

THE EFFECT OF EXPERIENCE ON GOAL-DIRECTED BEHAVIOUR IN A GROUP OF ITALIAN AIR FORCE FIGHTER PILOTS AND NAVIGATORS: THEORETICAL BASIS AND PRELIMINARY RESULTS



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Discovery of new task rules



Discovery of new task rules



Johann Friedrich Carl Gauss (1777-1855)

$$1+2+3+\dots+100 = ?$$

$$\begin{array}{cccc} 1+ & 2+ & 3+ & 4+\dots+100 + \\ 100= & 99= & 98= & 97=\dots= 1= \end{array}$$

$$101+ \quad 101+ \quad 101+ \quad 101+\dots+101$$

$$101 \cdot 100 / 2 = 5050$$

GOAL-DIRECTED BEHAVIOUR AND THE DISCOVERY OF NEW STRATEGIES

- The efficient implementation of an existing strategy involves top-down control:
 - The neural processing of sensory information has to be adjusted to allow for the efficient implementation of a certain strategy (**strategy exploitation**, *Donoso et al., 2014*).
 - Degradation of irrelevant information, makes exploring alternative strategies more difficult (*Schuck et al., 2015*).
- **Discovering new strategies requires** to evaluate the potential usefulness of apparently **distracting information** present in the environment (**strategy exploration**, *Donoso et al., 2014*).

**Opposition between strategy
exploitation and exploration**

OUR STUDY

AIM: how do high-level training and experience impact the strategy exploration and exploitation in fighter pilots and navigators?

PARTICIPANTS:

- 30 fighter pilots and navigators with low-experience (<750 flight hours) and 30 fighter pilots and navigators with high-experience (>750 flight hours) from the 6° Stormo of Italian Air Force - Ghedi Air Base, Brescia
- 60 healthy controls matched for age, sex and education

METHODS: Functional Magnetic Resonance Imaging (fMRI)

Spontaneous Strategy Switch Task (SSST)





Neuron. 2015 April 8; 86(1): 331–340. doi:10.1016/j.neuron.2015.03.015.

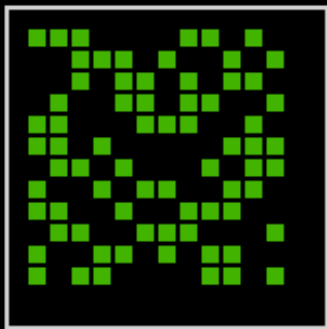
Medial prefrontal cortex predicts internally driven strategy shifts

Nicolas W. Schuck^{a,b,c,1}, Robert Gaschler^{b,d}, Dorit Wenke^b, Jakob Heinzle^{e,f}, Peter A. Frensch^b, John-Dylan Haynes^{f,g,h}, and Carlo Reverberi^{i,f,j,1}

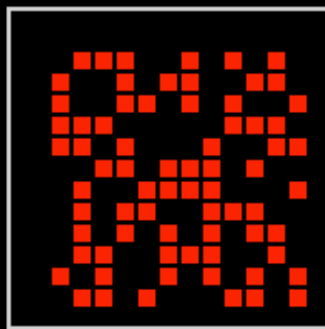
SSST: Discovery of new task rules

Instruction:

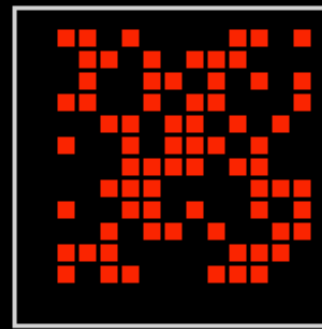
Judge which corner of the frame the little squares are closer to.
The squares are colored and can be either red or green.



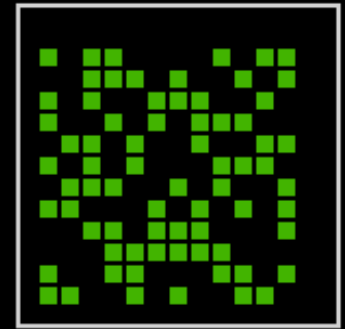
Upper left



Lower right



Upper right



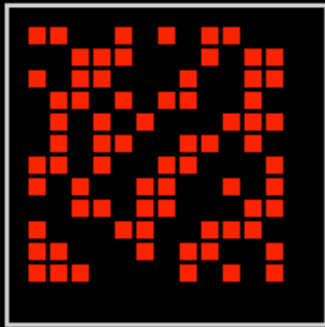
Lower left

press right

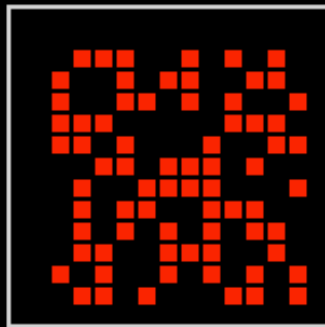
press left

SSST: Discovery of new task rules

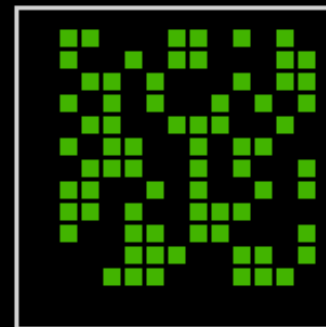
The color trick



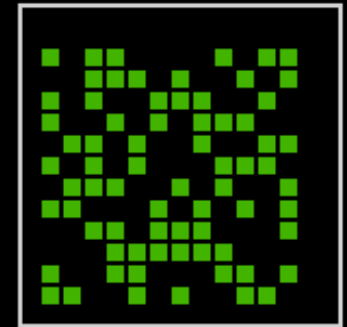
Upper left



Lower right



Upper right



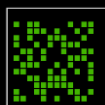
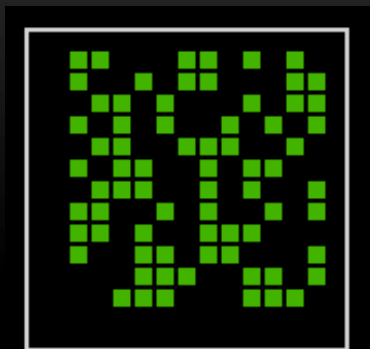
Lower left

press right

press left

Standard Trial (48 %)

