Pattern recognition and visual word forms
In other words: Even if you don’t like the theories, you have to explain the data.
The great “visual word form area” debate

- Is the “visual word form area” specialized for visual word forms?

- Larger debates:
  - Domain general vs. Domain specific
  - Organization-by-material vs. Organization-by-process
  - Roles of learning, expertise and evolution in shaping brain function.
Fusiform Gyrus and the “Visual Word Form Area”
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**VWFA**: Hypothesized to “contains a population of neurons that, as an ensemble, is tuned to invariant stimulus properties and structural regularities of written words” (McCandliss et al., 2003)
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Fusiform Gyrus and the “Visual Word Form Area”

- Response properties (McCandliss et al., 2003):
  - Responds reliably to letters and words.
  - May also respond to faces and objects.
  - Responds more to letters than pseudo-letters
  - Modality-specific (doesn’t respond to spoken words)
  - Invariant with regard to retinal location, letter case, size and font (neural priming studies)
  - Insensitive to lexical properties (e.g. frequency)
Left Fusiform is Activated by Visual Word Forms
(Cohen et al., 2002)

Passive viewing of words, letter strings and checkerboards

Words & Letters > Checkerboards in left, but not right, fusiform cluster.
Left Fusiform is Activated by Visual Word Forms (Cohen et al., 2002)

Passive viewing of words, letter strings and checkerboards

Words > letters in left fusiform cluster.
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- How does the VWFA become specialized?

- Written language is a recent cultural development (~5400 years ago), so can’t be evolution.

- Children do not show letter/word specific activation in VWFA before learning to read.

- Initial properties intrinsic to the region and its connectivity must determine its subsequent specialization for reading.

- May be specialized for foveal objects, local object features, and invariance for position and size.
Expertise for reading in the fusiform gyrus
(McCandliss et al., 2003)

- Expertise in different visual categories (e.g. birds, cars) linked to enhanced perception of category members via more holistic processing of the stimulus, through functional re-organization of visual areas.

- Expertise for word reading may be similar.
Expertise for reading in the fusiform gyrus
(McCandliss et al., 2003)

- Literate adults group letters together into a single perceptual unit (visual word form).
- Speed of word recognition is unaffected by the number of letters for 3-6 letter words.
- Suggests processed in parallel
Expertise for reading in the fusiform gyrus
(McCandliss et al., 2003)

Hypothesis: reading experience drives progressive specialization of a pre-existing inferotemporal pathway for visual object recognition.
Expertise for reading in the fusiform gyrus
(McCandliss et al., 2003)

Evidence:

- Younger children do show word length effects for 3-6 letter words.
- ERP data shows 10-year-olds have adult-like response to high frequency, but not low frequency, words.
- Activation level of VWFA correlated with phoneme-grapheme decoding ability, controlling for age.
- VWFA less active in adults with developmental dyslexia.
“The myth of the VWFA”  
(Price & Devlin, 2003)

¢ Is the VWFA really specialized for word forms?

¢ Neuropsychological evidence:

¢ “pure alexics” usually have much larger lesions (including cuneus, calcarine sulcus and lingual gyrus in addition to fusiform)

¢ “pure alexics” often have other perceptual problems (e.g. color naming, picture processing)
“The myth of the VWFA”
(Price & Devlin, 2003)

- Is the VWFA really specialized for word forms?

- Functional imaging evidence:

- Also active when subjects name familiar objects, make manipulation responses to pictures of unfamiliar objects, name colors and perform auditory and tactile word processing tasks.

3. Name Pictures > Read Name
“The myth of the VWFA”
(Price & Devlin, 2003)

So what does the “VWFA” do then? 3 possibilities:

1. Different populations of neurons in the same region, one for VWFs and others for naming, object perception etc.

Not very neurally plausible.

Would require single-cell evidence.
“The myth of the VWFA”
(Price & Devlin, 2003)

So what does the “VWFA” do then? 3 possibilities:

2. A single cognitive function, not yet identified underlies all these multimodal responses.
“The myth of the VWFA”
(Price & Devlin, 2003)

So what does the “VWFA” do then? 3 possibilities:

1. the same population of neurons could support different cognitive processes, depending on their interactions with other cortical and subcortical areas.
Visual Perceptual Learning of Words and the VWFA Debate (Xue & Poldrack, 2007)

- Korean characters presented in pairs: same/different judgment.
- Scanned before and after training.
- Difficulty controlled by amount of visual noise.
- English word control task.
Visual Perceptual Learning of Words and the VWFA Debate (Xue & Poldrack, 2007)

At pre-training scan, both words and Korean characters strongly activated VWFA. Not sig. different.

After training, less VWFA activation for Korean characters, both with same level of noise as pre-training scan, and same level of performance (by increasing noise).

Suggest that “VWFA is neither specific to words nor sensitized by visual expertise with specific writing systems”