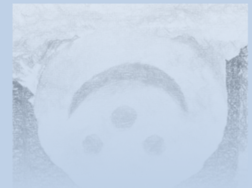
Winter 2015 Prosopagnosia Research Center

Face to Face

Prosopagnosia Research & Community

This newsletter is getting out a bit later than we would have liked, because we've been so busy shoveling snow this winter!



We hope you will contact us if you have thoughts or feedback to share!

-Prosopagnosia Research Center (faceblind@faceblind.org)

Face Selective Brain Areas and Prosopagnosia

by Brad Duchaine

In the 1990s, cognitive neuroscientists began using functional magnetic resonance imaging (fMRI) to measure which brain areas became active during particular psychological tasks. Several research groups were interested in seeing which areas became active when people viewed faces, partially because reports of prosopagnosia suggested face processing may depend on specialized brain mechanisms.

In 1997, papers from a group at Harvard (Kanwisher et al. 1997) and another group at Yale (McCarthy et al. 1997) reported that a region in the fusiform gyrus responded much more strongly to faces than to other objects (See figure below). The fusiform gyrus is a brain region in the occipital and temporal lobe. The activation in the fusiform gyrus seen in response to faces fit nicely with evidence that brain damage to this part of the brain led to prosopagnosia and thus was critical for face processing. This activation is often called the 'fusiform face area' (FFA), and it is one of the most well known findings from fMRI research.

In the nearly twenty years since the FFA was discovered, researchers have identified a number of other face-selective areas in the occipital, temporal, and frontal lobes (See Figure). Shortly after the FFA was reported, the occipital face area (OFA) was found more toward the back of the brain, and a region in the posterior superior temporal sulcus was found in a region on the side of the temporal lobe. More recently, additional areas have been found in the anterior temporal lobe, the anterior superior temporal sulcus, and the inferior frontal gyrus. These areas are typically present in both the left and right hemispheres, but the response in the right hemisphere is usually stronger.

(continued on Pg. 2)

The Classics

In this section, we summarize a classic paper in face recognition research. If you would like access to the original article please visit https://www.cnbc.cmu.edu/~behrmann/dlpapers/Moscovitch_et_al_1997

Moscovitch, M., Winocur, G. and Behrmann, M. (1997). What is special about face recognition? Nineteen experiments on a person with visual object agnosia and dyslexia but normal face recognition. Journal of Cognitive Neuroscience, 9, 5, 555-604.

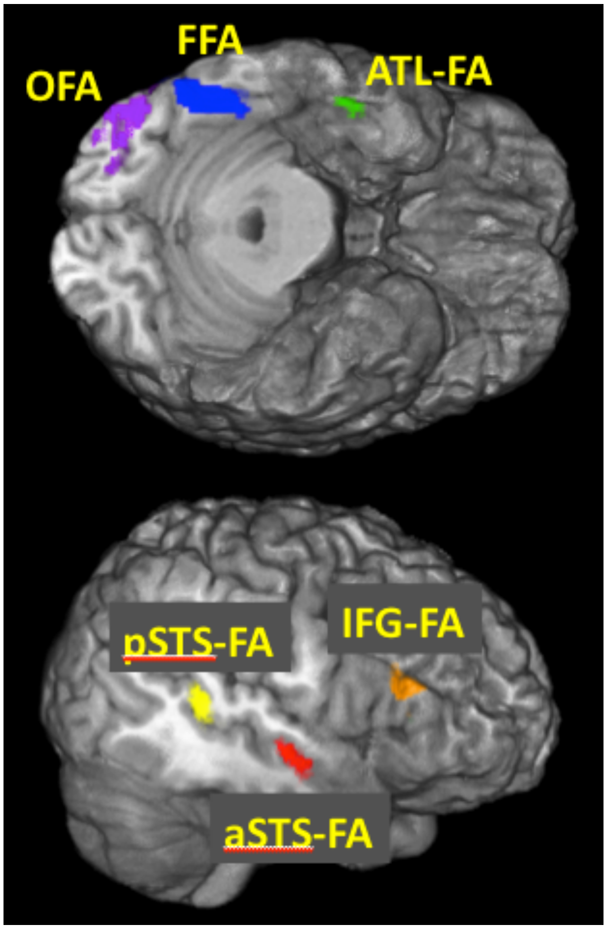
Some people with prosopagnosia can recognize other objects normally despite severe face problems with faces. This condition is called 'pure prosopagnosia', because faces appear to be the only category these individuals have problems with. Pure prosopagnosia suggests face processing depends on different processes than other types of visual recognition. If face recognition depends on specialized mechanisms, you might expect the opposite condition might also exist. Just such a case was reported in a classic paper from 1997.