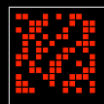
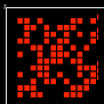
Stimulus Duration: 400 ms



Ambiguous Trial (19 %):

No corner

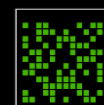
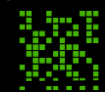
Stimulus Duration: 400 ms



NoGo Trial (19 %):

No Frame

Stimulus Duration: 2000 ms



left button
press



left button
press



free choice
(color guided?)



right button
press

2000 ms

no response

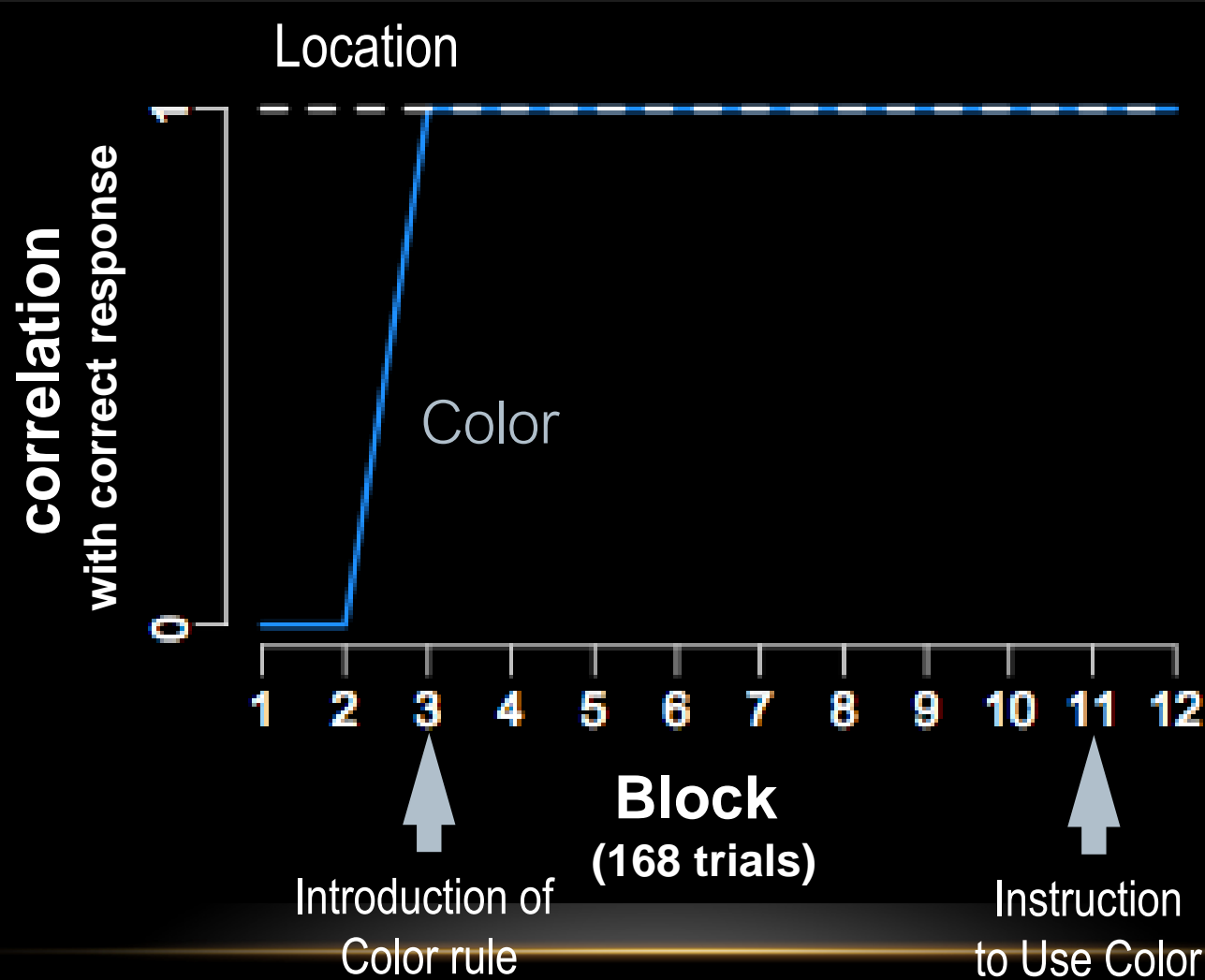


left button
press

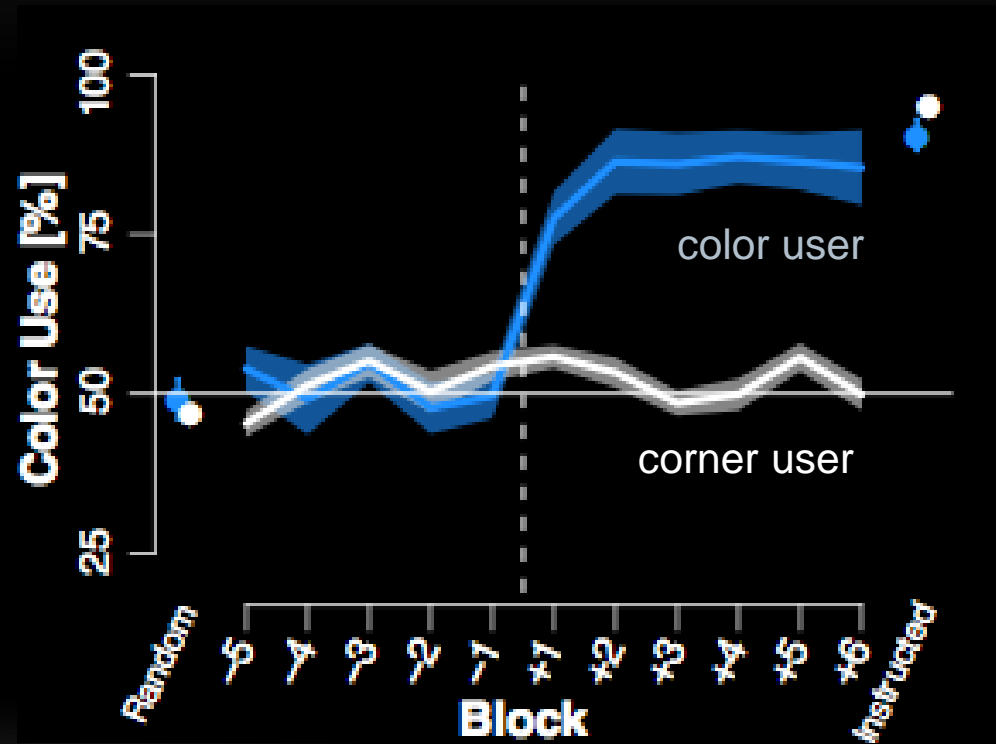
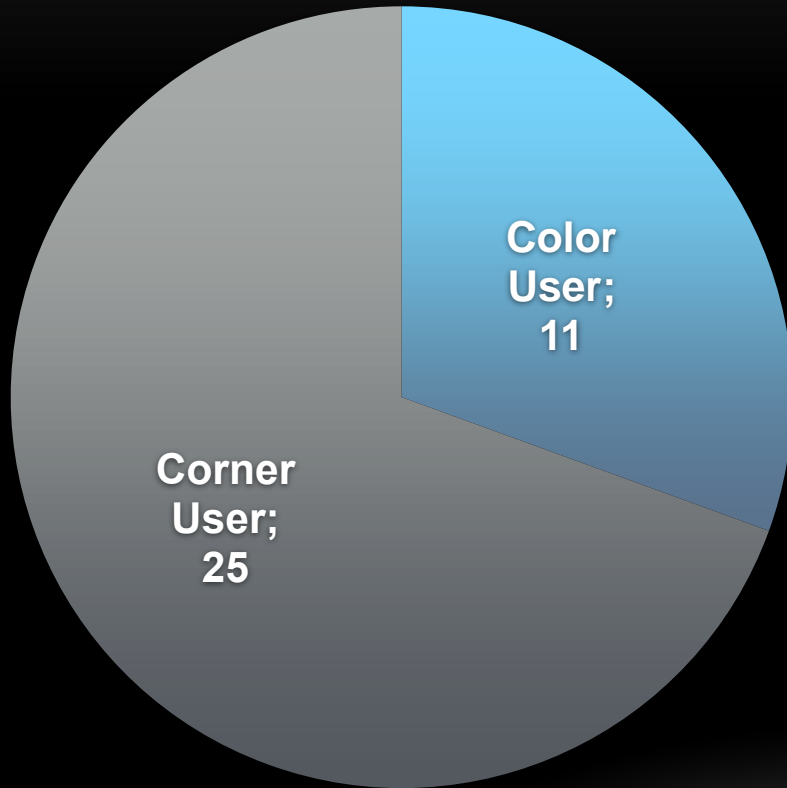
RSI: 400ms

