Multivariate fMRI evidence of opposite laterality and contra-hemifield bias for words and faces

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The "neuronal recycling hypothesis" claims reading is made possible by virtue of adapting pre-existing face recognition mechanisms to word recognition [1]. This hypothesis is associated with opposite laterality for words and faces, reported for both functional MRI (fMRI) and behavioral studies that employ *lateralized stimuli* [2,3].
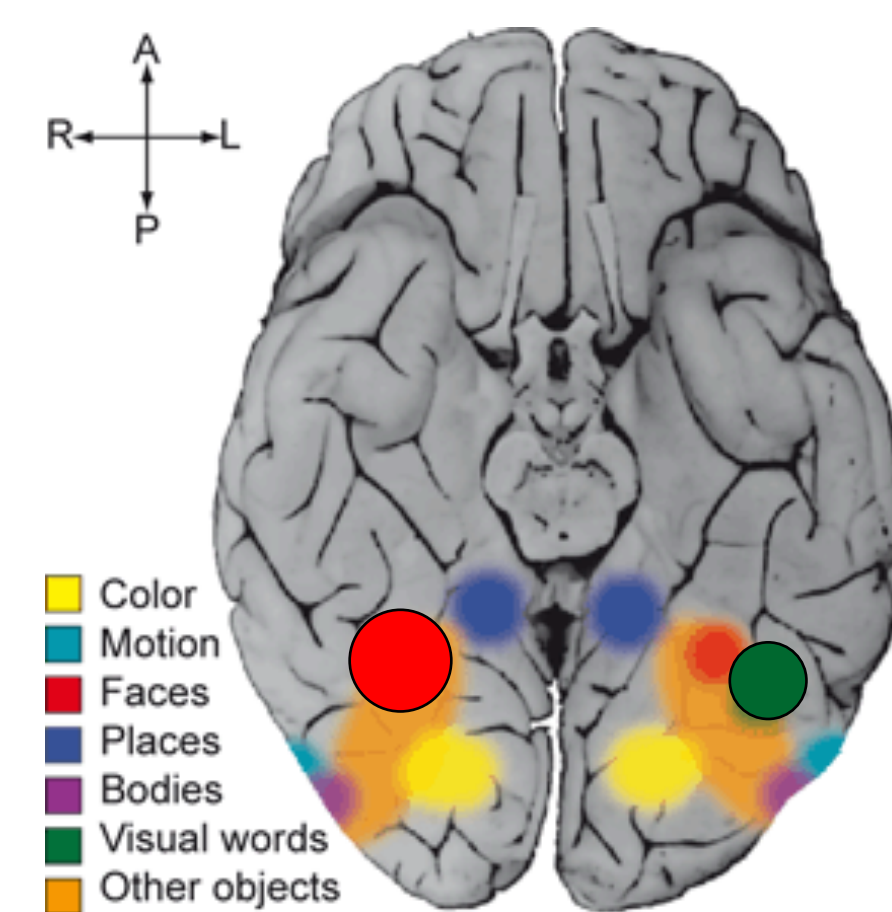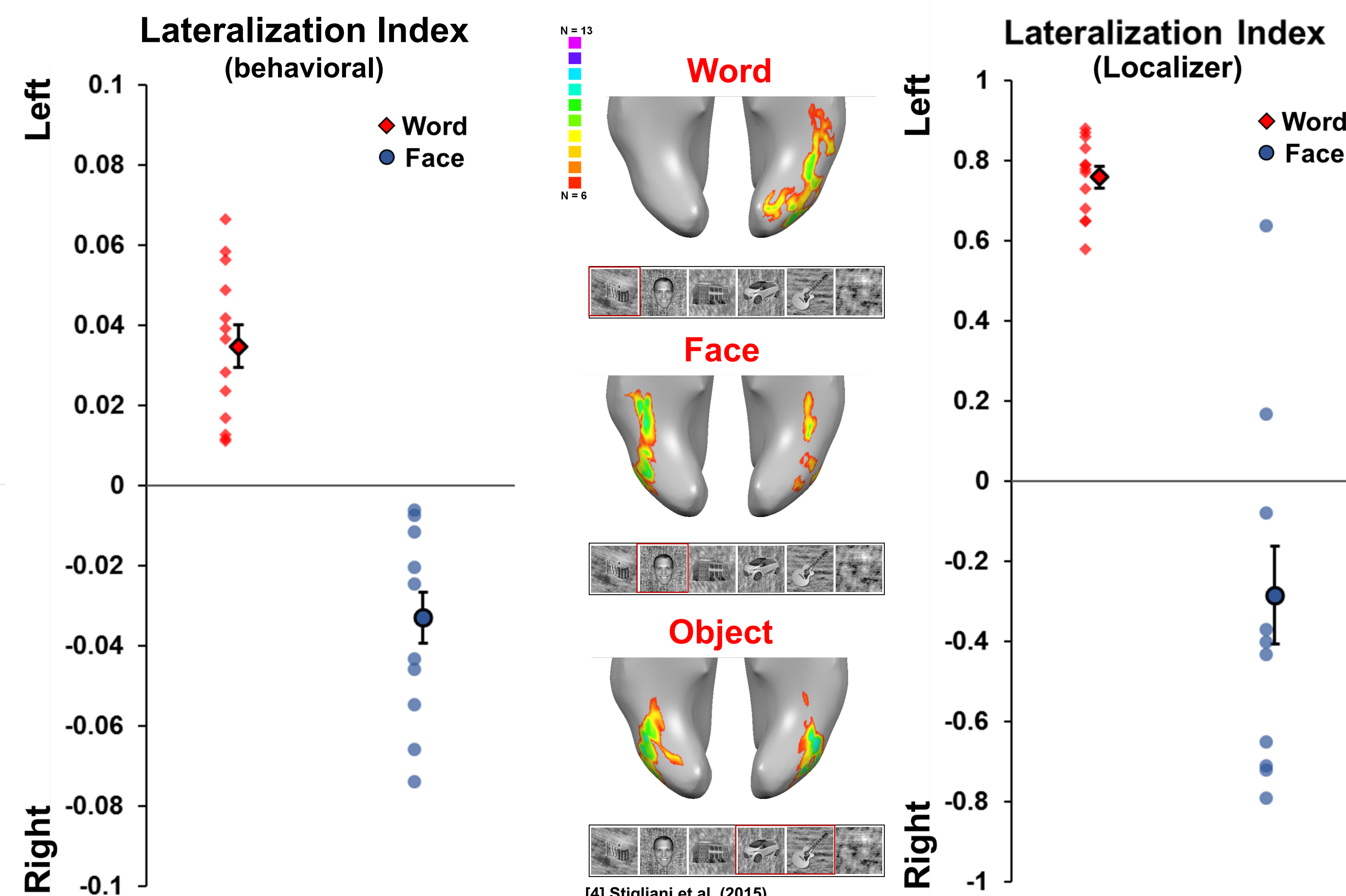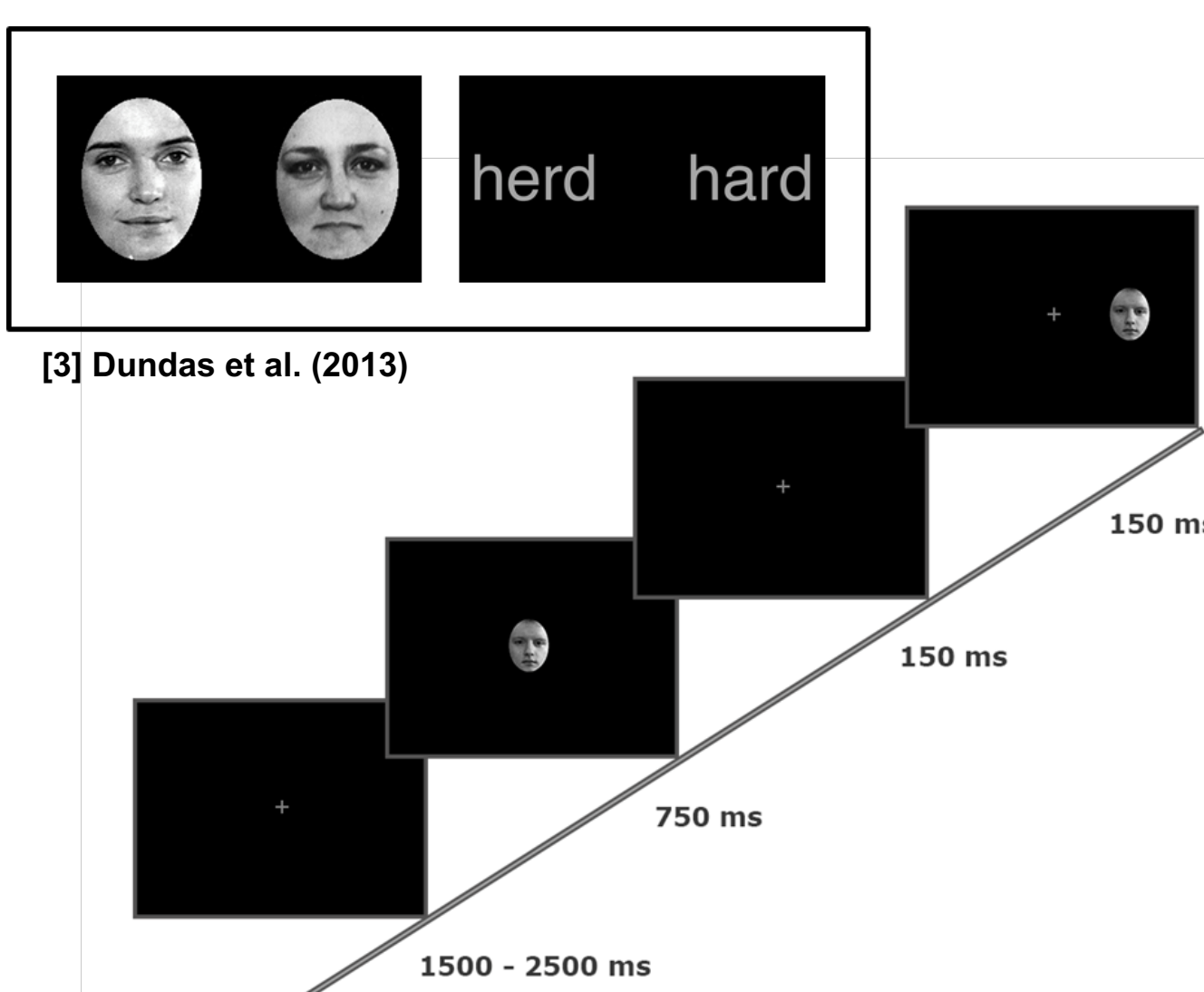
Visual processing of words and faces involves neural mechanisms in ventral occipitotemporal cortex (VOTC). VOTC exhibits both a neural and behavioral *contralateral bias* (i.e., words in the left and faces in the right hemisphere).
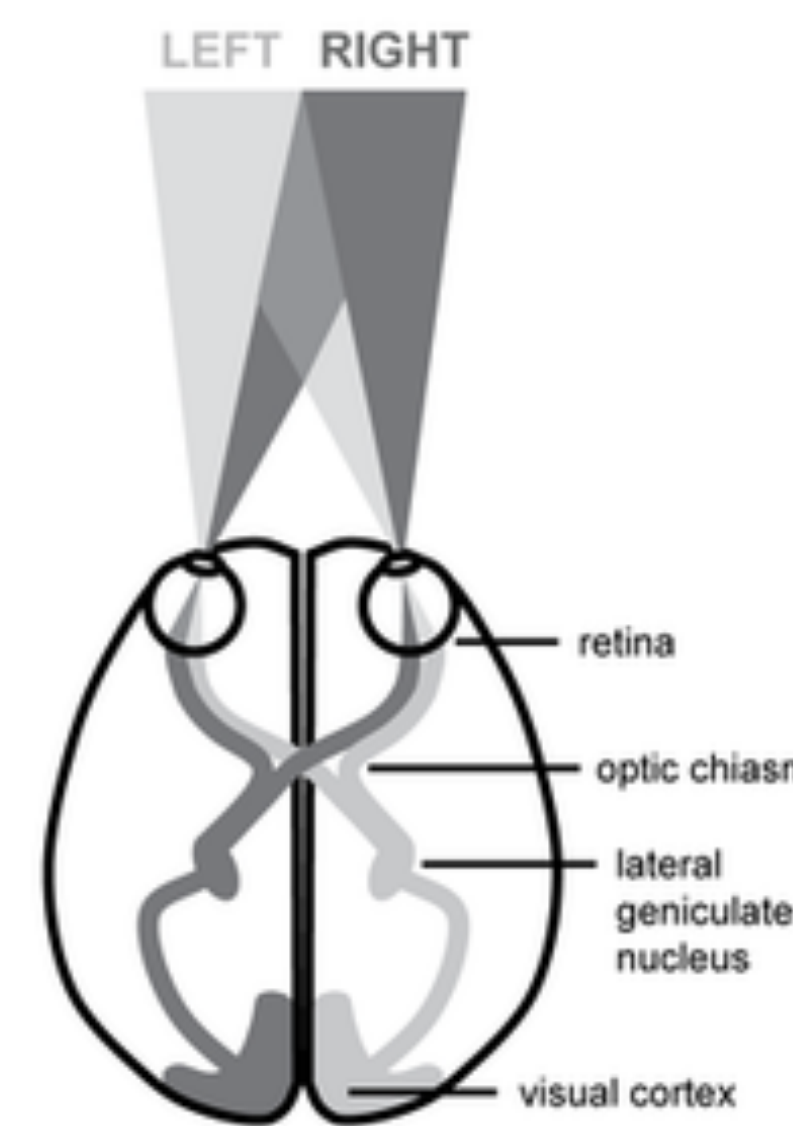
The neural architecture of the visual system is claimed to reconcile neural and behavioral evidence of opposite laterality. <u>This claim has never been tested</u>. We used multivariate pattern analyses applied to fMRI data to test for a straightforward relationship between opposite OTC laterality for words and faces, and opposite contralateral visual field advantages observed in divided field experiments [2,3].

