Face to Face
Prosopagnosia Research & Community

Happy New Year! 2014 not only brings the continuation of the Polar Vortex (in much of the US, at least), but also the **eighth** issue of Face to Face! We've got some exciting new research to share and new researchers to introduce - we hope you will contact us should you have thoughts or feedback to share!

-Prosopagnosia Research Center (faceblind@faceblind.org)

Working Toward Treatments for Prospopagnosia
by Dr. Joseph DeGutis & Sarah Cohan

"There's no treatment for prosopagnosia…is there?"

Prosopagnosia has been studied for decades, and clinicians and researchers have generally believed that prosopagnosia cannot be treated. Instead, it has been thought that prosopagnosia could only be compensated for by using alternative methods of recognition such as a person's voice, hair, or clothing style. The seeds of these current beliefs were likely planted by a handful of case studies in the 60s, 70s, and 80s that demonstrated generally discouraging results in attempts to enhance face recognition in acquired prosopagnosics (individuals with prosopagnosia due to acquired brain injury). These current beliefs could be also be rooted in the notion that the brain, and specifically the face processing system, only has a limited ability to change after it has been damaged. This 'limited change' view may be particularly applied to faces because face processing is sophisticated, automatic, and relies on specific brain regions (e.g., fusiform face area). Furthermore, evidence suggests that face processing has a sensitive period early in life – a time during which the visual system goes through relatively dramatic changes in response to seeing faces – after which changes are smaller or qualitatively different.

It has therefore largely been assumed that, after brain injury, it is not possible for adults to re-learn this sophisticated, automatic ability. Considering this, the main rehabilitation strategy for acquired prosopagnosia in the clinic (if any rehabilitation strategy is used at all!) has been to have prosopagnosics learn to better use compensatory strategies such as paying more attention to hair, voice, posture/gait, and context as alternative means to…

The Classics

In this section, we summarize a classic paper in face recognition research. If you would like access to the original article, or want to know more about follow-up studies, please e-mail lab member Dr. Lucia Garrido at garridolucia@gmail.com.

Tsao, Freiwald, Tootell, & Livingstone (2006). A cortical region consisting entirely of face-selective cells. *Science, 311*, 670-674.

This study showed that monkeys have brain regions that respond much more strongly to faces than to other visual stimuli, and that most neurons within these regions respond almost solely to faces.

The researchers first scanned monkeys using functional magnetic resonance imaging (fMRI). While in the scanner, monkeys were shown faces and other visual stimuli, such as bodies, fruits, hands, and gadgets. They observed that some brain regions in the temporal lobes showed much stronger responses to faces, when compared to the other stimuli. This had already been shown repeatedly in humans, as we also have brain regions that consistently respond much more strongly to faces than to other visual stimuli.

Tsao and colleagues, however, further explored these regions by recording the activity from single neurons within one of the face-selective regions (called middle face patch). They used electrodes to…
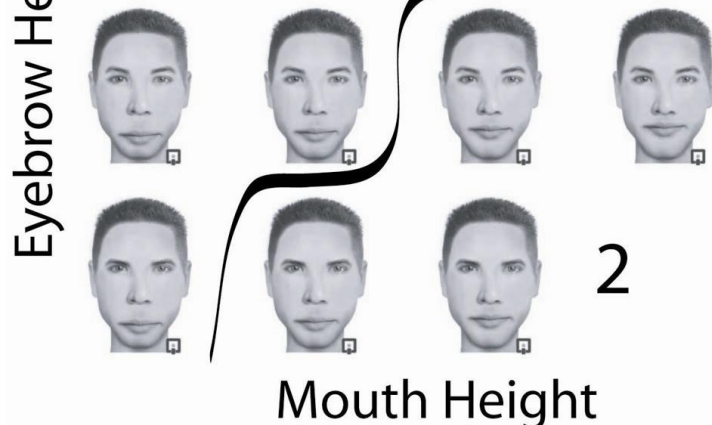
Working Toward Treatments…, continued from pg 1.

…recognize a person.   Though useful, these compensatory cues are typically not very reliable.

With the first report of developmental prosopagnosia (lifelong prosopagnosia due to a genetic cause or problems in brain development) in 1976 by McConachie and intense study of this larger group of prosopagnosics since the late 90s by a number of labs, a different picture of the treatment of prosopagnosia has begun to emerge.   On one hand, developmental prosopagnosics have shown equally severe face processing deficits as those with prosopagnosia from brain injury.   At the same time, many developmental prosopagnosics (even those with more severe symptoms) have shown some neural signatures of face processing found in individuals without prosopagnosia, such as the presence of face selective activity in the fusiform face area, a key brain area engaged when non-prosopagnosic individuals process faces. Furthermore, a recent study by Eimer and colleagues (2012) found that on occasion when developmental prosopagnosics successfully recognize a face, their sequence of brain activity looks very similar to non-prosopagnosic individuals recognizing a face.   Together, this suggests that despite severe face recognition deficits, developmental prosopagnosics may have a somewhat intact brain infrastructure for face processing.   This stands in contrast to acquired prosopagnosics, who typically have damage to key face processing brain regions. This more intact face infrastructure in developmental prosopagnosics may allow greater potential for improvement in face processing abilities.