Trial Duration: RT + 400ms

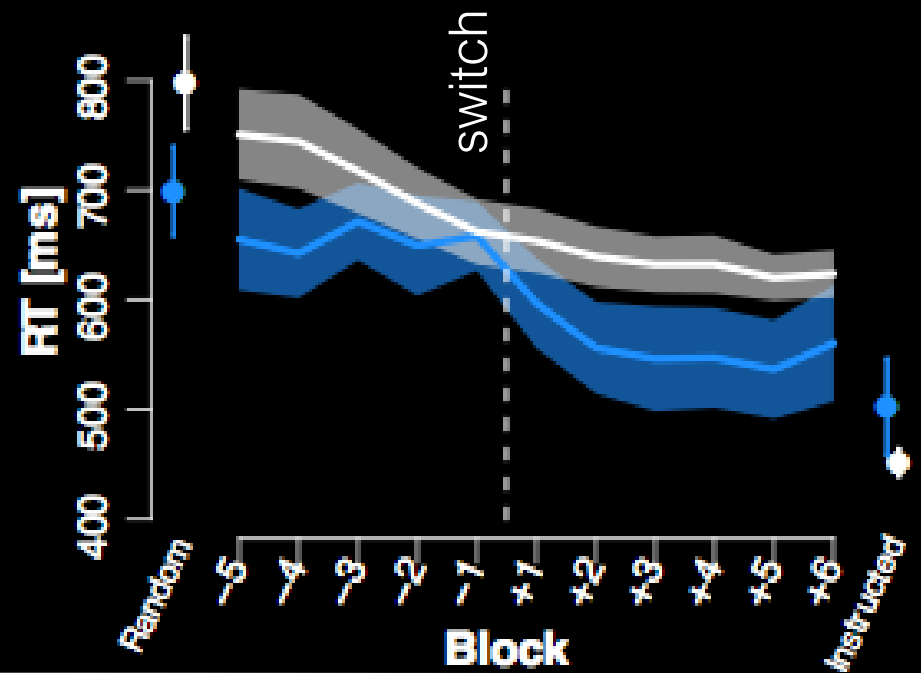
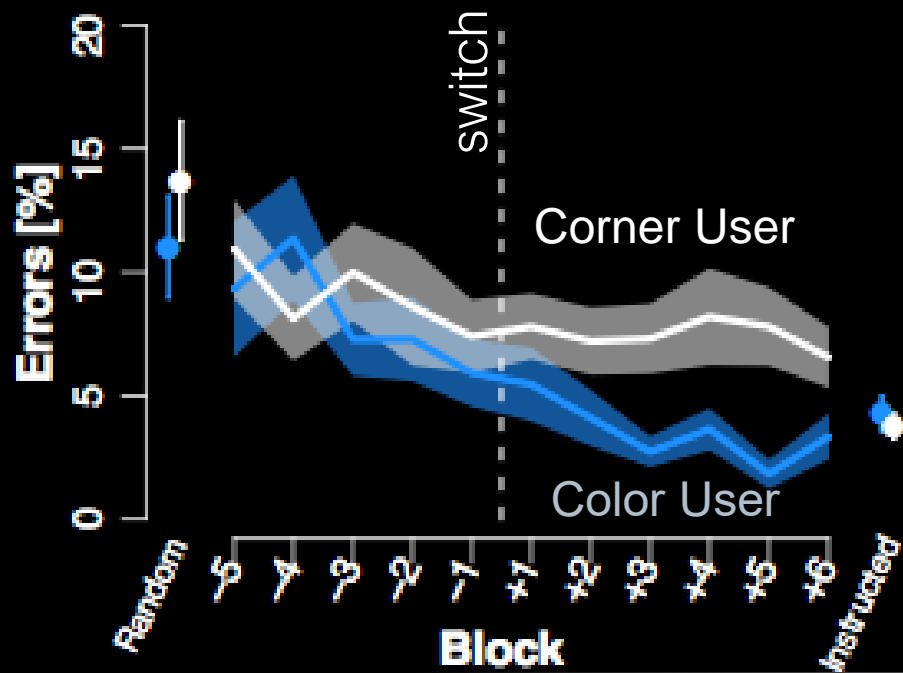
Discovery of new task rules



