Perceptually-matched images and afterimages share whole brain fMRI dynamics

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Primary Aim: Map the cortical and subcortical fMRI responses for perceptually-matched images and afterimages; examine link between afterimages and visual imagery.

1. Motivation and Background

- Afterimages are illusory, visual perseverations, studied towards investigating the neural mechanisms of conscious perception. (1)
- While the precise neural mechanisms of afterimages are unknown, previous studies suggest retinal and cortical contributions. (2,3)
- Previous findings suggest a link between afterimages and certain kinds of interoceptive conscious perception (e.g., imagery). (4)
- Future investigations may use afterimages as a perceptual *model* of interoceptive perception (e.g., imagery and hallucination).

2. Participants & Methods
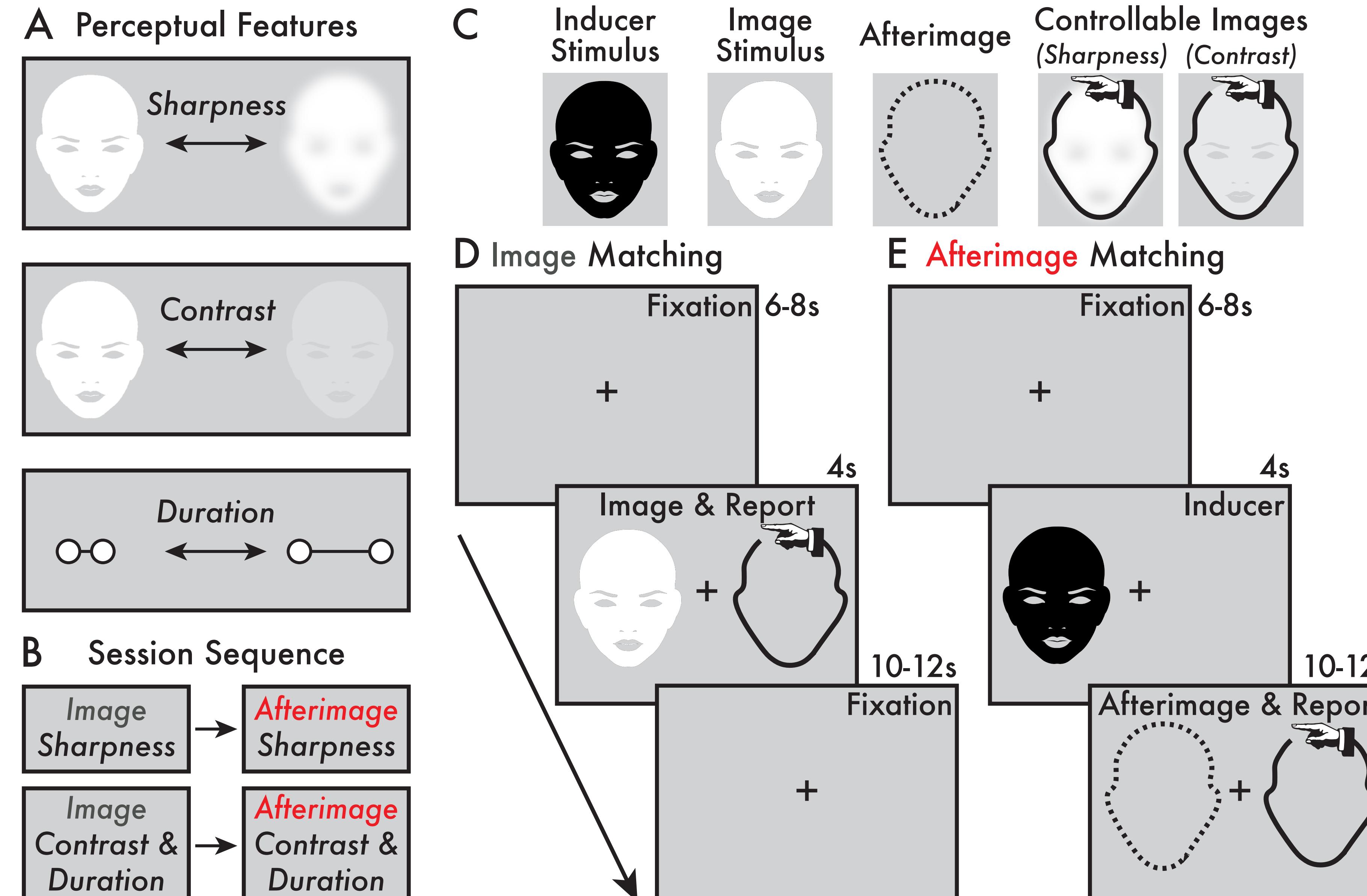
(1) *Behavioral Data:* N = 63 (mean age: 29.1yrs; SD: 10.4yrs)
(2) *fMRI Data:* N = 35 (mean age: 27.6yrs; SD: 8.5yrs)
Whole Brain Sequence (BOLD; 7T; TR: 1s; voxel size: 1.2mm³)
*V1 Sequence* (BOLD/VASO; 7T; TR: 3s; voxel size: 0.8mm³)
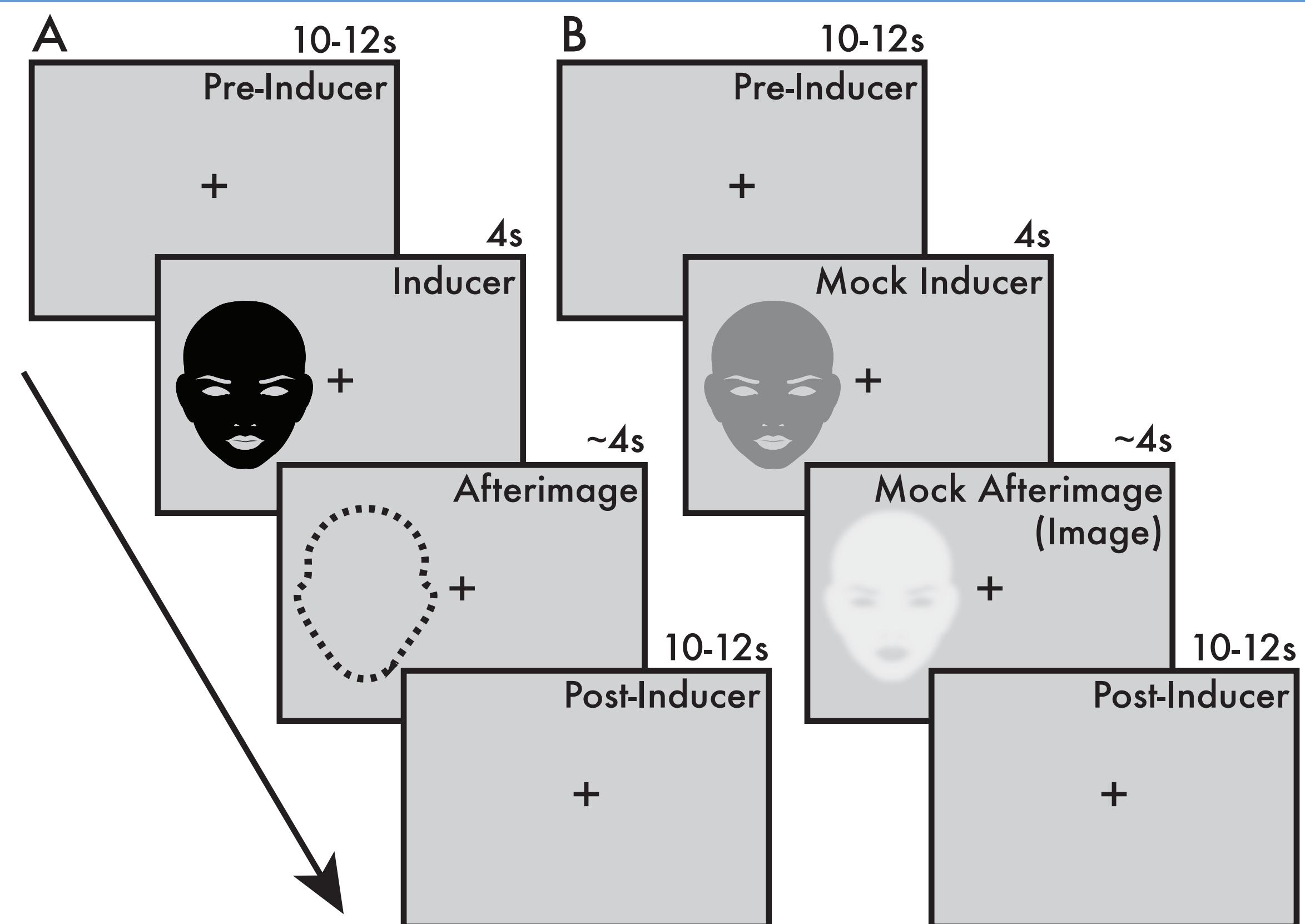
3. Perception Matching

