Are faces processed configurally?
Some questions before answers

Ben Cipollini, UC San Diego
Jim shared a paper in the April PEN call re: configural processing in familiar face recognition.

What are the different ways that faces are processed behaviorally?
Some of us are reading about parallel streams in ventral visual cortex (retinotopy).

What are the different (path)ways that faces are processed neurally?
Some of us are reading about parallel streams in ventral visual cortex (retinotopy)

What are the mapping between behavior and neural systems for faces?

The Macaque Face Patch System: A Window into Object Representation

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I don’t know the answers to these questions. I sent out a survey to PEN.

June PEN Conference Call Survey

- How many kinds of face processing are there?
- How many visual processing pathways are there?
- Are there any simple mappings between the two?

For the June Conference Call, I hope to get a sense of how we, as a group, think about face processing, visual processing, and how the two connect. My own thinking is rather simple and rather flawed, and I really don’t know how others think about this—despite being a PEN participant for quite some time.

I hope this discussion could identify any potential gaps (either in our shared mental model, or in differences on how we’re thinking about these things), even if they’re just my own, for discussion during the call!

How does PEN, as a whole, divvy up the space of face processing?
The survey results were very heterogeneous. I have three goals for the conference call.

Outline some potential answers to the questions.

Get feedback from y’all

Prime everybody for a second round on the survey!

Any questions or concerns about my questions about questions, or about the survey?
Here are face processing behaviors from the literature and survey.

Survey responses:

- Detection
- Familiarity (have you seen this face before?)
- Recognition (identification)
- Learning (generalizing across pose to learn an ID)
- Memory / imagery (trying to picture a face)
- Individual characteristics (age, attractiveness, trustworthiness) *[could be recognition or categorization]*
- Face actions (expressions, eye gaze direction, speech visemes)

These responses matched well with the literature. (Burton et al., 2015; Jiang et al., 2015)
Here are face processing **neural systems** from the literature and survey.

**Survey responses:**
- Dorsal stream (MT+ / pSTS)
- Ventral stream ("OFA" / FFA 1,2 / aIT)
- Amygdala
- Prefrontal cortex?

I found some other possibilities in the literature:
- Other subcortical (superior colliculus, pulvinar) (Johnson, 2005)
- Parallel ventral stream pathways (Kravitz et al., 2013)
- Six output pathways (Kravitz et al., 2013)
- Middle and anterior STS? (Weiner & Grill-Spector, 2015)
- Top-down / feedback networks? (frontal: Bar et al., 2006; parietal: Kravitz & Behrman, 2011)
The feed-forward view of the ventral visual stream.
The parallel processing view of the ventral visual stream (connectivity).

Kravitz et al. (2013)
The parallel processing view of the ventral visual stream (retinotopy).

center/periphery    upper/lower (and contralateral)

Kravitz et al. (2013)  Silson et al. (OHBM, 2015)
Connectivity with speech areas affects the ventral visual stream (connectivity).
Here are associations between behavior and neural systems, from the literature & survey.

Survey responses:

- **Early visual cortex, V1-3**: features like shape, contour, edge, color, size, brightness, etc
- **Intermediate extrastriate regions**: some complex features/dimensions like animacy, faceness, objectness, etc
- **Higher-order occipitotemporal regions like OFA (Lower VF bias) & FFA (Upper VF bias)**: sensitive to face identity and configural processing
- **MT/MT+ to STS pathway**: sensitive to facial expression, gaze, dynamic/social aspects
- **Occipitotemporo-amygdaloid pathway**: related to facial expression/emotion processing
- **Dorsal regions like V3A/B and IPS0-7**: given that they are essential for selection of object locations, I suspect they are related to face detection in particular.
- **Anterior temporal cortex**: semantics / individuation

I found some other possibilities in the literature:

- **Subcortical**: facedness (Johnson, 2005), some identification (Gabay et al., 2014a, b)
- **Intermediate extrastriate regions**: some complex features/dimensions like animacy, faceness, objectness, etc
- **Prefrontal direct pathway** (e.g. Bar, 2003): fast, low-frequency processing
- **Orbitofrontal cortex**: facial attractiveness (Ishai, 2007) (mentioned by Jiang et al., 2015).
- **Inferior frontal gyri (IFG)**: assessment of emotion (Nakamura et al., 1999; Phillips et al., 1997) & facial imagery tasks (Ishai, Haxby, & Ungerleider, 2002) (mentioned by Jing et al., 2015)
There are six output pathways of cortical visual processing.

- All areas to the neostriatum (for stimulus-response associations)
- aIT: amygdala (for emotional salience)
- aIT: ventral striatum (valence)
- aIT: ventrolateral prefrontal cortex (for object working memory)
- aIT: orbitofrontal cortex (for object-reward association)
- aIT: medial temporal cortex (for long-term memory)
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Many features could be used (including contrast configurations, pose)
Face processing does seem heterogeneous

Task-based responses need not be using configural features

Unclear what the real interactions between the systems are (including their time-courses)
There are many neural pathways to process faces.

Understanding each, and how they relate, may help make sense of a large, complex literature :)

There are many ways to respond to faces.