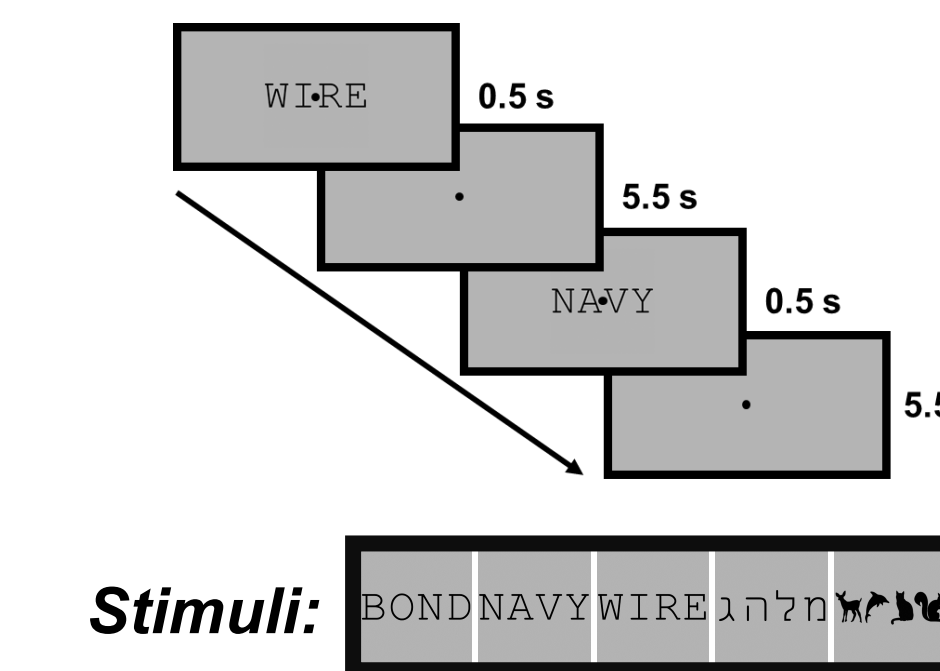## Participants (pre-selection criteria & laterality)

