# The effects of distraction on the retention of information in visual working memory

**Jarrod A. Lewis-Peacock and Bradley R. Postle**
Department of Psychology, University of Wisconsin-Madison
lewispeacock@wisc.edu

## 1 Introduction

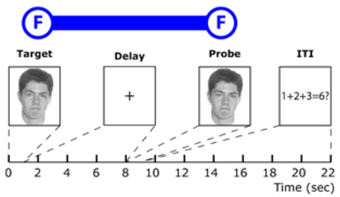
- Evidence in monkeys has shown that although delay-period brain activity in inferior temporal (IT) cortex can represent both retrospective and prospective information, only the latter persists in the face of distracting stimuli. (Takeda, Naya, Fujimichi, Takeuchi, & Miyashita, 2005)
  - Some previous accounts had suggested that only neurons in prefrontal cortex (PFC) can sustain representations across distraction. (e.g., Miller, Erickson, & Desimone, 1996, and Constantinides, Franowicz, & Goldman-Rakic, 2001)
- We explored the **effects of visual distraction** on the short-term retention of information in humans.
  - This study applied pattern classification to fMRI data: training on delay-period activity from one task, and decoding brain activity from a second task. (see Lewis-Peacock & Postle, 2008)

**We addressed 2 main questions:**

1. Do we find prospective representations in the human brain that are robust to interference?
2. Is there anatomical specificity for this property?

## 2 Experiment

**1.** Delayed recognition of Faces, Scenes, & Objects



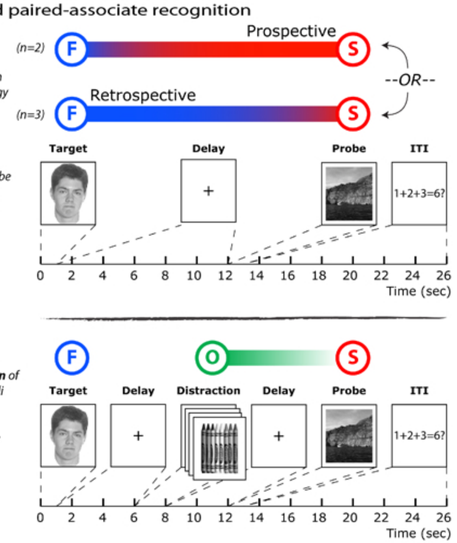

- *Non-famous faces, scenes, & common objects*
- *All pictures in grey scale*
- *120 total trials (40 of each)*
- *4 TRs (0-8s) from each trial used to train classifier*

**2.** Learn arbitrary cross-category stimulus pairings (offline)



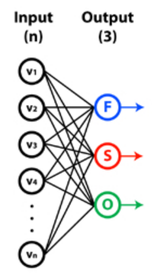

**3.** Delayed paired-associate recognition

- *Subjects were instructed which cognitive strategy to use.*
- *Respond Y/N whether the Probe was the correct associate of the Target.*
- 144 total trials
  48 F-S & S-F
  48 F-O & O-F
  48 S-O & O-S
- *On 1/2 of trials, RSVP **distraction** of irrelevant stimuli during delay*
- *Distractors were always chosen from different category than target & probe*



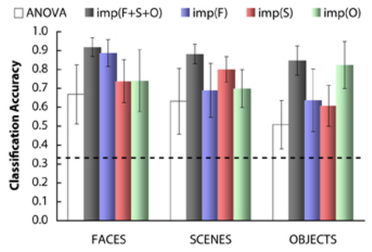

## 3 Training a classifier on delay-period activity

**a)** Network architecture



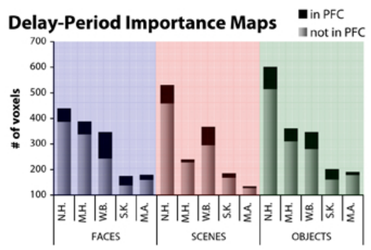

**b)** Training performance under different voxel selection conditions.

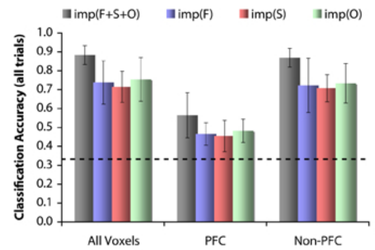
- *ANOVA* = Statistical analysis run on each voxel separately; selected voxels that showed main effect of task condition. (see Polyn et al., 2005)
- *imp(x)* = importance map derived from post-training network-weight analysis for Face (F), Scene (S), and Object (O) trials.
- *imp(F+S+O)* = aggregate of individual importance maps for F, S, & O.