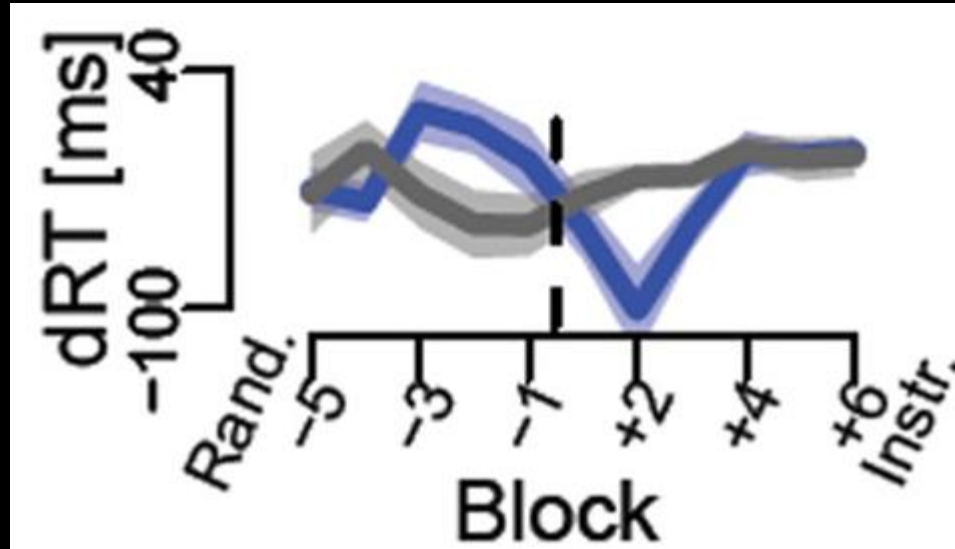
Discovery of new task sets



Changes in Errors and RTs

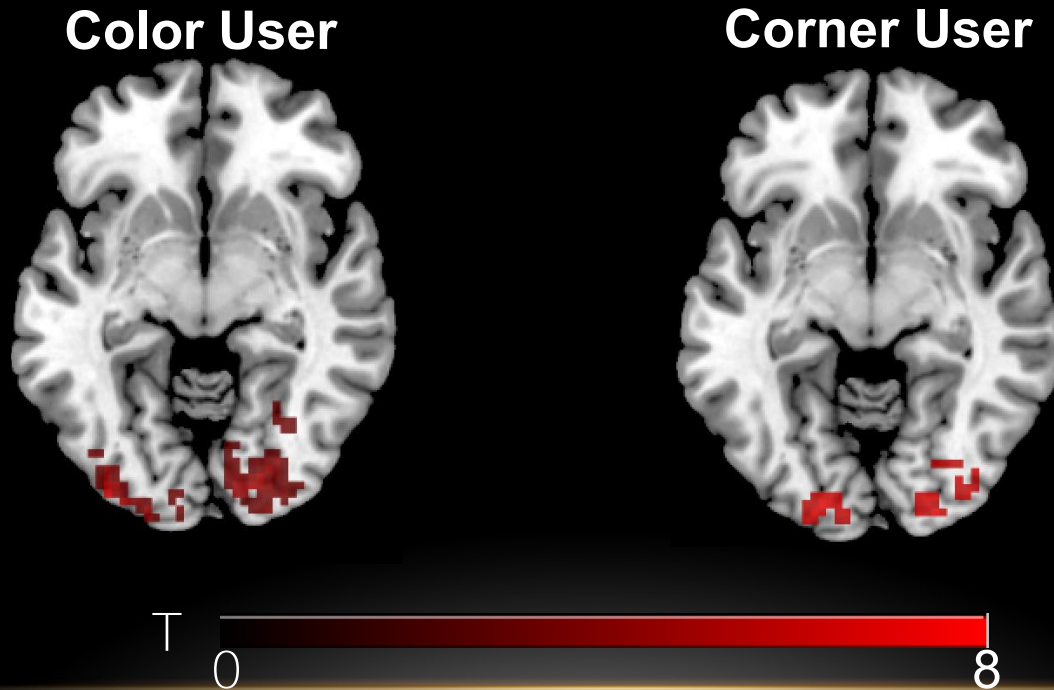


Slow down of RTs in color users before the switch



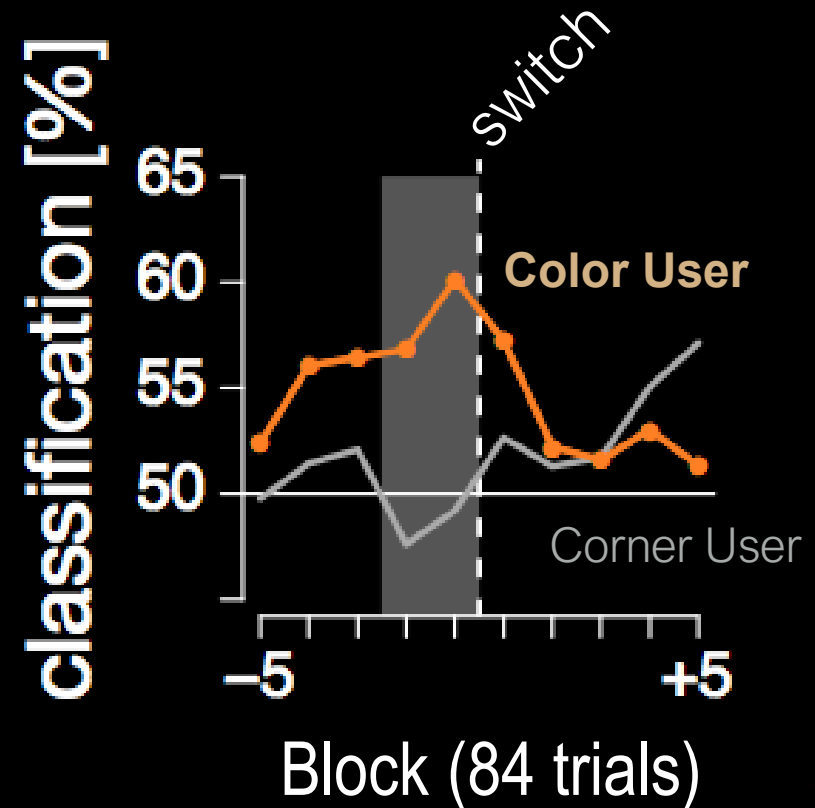
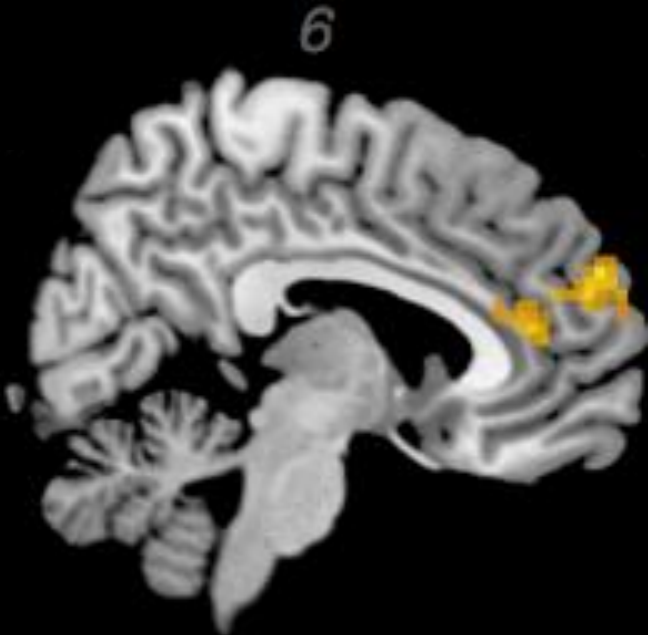
Discovery of new task rules