We restricted participants (n = 13) in our study to right-handed native English speakers who showed expected opposite word-face laterality for *behavior* (divided field).
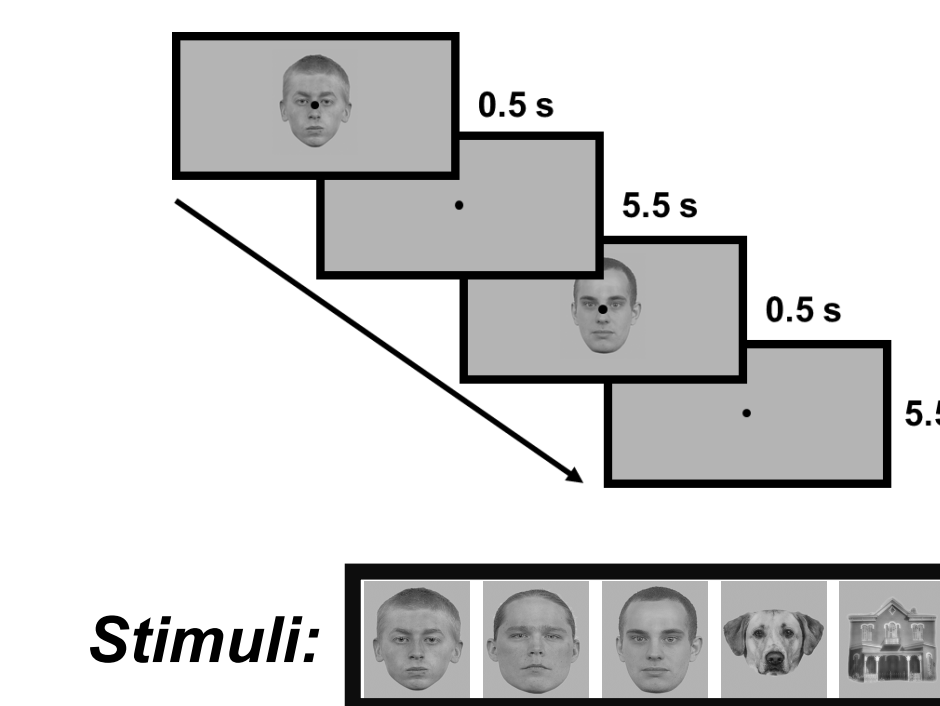

