, similar activation patterns were found in functional homologs, but with less contralaterality in cue/memory periods.



Future work

- Reward modulation of anticipatory and delay activity.
- Action-planning and decision-making studies using effector-specific *(eye* and *joystick* movements) responses.
- fMRI-guided recordings (spikes and LFPs) in the same monkeys using identical paradigms, to study underlying neuronal correlates of the BOLD signals.

Acknowledgements

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