COLOR CAN BE CLASSIFIED IN EARLY VISUAL AREAS IN ALL SUBJECTS

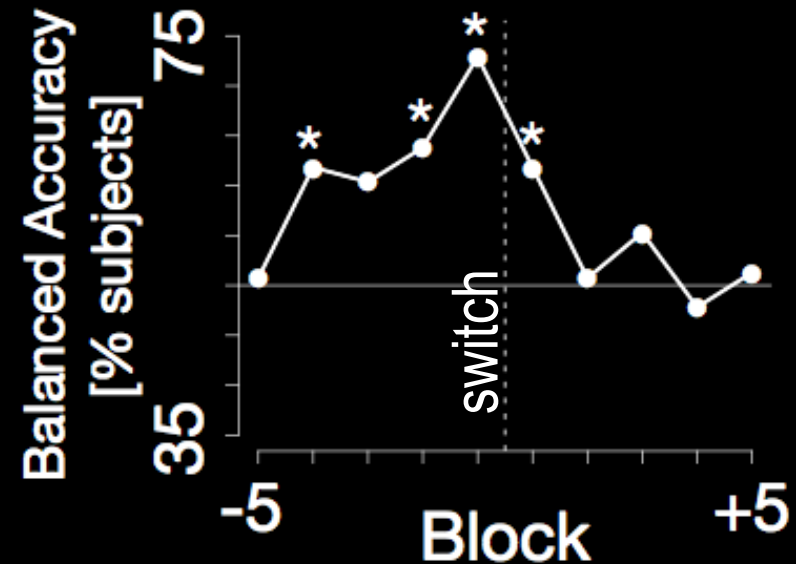
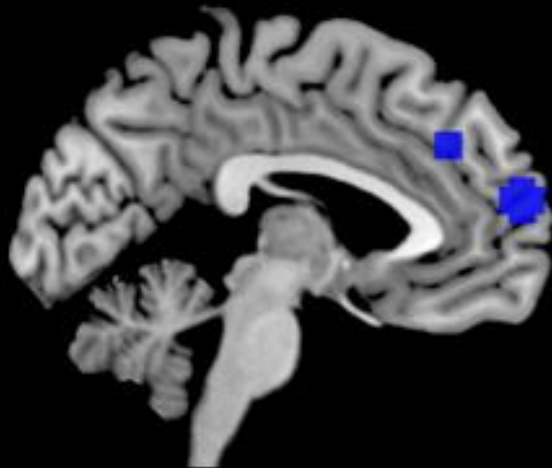


Discovery of new task rules

STIMULUS COLOR ENCODING EMERGES
IN MEDIAL PREFRONTAL CORTEX BEFORE SWITCH

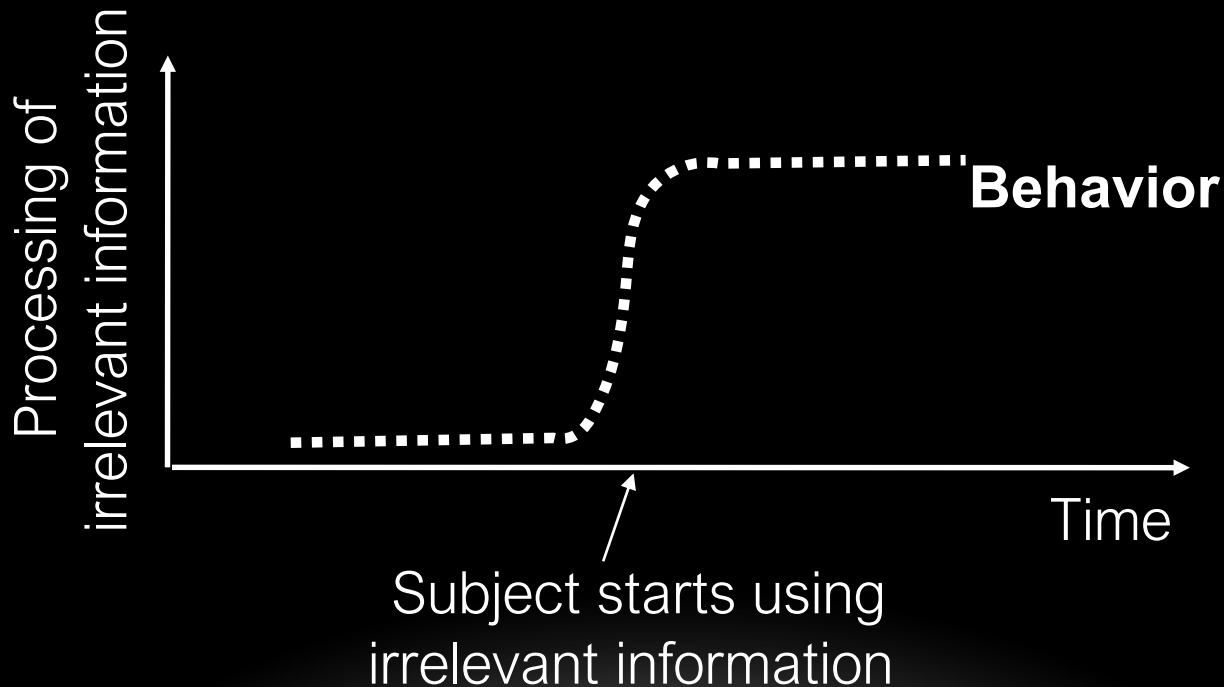


COLOR ENCODING IN MEDIAL PREFRONTAL CORTEX PREDICTS FUTURE SUBJECT BEHAVIOUR!