[3] Dundas et al. (2013)

Lateralization Index (behavioral)
- ◆ Word
- ● Face

Lateralization Index (Localizer)
- ◆ Word
- ● Face

[4] Stigliani et al. (2015)

Behavioral results were largely consistent with results from standard univariate *fMRI localizer*. All participants showed strong left lateralization for words, but to a lesser degree for faces.

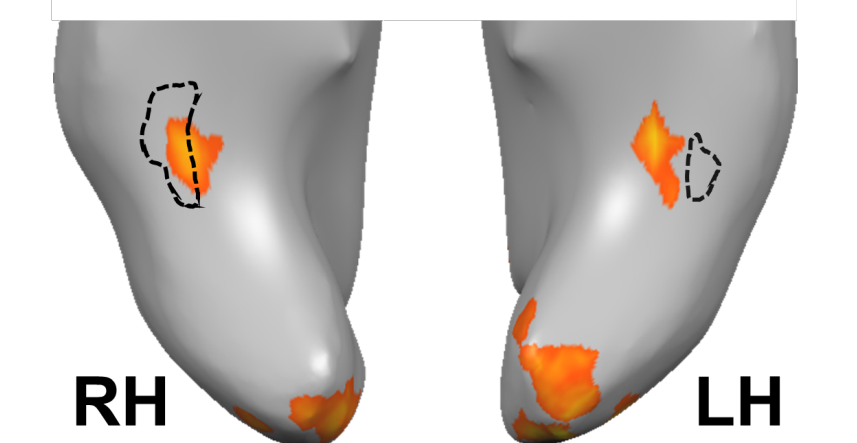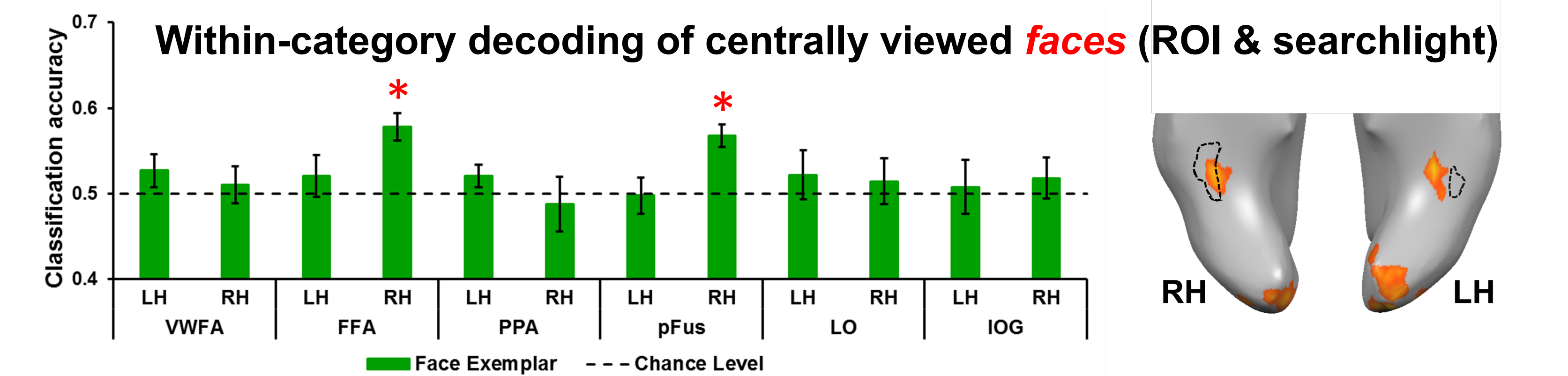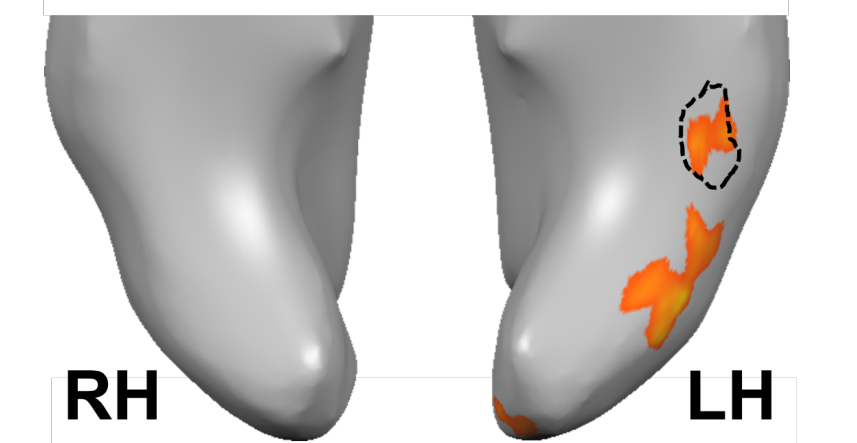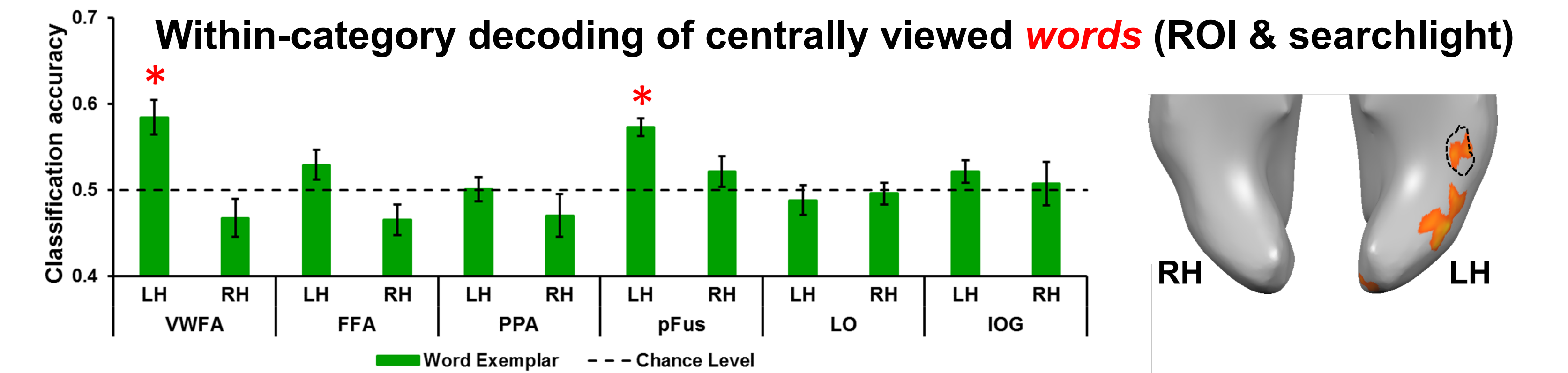## Main fMRI Experiment 1 (Center)