Perceptual Matching Paradigm. **(A)** Tested perceptual features. **(B)** Session sequence. **(C)** Task stimuli. **(D)** Image matching task phase. **(E)** Afterimage matching task phase.
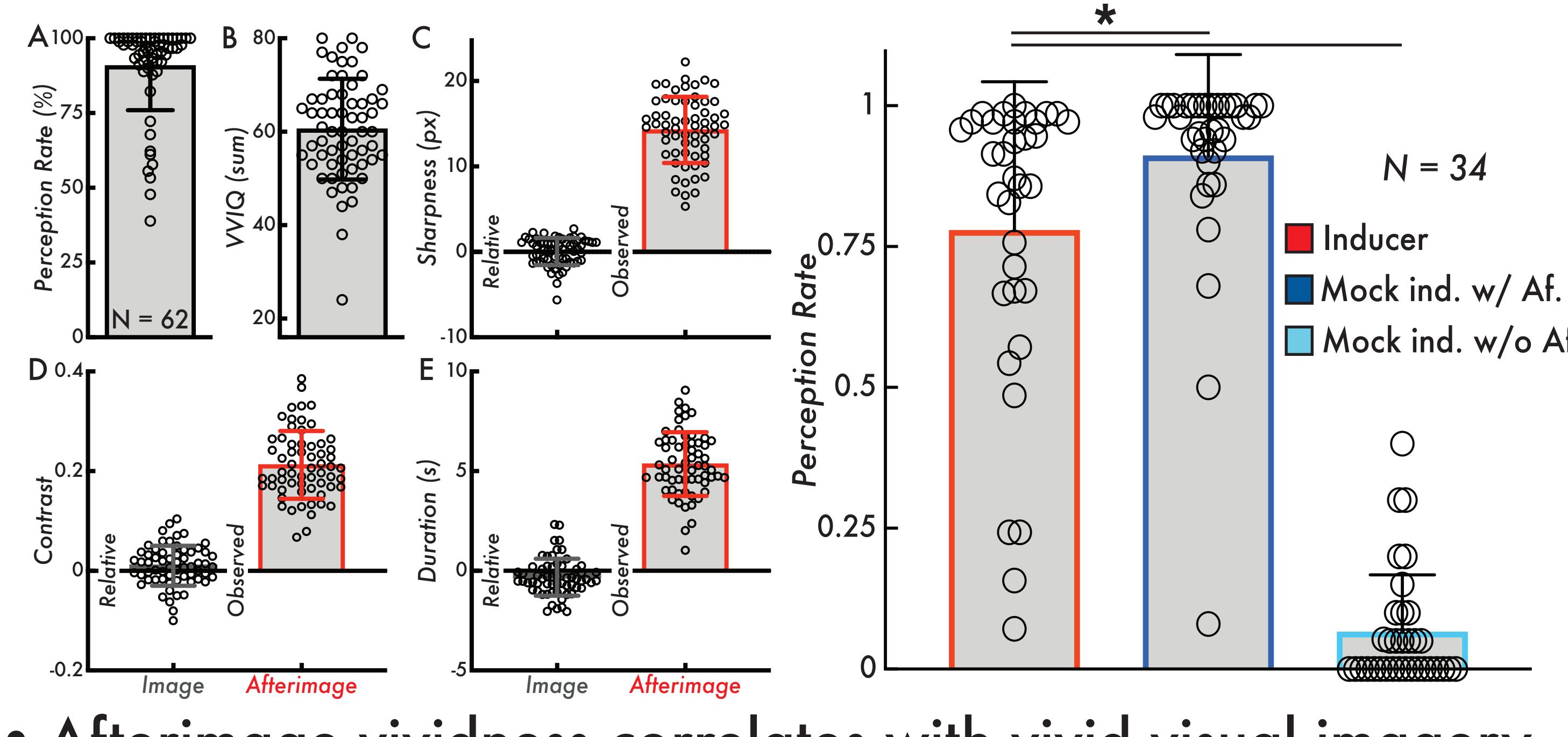
- Participants completed the Vividness of Visual Imagery Questionnaire (VVIQ).
- Afterimage matching information was used to create "mock afterimages".