Consistent with this idea, in the last eight years there have been several studies that collectively provide 'proof of principle'[1] that improving face processing in developmental prosopagnosia is possible. Brunsdon and colleagues (2006) published the first positive attempt to improve face processing in an eight-year-old developmental prosopagnosic (AL) using 'feature naming' training. In particular, AL was taught to perceive, discuss, and remember five distinctive facial characteristics of 17 faces of people he knew. The first two characteristics were always age and gender (which AL could likely recognize) and the other three characteristics were distinctive facial features such as "long thin face", "wide nostrils", "high curved eyebrows", "wrinkles around the eyes", and "freckles". After 14 practice sessions over one month, AL showed improved recognition of not only the originally trained face images, but also to images of the same
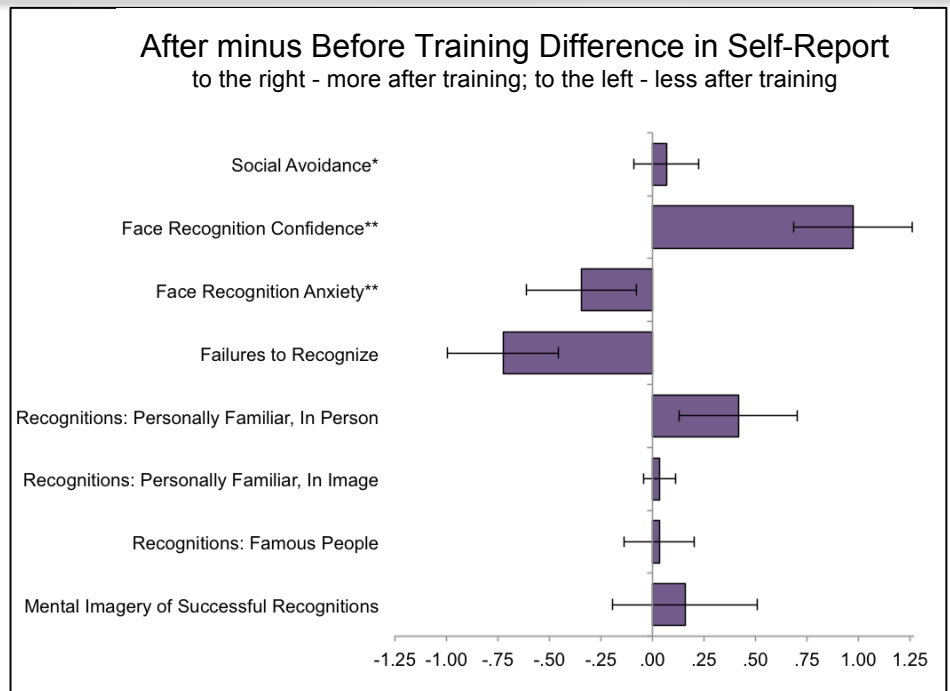

Participants in our study were trained to categorize faces into two groups, based on the distance between the eyes and eyebrows, and between the mouth and nose.

faces from different angles with and without hair, as well as anecdotal real-life improvements of recognizing these faces. Using the same training approach with a four-year-old developmental prosopagnosic, Schmalzl and colleagues (2008) showed similar positive results.

A recent study from our laboratory provides evidence that face processing can be enhanced in a group of developmental prosopagnosics by using cognitive training targeting holistic face processing (DeGutis et al., In Press). Holistic face processing refers to the simultaneous processing of facial features and spacing amongst features into a coherent representation, and is dysfunctional in prosopagnosia. In our study, we had 24 developmental prosopagnosics perform 10 hours of cognitive training targeting holistic face processing (see figure on left). After training, participants demonstrated overall enhanced face perception on behavioral assessments and some

preliminary evidence of subjective improvements (see figure on right). Furthermore, those who particularly excelled at the training task showed the strongest improvements on measures of face perception and enhanced holistic face processing.

Finally, a recent study by Bate and colleagues (2014) suggests that intranasal oxytocin can also improve face processing in developmental prosopagnosics. Oxytocin is a hormone that is involved in pair bonding, trust, and other aspects of social cognition and has been shown to increase attention to the eye region of faces. This is particularly relevant to developmental prosopagnosics because the eye region is very important for face recognition and prosopagnosics have demonstrated specific impairments in processing the eye region of the face. Bate and colleagues had 10 developmental prosopagnosics perform face memory and perception tasks 45 minutes after either inhaling intranasal oxytocin or a placebo. Results showed that face perception and recognition were significantly enhanced when comparing post-oxytocin inhalation to post-placebo inhalation.