Morris Moscovitch is a prominent neuropsychologist at the University of Toronto, and he published an influential series of papers about a man named Mr CK who suffered brain damage after he was hit by a car while jogging. As a result of the brain damage, CK suffers from severely impaired object recognition and word recognition.

(continued on Pg. 4)

Face Selective Brain Areas…, continued from pg 1.

The existence of these areas has led to many proposals and experiments about the function of these areas, but our understanding of the function of these areas still remains sketchy.



Face-selective areas. The six face-selective areas discussed here are shown in two views of the brain of a participant with normal face processing. The view at the top of the figure shows the right hemisphere ventral face-selective areas: occipital face area (OFA), fusiform face area (FFA), and ATL-FA. The view below shows the dorsal face-selective areas: pSTS-FA, aSTS-FA, and IFG-FA.

Not surprisingly, research into the neural basis of prosopagnosia has focused on these face-selective regions. In studies of people with developmental prosopagnosia, early fMRI work with small numbers of participants showed that these areas were usually present despite severe face recognition impairments. This finding came as a surprise to some researchers, but more recent studies with larger samples of subjects suggests that face-selective areas in people with developmental prosopagnosia are smaller and less responsive to faces than these areas in people without prosopagnosia. In some cases, people with developmental prosopagnosia don't show any regions that show a stronger response to faces than to objects. Much more work however will be necessary to better understand the neural abnormalities in developmental prosopagnosia. One intriguing question is whether abnormalities in different face-selective areas lead to different types of developmental prosopagnosia, and this is a question that is currently being investigated by the prosopagnosia lab at Dartmouth.

Another approach to the question of the function of face-selective areas is to study what happens when face-selective areas are lost due to brain damage. Over the last few years, the lab at Dartmouth has carried out fMRI and extensive behavioral testing with a group of people with acquired prosopagnosia, and they plan to test more people in the coming years. In a recently published paper from the Dartmouth lab (Yang et al., in press), they demonstrated that a man referred to as Galen (pseudonyms are usually used in these sorts of studies) lost the FFA and OFA in his right hemisphere following brain surgery. Despite the loss of these regions, his other face-selective regions appear to respond normally to faces. Most surprising to us was the normal response of the face-selective area in the right anterior temporal lobe, because this area would be expected to receive its primary input from the FFA and OFA. Studies like this one shed light on how the face areas interact with one another and demonstrate the value of studying face areas in prosopagnosia. ▿

Kanwisher, N., McDermott, J., & Chun, M. (1997) The Fusiform Face Area: A Module in Human Extrastriate Cortex Specialized for the Perception of Faces. Journal of Neuroscience. 17: 4302-4311.

McCarthy, G., Puce, A., Gore, J.C., & Allison, T. (1997) Face-Specific Processing in the Human Fusiform Gyrus, Journal of Cognitive Neuroscience, 9: 605-610.

Yang, H., Susilo, T., & Duchaine, B. (in press). The anterior temporal face area contains invariant representations of identity that can persist despite the loss of right FFA and OFA. Cerebral Cortex.

Scaling Up Prosopagnosia Research by Tirta Susilo

In the last decade or so we have learned a lot about developmental prosopagnosia from studying some of you in our laboratories. Along the way we have discovered important things about prosopagnosia and how normal face recognition is supposed to work, some of which we've shared in the newsletter. But most of these studies have very small samples. Prosopagnosia studies with samples above 10 are rare, and the biggest study to date has about 40 participants. For comparison, studies of dyslexia regularly test hundreds of people, and the biggest study of synesthesia has a sample of 19,133.

There is a clear drawback of studies with small samples: they are not suitable for drawing precise estimates that would help us better characterize prosopagnosia. For examples, we don't have good answers to fundamental questions like: What is the proportion of people with prosopagnosia who also have difficulties recognizing facial expressions? How common are people whose visual recognition problems are strictly restricted to faces and nothing else (called *pure prosopagnosia)*? Do the majority of prosopagnosics have problems processing a face as a single unit of visual analysis (a phenomenon known as holistic face perception)? We need to answer these questions and many others if we are to have a deep understanding of prosopagnosia and how face recognition can be improved in prosopagnosia.