4. fMRI Behavioral Paradigm
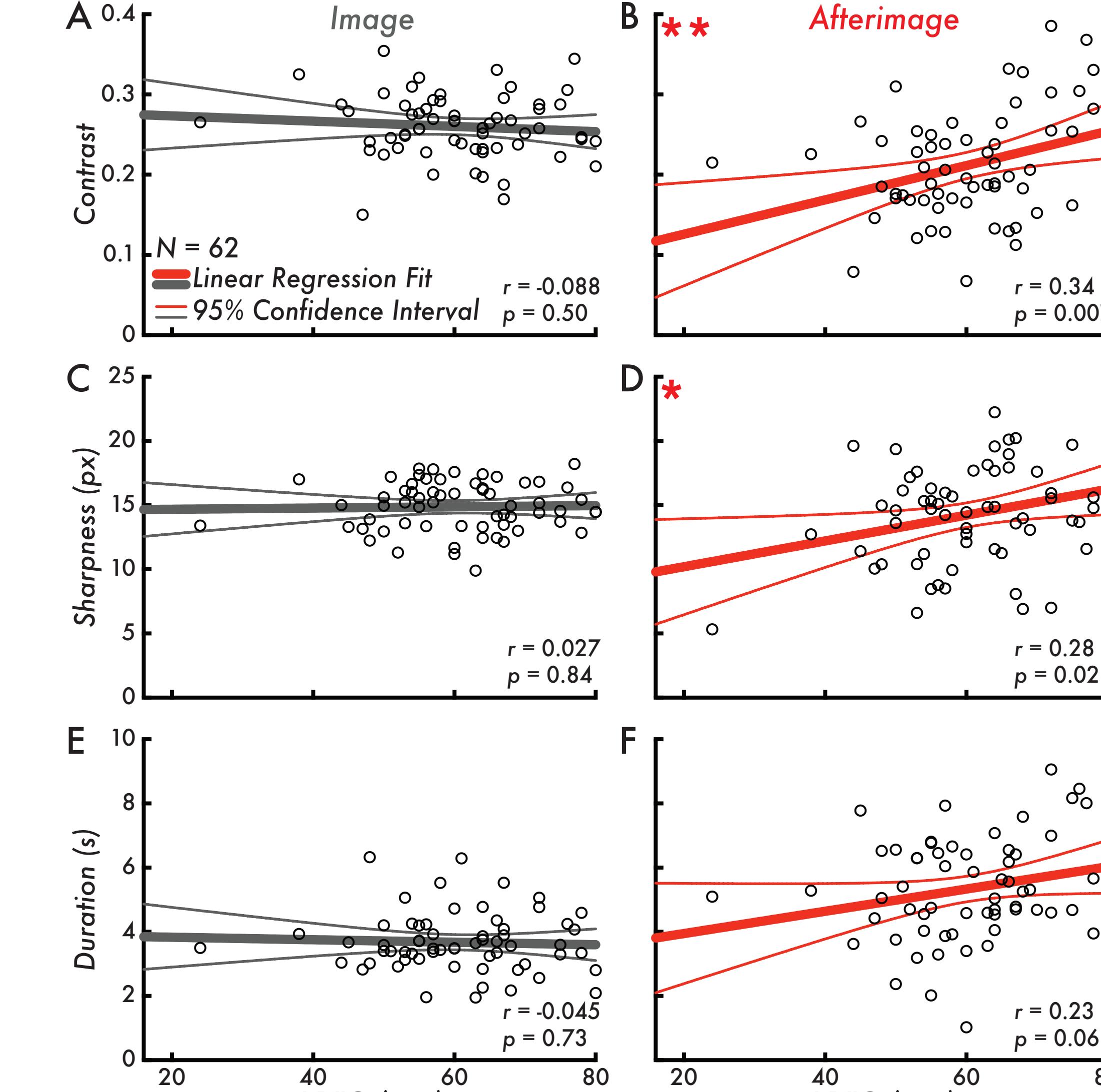
fMRI Paradigm Trials. **(A)** Inducer/afterimage trial. **(B)** Mock inducer/afterimage trial. Trial order was random.
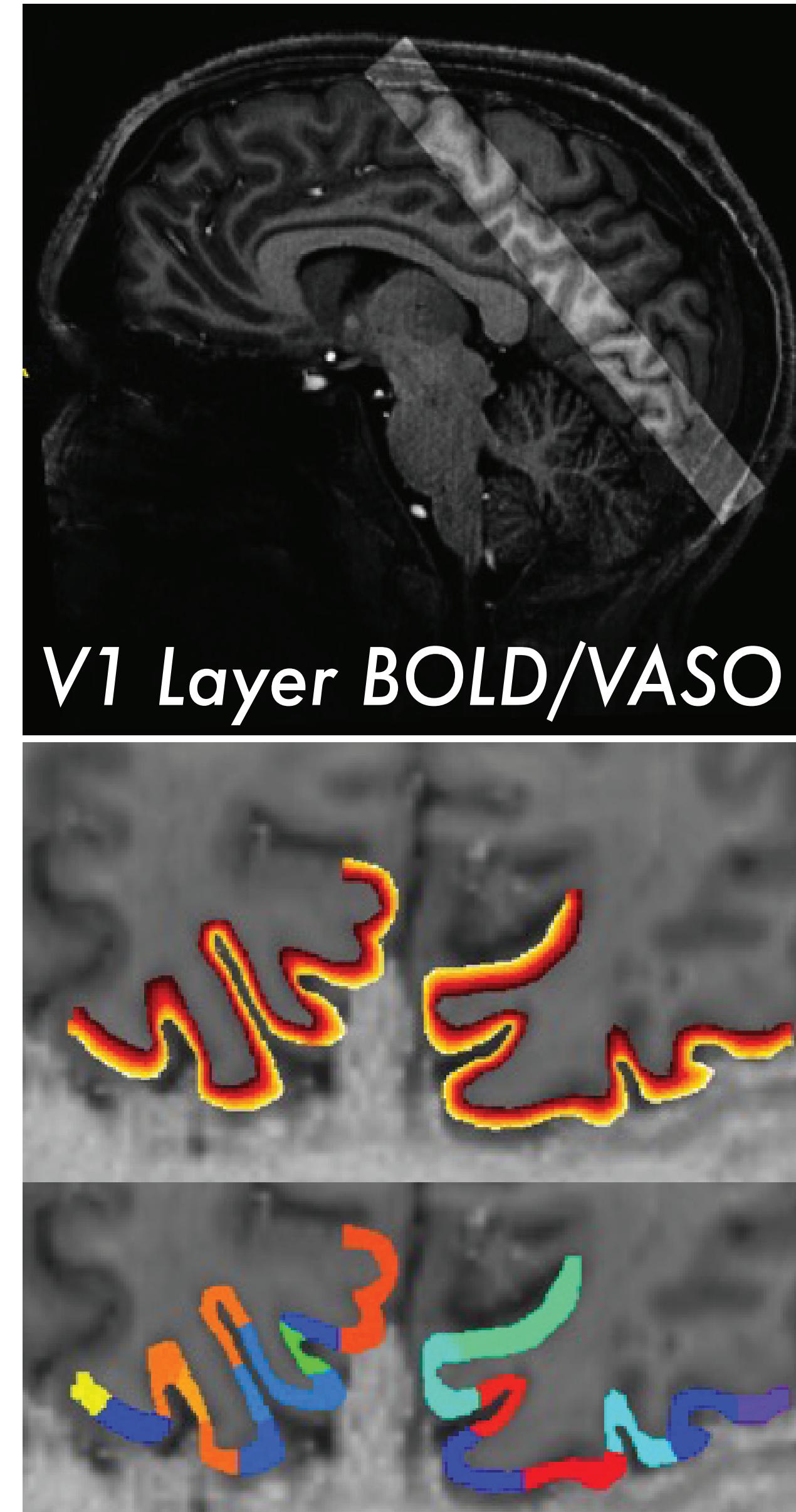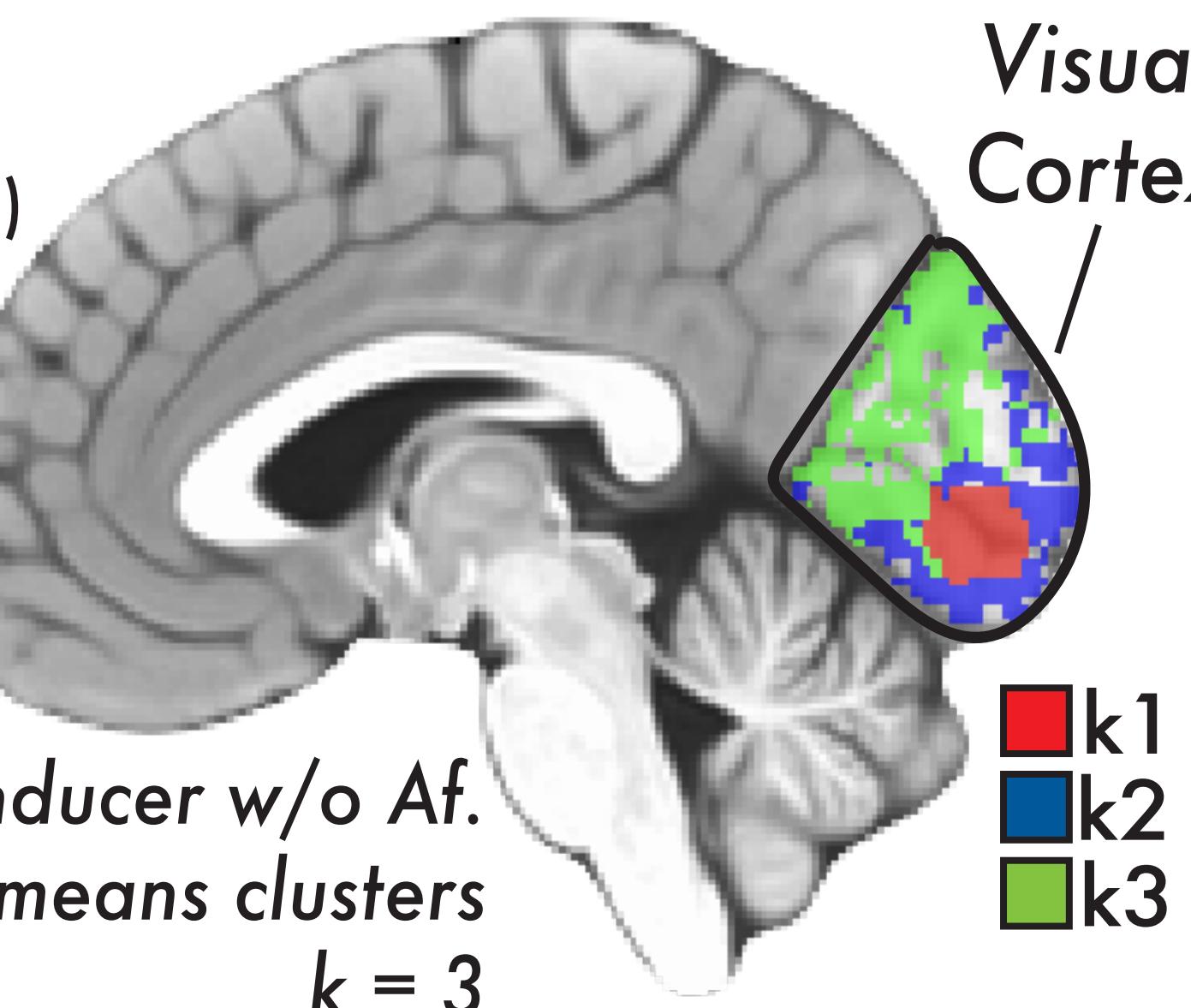