Method: 1-back task

Stimuli: BONDNAVYWIRE

Within-category decoding of centrally viewed *words* (ROI & searchlight)

- Word Exemplar
- – – Chance Level

Within-category decoding of centrally viewed *faces* (ROI & searchlight)
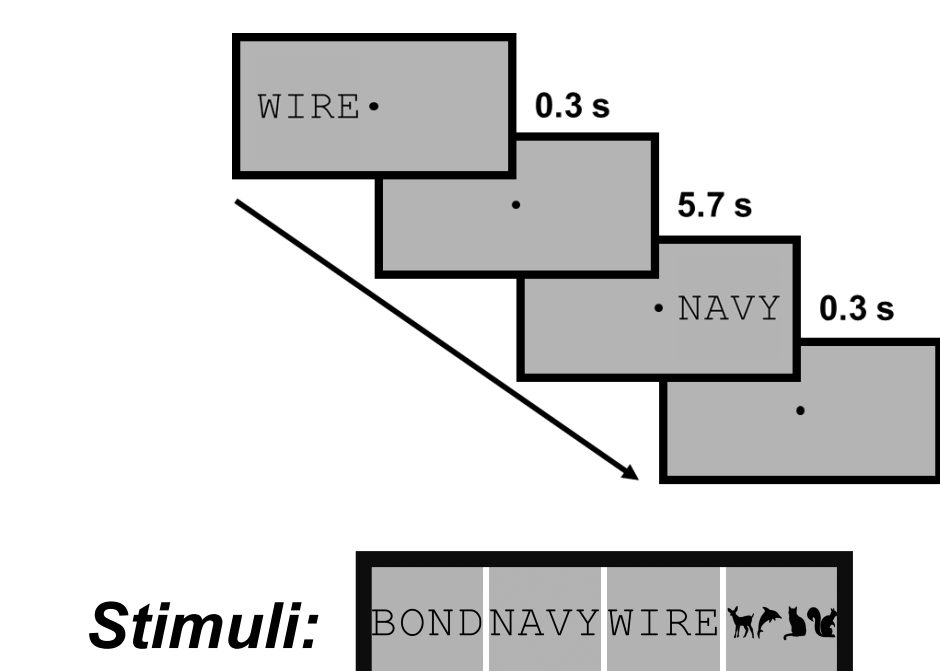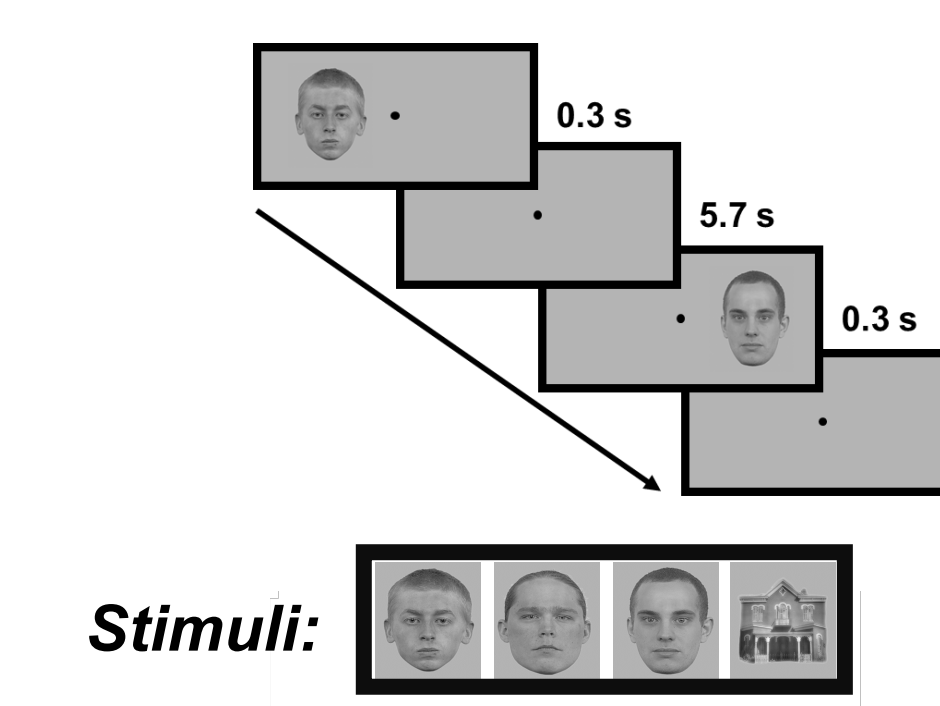
- Face Exemplar
- – – Chance Level

Main fMRI Experiment 2 (LVF/RVF)

Method: 1-back task (same as in Center)