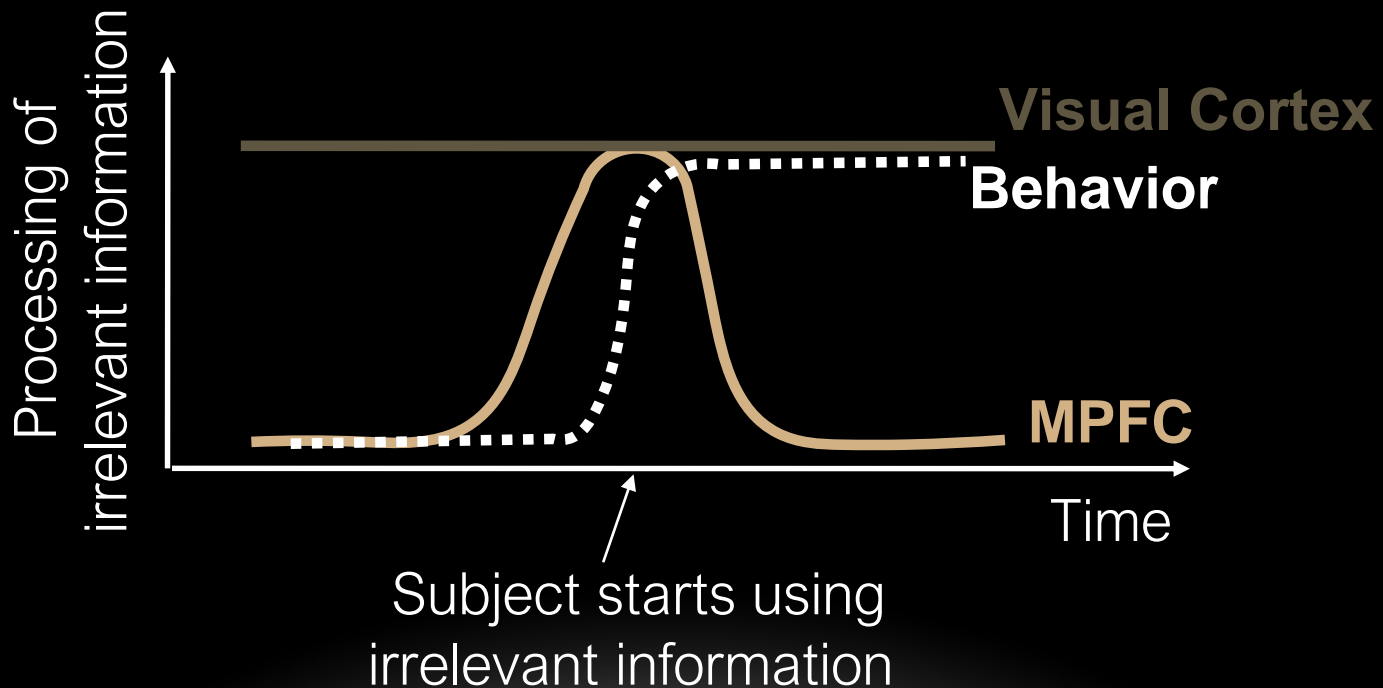


MPFC encodes color only in switchers

SUMMARY



SUMMARY



SUMMARY

The activity in **medial prefrontal** cortex represents features of **yet-to-be-implemented** rules.

The activity in **medial prefrontal** cortex is able to distinguish the color users from the corner users: a neural biomarker of strategy exploration when the individual is still performing the instructed strategy.

Schuck et al., Neuron, 2015

Why this study in fighter pilots and navigators?

- Navigating an aircraft, in particular during a military mission, is a highly demanding and complex activity to be performed in complex environments.
- The search of new strategies outside the instructed strategy in these complex situations is often not necessary and potentially dangerous.

Increased in RTs during the strategy exploration!!!

Why this study in fighter pilots and navigators?

- The best predictor of pilot performance, among individual factors is the previous training experience (Martinussen, 1996).
 - To investigate the effect of expertise on the discovery of new strategies in highly-trained fighter pilots and navigators.
-

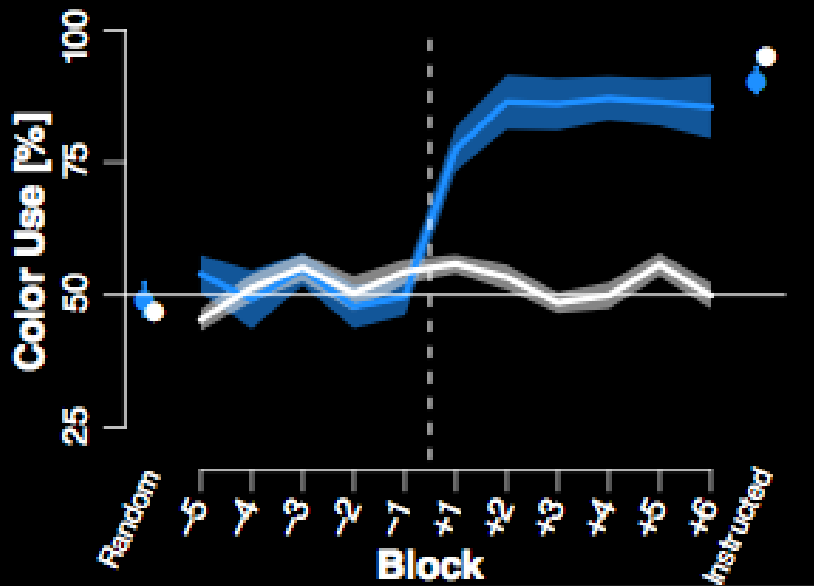
HYPOTHESIS

- Hp: High-level military training induces a **strong top-down control** in fighter pilots and navigators with a reduction or suppression of apparently unnecessary information for the current and instructed strategy.
- We expect a difference between low and high-experienced military pilots and navigators:
 - Low-experienced pilots and navigators will be (in part) classified as color users (activity in MPFC).
 - High-experienced pilots and navigators will be classified as corner users, using the instructed strategy (no activity in MPFC).