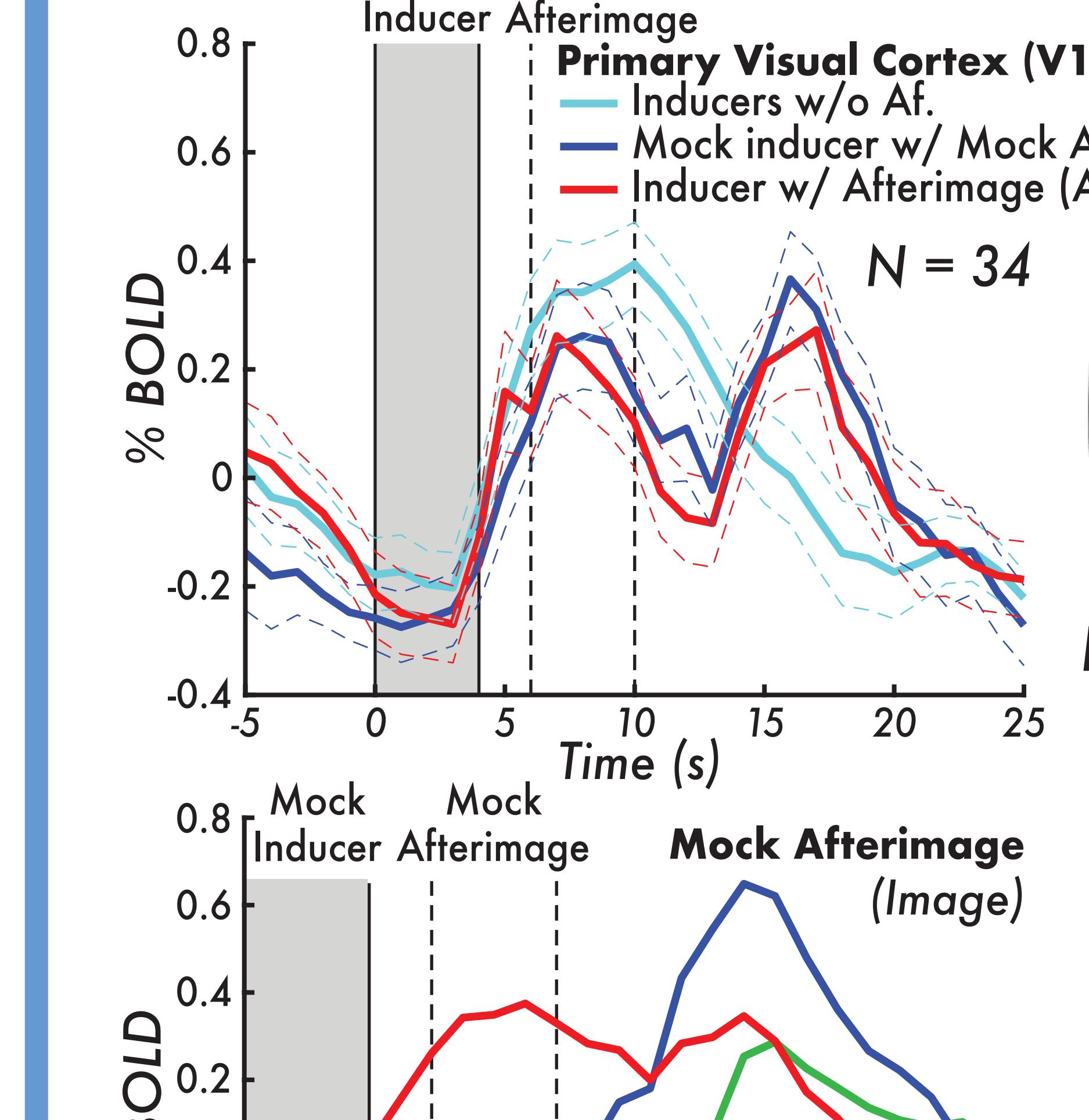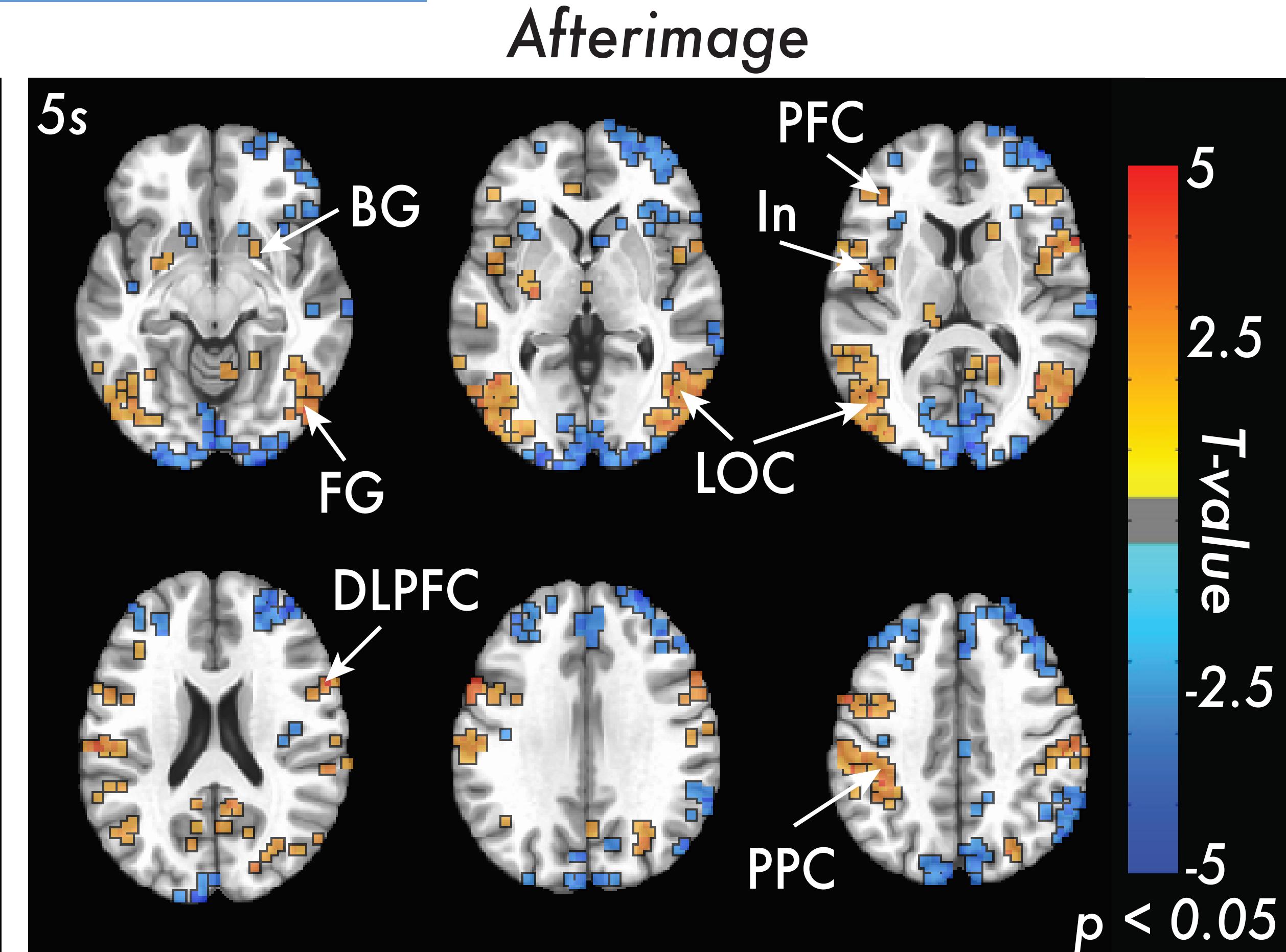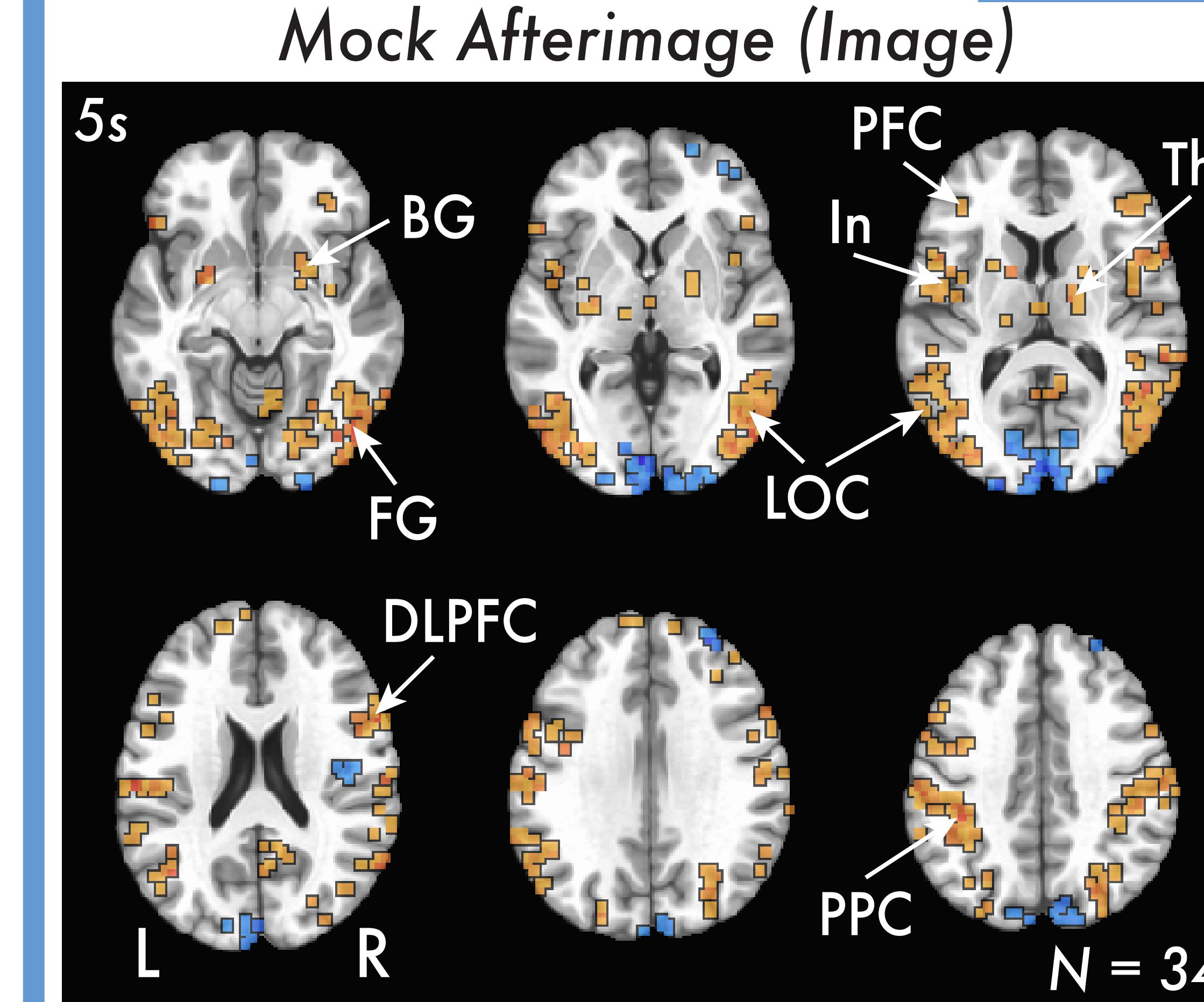
5. Behavioral Results

- Afterimage vividness correlates with vivid visual imagery.

6. fMRI Results

Mock Afterimage (Image) — *Afterimage*

$p < 0.05$, N = 34

Primary Visual Cortex (V1)
- Inducers w/o Af.
- Mock inducer w/ Mock Af.
- Inducer w/ Afterimage (Af.)

Inducer w/o Af. k-means clusters k = 3

V1 Layer BOLD/VASO

7. Conclusions

- Afterimages can be reliably induced and perceptually-matched with self-reporting.
- Afterimage and visual imagery vividness (VVIQ) are positively correlated.
- Perceptually and task-matched mock and real afterimages share widespread cortical and subcortical BOLD, including V1, FG, LOC, In, DLPFC, Th, PPC, and BG.
- Afterimage perception involves three visual cortex networks (k-means).

8. Future Directions

- Study the feedforward and feedback contributions for afterimage perception in V1 with layer resolution fMRI.

References

1. Shimojo et al., Science, 2001
2. Dong et al., Scientific Reports, 2017
3. Sperandio et al., Nature Neuroscience., 2012
4. Downey, J., Psychological Review, 1901