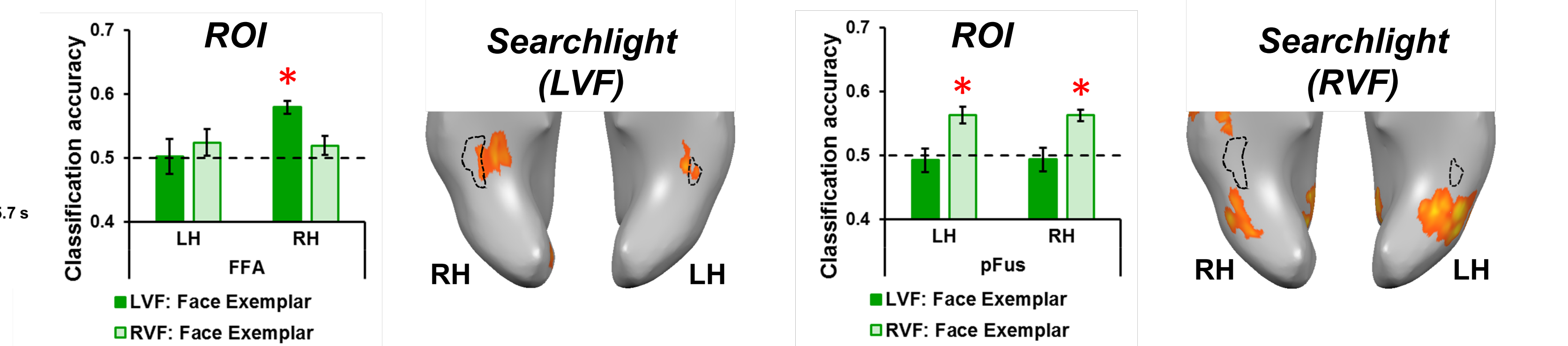*Stimuli:* BONDNAVYWIRE

Within-category decoding of *words* viewed in LVF/RVF

ROI — VWFA — *Searchlight (RVF)*
- LVF: Word Exemplar
- RVF: Word Exemplar

ROI — pFus — *Searchlight (LVF)*
- LVF: Word Exemplar
- RVF: Word Exemplar
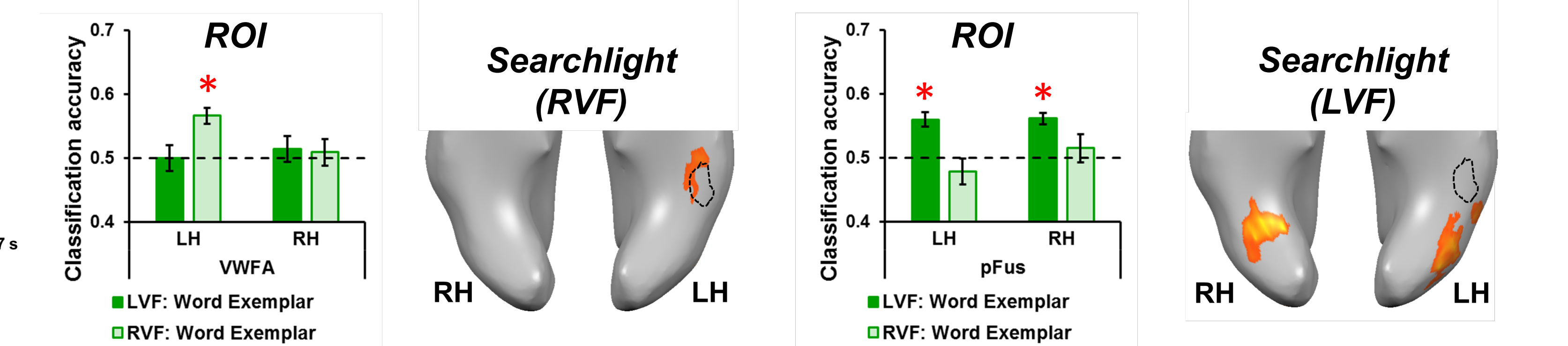
Within-category decoding of *faces* viewed in LVF/RVF

ROI — FFA — *Searchlight (LVF)*
- LVF: Face Exemplar
- RVF: Face Exemplar

ROI — pFus — *Searchlight (RVF)*
- LVF: Face Exemplar
- RVF: Face Exemplar

Contralateral univariate contrast LVF-RVF word

Contralateral univariate contrast LVF-RVF face

Within- and between category decoding of *words* across LVF/RVF
- Cross Location: Word Exemplar
- Cross Location: Word vs. Animal
- – – Chance Level

Within- and between category decoding of *faces* across LVF/RVF
- Cross Location: Face Exemplar
- Cross Location: Face vs. House
- – – Chance Level

No cross visual field within-category decoding was found in VOTC.

Conclusions:
1) Lateralized category-selective VOTC shows contralateral within-category decoding for stimuli viewed in preferred location.
2) Laterality is not limited to category-selective VOTC.
3) Object-selective pFus shows bilateral within-category decoding for stimuli viewed in non-preferred location, which complicates (negates) a simple relationship between opposite laterality for words and faces, and contralateral bias in VOTC.

[1] Dehaene, Stanislas, and Laurent Cohen. "Cultural recycling of cortical maps." *Neuron* 56.2 (2007): 384-398.
[2] Behrmann, Marlene, and David C. Plaut. "Distributed circuits, not circumscribed centers, mediate visual recognition." *Trends in cognitive sciences* 17.5 (2013): 210-219.
[3] Dundas, Eva M., David C. Plaut, and Marlene Behrmann. "The joint development of hemispheric lateralization for words and faces." *Journal of Experimental Psychology: General* 142.2 (2013): 348.
[4] Stigliani, Anthony, Kevin S. Weiner, and Kalanit Grill-Spector. "Temporal processing capacity in high-level visual cortex is domain specific." *Journal of Neuroscience* 35.36 (2015): 12412-12424.