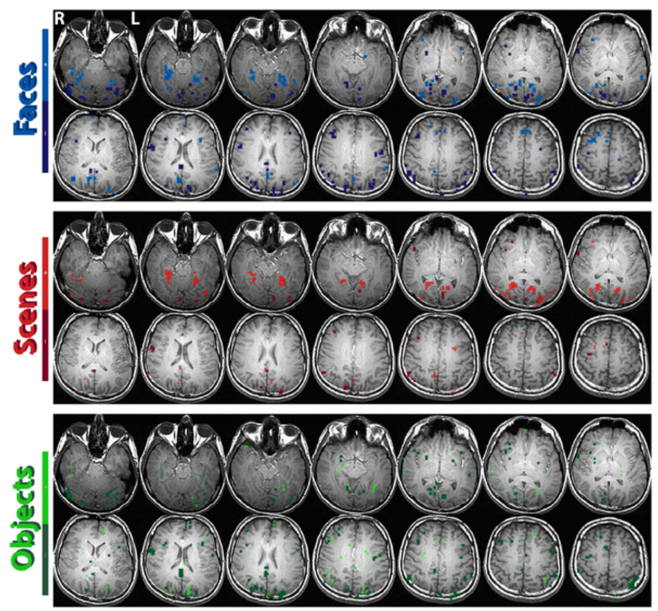

*collapsing across stimulus category*

## 4 Important voxels inside & outside PFC




## 5 Which voxels support classification?

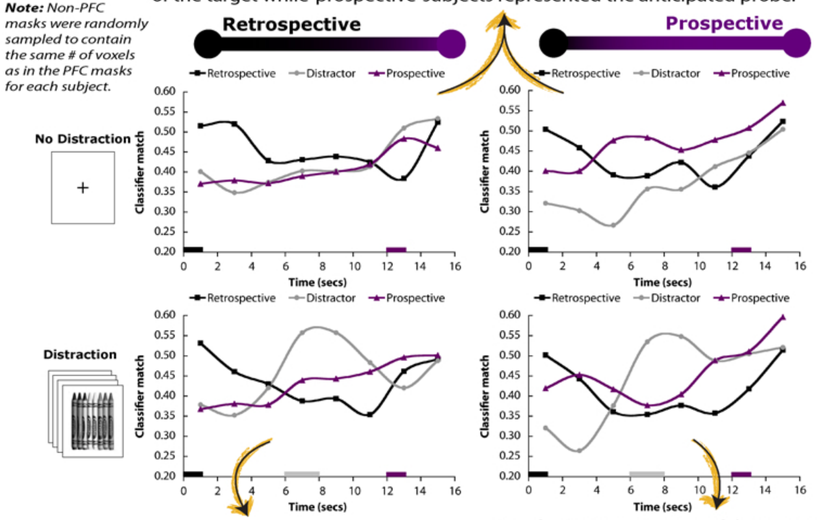



- Voxel ***importance maps*** were calculated from network weights and voxel activities. (Polyn et al., 2005)
  - Maps were notch filtered between *mean +/- 2 s.d.* of importance values.
- Voxels are colored that were important for discriminating patterns of delay-period activity corresponding to the representations of Faces, Scenes, & Objects. *(for subject M.H.)*
  - Light colors indicate positive (+) importance, and dark colors indicate negative (-) importance.
- ***Note:*** Canonical category-selective brain areas contributed to the classification of the three categories.

## 6 Decoding brain activity *outside* PFC

***Result*** - During the delay period, 'retrospective' subjects maintained a trace of the target while 'prospective' subjects represented the anticipated probe.

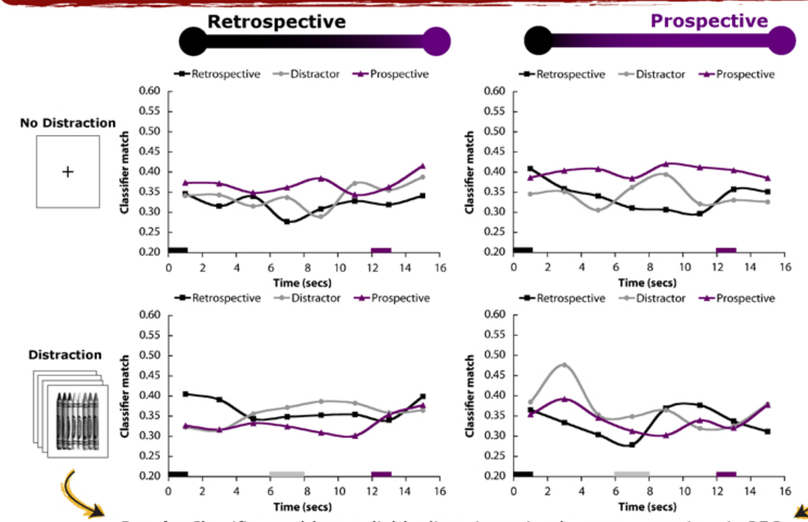
***Note:*** *Non-PFC masks were randomly sampled to contain the same # of voxels as in the PFC masks for each subject.*




***Result*** - Representations of the target stimulus were eclipsed by the distractors. Following distraction, activity corresponding to the anticipated probe stimulus was enhanced.

***Result*** - Representations of the anticipated probe stimulus were temporarily eclipsed by the distractors. However, following the offset of distraction, prospective representations rebounded and were enhanced.

## 7 Decoding brain activity *inside* PFC




***Result*** - Classifier could not reliably dissociate stimulus representations in PFC.

## Conclusions

1. Upon distraction during WM retention, the human brain, like the monkey's, prioritizes preparing for the future (prospective coding) over remembering the past (retrospective coding).

**2a.** This property was observed in posterior brain regions (including IT), but not in PFC.

**2b.** In PFC, diminished training performance on delay-period activity combined with 'noisy' decoding of the delayed paired-associate recognition task suggest that PFC may not reliably represent task memoranda during WM retention.

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