After minus Before Training Difference in Self-Report
to the right - more after training; to the left - less after training

*A figure from our lab's paper: Pre/post difference scores for quantitative items in the self-report diary. Error bars indicate the standard error of the mean of the difference scores. *Social Avoidance was measured on the following scale: N/A, Not At All, Somewhat, Yes, Very Much. **Confidence and Anxiety were rated on a scale from 1 to 10. All other measures listed were open-ended numerical responses.*

This collection of 'proof of principle' studies provides substantial hope for advancing treatments for developmental prosopagnosia, and may eventually lead to improvements for those who experience acquired prosopagnosia as well. However, these studies represent only the initial steps in this process and there remains much to be done before one can conclude that developmental prosopagnosia is, in fact, treatable. First and foremost, there needs to be objective evidence of whether treatments produce real-world improvements in face recognition. Following treatment, do prosopagnosics have less face recognition difficulty? Can they recognize characters on TV better? These aspects of face recognition are quite challenging to measure and may require implementing new technology (e.g., wearable cameras) but moving forward, should be considered the gold standard of treatment success. Another important question is how long the effects of treatments last. Temporary improvements may be interesting from a theoretical perspective, but are impractical. Additionally, it will be important to know if there are certain sub-types of prosopagnosics that respond better to certain treatments. Until we address these issues, it is difficult to claim that developmental prosopagnosia is treatable. ∇

Bate, S., Cook, S. J., Duchaine, B., Tree, J. J., Burns, E. J., & Hodgson, T. L. (2014). Intranasal inhalation of oxytocin improves face processing in developmental prosopagnosia. Cortex, 50, 55-63.

Brunsdon, R., Coltheart, M., Nickels, L., & Joy, P. (2006). Developmental prosopagnosia: A case analysis and treatment study. Cognitive neuropsychology, 23(6), 822-840.

DeGutis, J., Cohan, S., & Nakayama, K. (In Press). Holistic face training enhances face processing in developmental prosopagnosia. Brain.

Eimer, M., Gosling, A., & Duchaine, B. (2012). Electrophysiological markers of covert face recognition in developmental prosopagnosia. Brain, 135(2), 542-554.

Schmalzl, L., Palermo, R., Green, M., Brunsdon, R., & Coltheart, M. (2008). Training of familiar face recognition and visual scan paths for faces in a child with congenital prosopagnosia. Cognitive Neuropsychology, 25(5), 704-729.

The Classics, continued from pg 1.

…record neural activity. The authors again showed faces and other visual stimuli, and they found that most neurons within the middle face patch fired in response to faces but did not fire when other stimuli were presented.

This study showed that the monkey brain has some regions that are almost entirely dedicated to processing faces. The existence of such face-selective regions provides an explanation for cases of prosopagnosia in which face processing is impaired while other types of visual recognition (object recognition, scene recognition) are normal. Recent research in monkeys has explored how different face-selective regions contribute to face recognition. For example, some of these regions might be crucial for detecting a face in the environment, other regions might be important for expression recognition, and others might be critical for recognizing individual faces. ∇
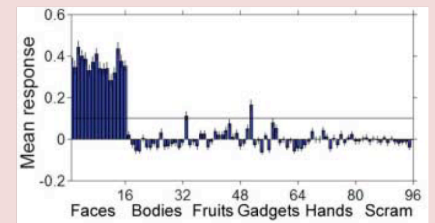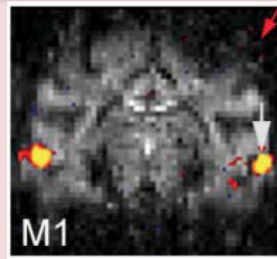
The figure on the left shows an fMRI image of monkey M1's brain. The yellow blobs show regions of the brain that responded much higher to faces than to other visual stimuli, while the monkey was in the fMRI scanner. The figure on the right shows average responses of neurons that are face selective (that is, neurons within the yellow blobs from the figure on the left). You can see that most cells respond almost exclusively to faces.

Researcher Spotlight

Hua Yang

Hua is originally from China and did her undergraduate work at Peking University. She is now a fourth-year Ph.D. student working with Dr. Brad Duchaine. Her work focuses on the neural substrates of face recognition and prosopagnosia using fMRI. She spends most of her free time doing volunteer work to make a better world, and hopes to help people through her lab research as well.

Jiahui Guo

Jiahui received her B.S. from Beijing Normal University in China and is currently a first year graduate student with Dr. Brad Duchaine, working on her Ph.D. in the Department of Psychological and Brain Sciences at Dartmouth College. She is curious about the cognitive and neural mechanisms behind face perception, and is interested in researching this through the help of those with prosopagnosia, identifying how they differ from those without prosopagnosia. She loves reading books in her free time, and also really enjoys collecting toys of her favorite cartoon characters.

Tirta Susilo

Tirta is a postdoctoral researcher in the Social Perception Laboratory at Dartmouth College. He holds a Ph.D. in cognitive psychology from the Australian National University. Tirta is interested in understanding how human face processing works, and how face perception predicts real-world outcomes in politics, business, and sports. In recent years Tirta has spearheaded several projects aimed to better characterize face process deficits in prosopagnosia, during which he traveled around North America to work with some of you. Tirta hails from Indonesia, which he believes objectively has the best collection of food the world over.