Thanks to the possibility of online testing, we now have the means to address these issue with large samples. Over the last few years we have designed and refined a wide range of tests that can be administered online. We, and others, have shown that these tests produce data similar to those collected in the laboratory. We are really excited about online tests because they allow us to scale up our research significantly without sacrificing quality, and more of you will be able to participate in our studies and learn about yourself without having to leave home.

More than 10,000 people have registered at www.faceblind.org because they have face recognition problems. This means we have the potential to run prosopagnosia studies with hundreds or even in thousands of participants. For prosopagnosia research, these numbers are unprecedented. If many of you participate in our online studies, we will be in a great position to answer the basic questions above and many more. So please keep your eyes peeled for an email inviting you to participate in our studies. Together we'll take prosopagnosia research to new heights! ∇

Prosopagnosia in the News!

Developmental prosopagnosia in a man tested in the Birkbeck lab:
http://www.huffingtonpost.co.uk/2015/01/20/prosopagnosia-face-blindness-recognise-own-family_n_6501638.html

Acquired prosopagnosia in a man tested in several London labs:
http://www.dailymail.co.uk/news/article-2995696/Father-left-unable-recognise-family-s-faces-suffering-stroke-realised-problem-struggled-son-school-gates

White matter deficits in developmental prosopagnosia (Stanford):
http://news.stanford.edu/news/2015/january/face-blind-brain-013015.html

The Classics, continued from pg 1.

For instance, while visiting Professor Moscovitch's lab, CK was unable to recognize a coffee cup placed on a table with several other objects. He is also unable to read.

Vertumnus, one of the Arcimboldo paintings, shown to Mr CK.

Despite his severe agnosia and dyslexia, CK can recognize upright faces perfectly normally. In the 1997 paper, Professor Moscovitch tested CK with 19 different tests to explore his face processing. As long as faces were upright and intact, CK was just as good as control participants. He recognized famous faces well and had no problem with upright photos, cartoons, and even overlapping line drawings of faces. However if faces were turned upside down, CK's performance was much worse than control participants. This normal performance with upright faces along with a severe deficit with inverted faces provides strong evidence that the recognition of upright and inverted faces depend on different processes.

In an especially interesting experiment, CK was presented with paintings that showed faces composed of objects by the Italian artist Arcimboldo (See Figure). The control participants reported seeing both the faces and the objects, but except for a few painting, Mr CK only saw the faces. Not only could CK not recognize the objects, he couldn't even see them! He was blind to the objects when they were in the context of a face. ∇

Researcher Spotlight

Professor Martin Eimer

Martin was a Postdoc in Munich, Germany, before moving to the University of Cambridge, UK, in 1997. He joined Birkbeck College, University of London, in 2000, where he is the head of the Brain and Behaviour Lab. Martin's lab investigates the neural basis and the time course of perception, attention, and action control, mainly with EEG measures. He and his team work with Brad to find out more about face processing in prosopagnosia. Martin loves soccer and all other sports, and enjoys reading books about history and going to the theatre.

Katie Fisher

Katie is currently a Ph.D. student in the Brain and Behaviour lab at Birkbeck, University of London, investigating face perception and recognition in neurotypical adults and individuals with prosopagnosia. Before working on face processing and prosopagnosia Katie received her MSc in Cognitive Neuroscience from University College London where she studied the neural basis of decision making in real time using electroencephalography (EEG). Katie's Ph.D. research is focused on using specific event-related brain potentials to better understand the time course and component processes involved in perceiving and recognising individual faces. Katie enjoys painting, cycling holidays and orienteering.

John Towler

John is a postdoctoral researcher in the Brain and Behaviour lab at Birkbeck College. He has a Ph.D. in Experimental Psychology and Cognitive Neuroscience from the University of London. John's research interests include basic cognitive processes such as visual perception, selective attention and working memory. His Ph.D. and subsequent postdoctoral work has primarily focused on using event-related brain potentials (ERPs) to study face perception and recognition. John uses this technique to reveal the cognitive and neural locus of face processing impairments in individuals with prosopagnosia. In his free time John enjoys reading and playing music.