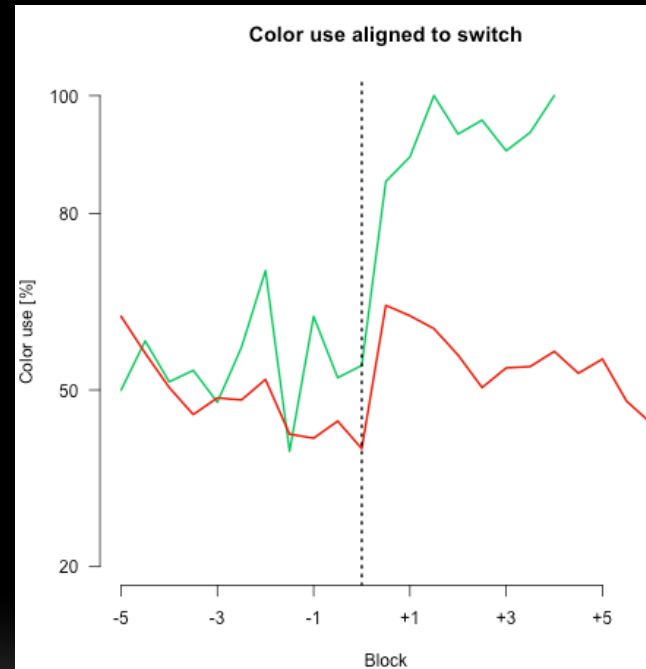
PRELIMINARY RESULTS

- **12 fighter pilots and navigators** with different levels of expertise (400-3000 hours of flight experience; males; mean age: 36 ± 6.3 ys).
 - Behavioural data collected during fMRI experiment
 - fMRI analyses: ongoing (with MVPA)
-

PRELIMINARY RESULTS: COLOR USE



Schuck et al., Neuron, 2015

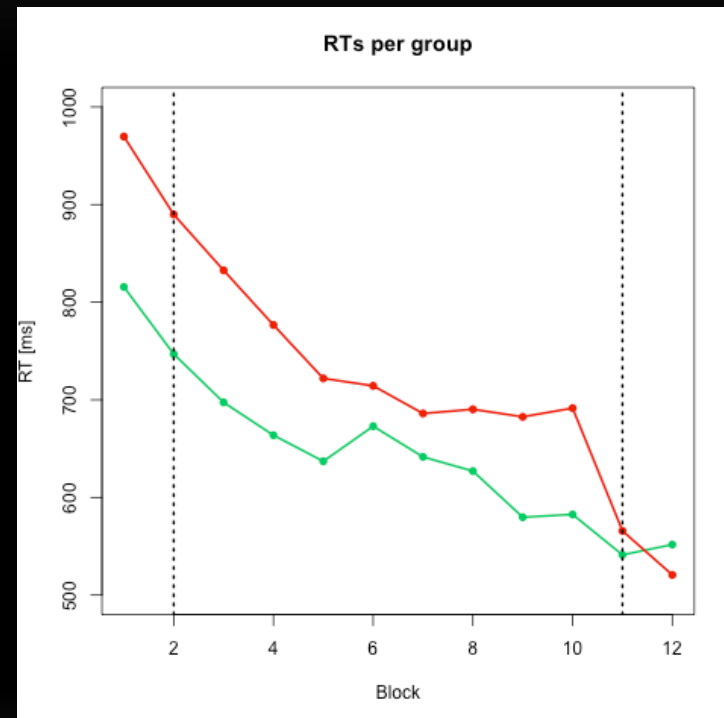
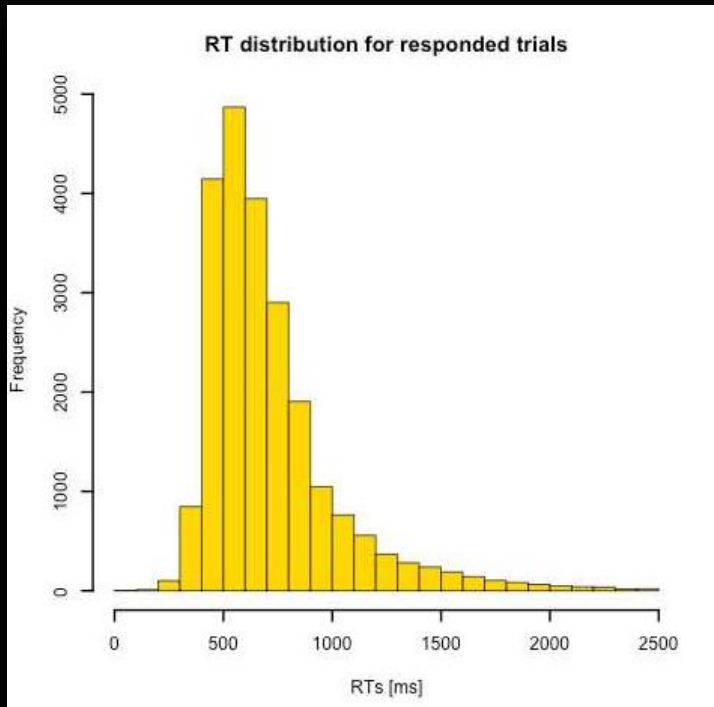


Our study

PRELIMINARY RESULTS

- 3 out of 12 pilots and navigators were classified as color users.
 - 2 color users were the youngest (M, 25 and 26 ys) and less experienced pilots (<500 hours of flight experience).
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PRELIMINARY RESULTS: REACTION TIMES



Corner users RTs = 728 ms
Color users RTs = 648.8 ms
 $p << .001$

Thank you for your attention!



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