Temporal Dynamics of Learning Center

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Research Highlights

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Toward Better Recognition of Expressions by Children with Autism

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TDLC researchers are collaborating on an exciting new project intended to enhance the facial expression production abilities of children with autism. The new project integrates the computer-based intervention known as Let’s Face It! (LFI!) with UCSD’s Computer Expression Recognition Toolbox (CERT). LFI! is a training program designed to improve the face processing skills of children with autism. CERT is a software package that performs real-time expression detection via web-cam input.

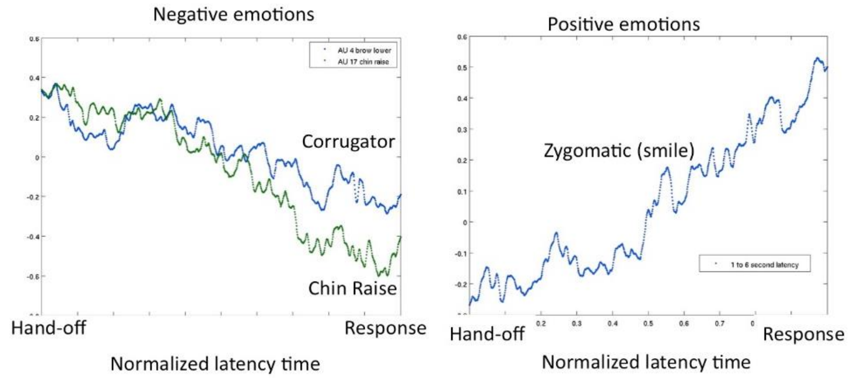
Integration of LFI! and CERT allows the child to receive immediate feedback on their facial expression production. This technology has recently been implemented in an interactive exercise called "Smile Maze," in which users are required to produce and hold the target expression for varying lengths of time in order to navigate past obstacles located in a maze. Another new game, “Face-Face-Revolution,” is modeled after the popular game Dance-Dance-Revolution. In this instance, the child is visually cued to produce the facial expressions of happy, angry, sad, and disgusted. It is believed that the motor production system may play a crucial role in the perception of visually-presented facial expressions, and the exercises developed by these TDLC researchers engage the production system. Thus, it is hoped that they may aid children with autism in learning the nonverbal behaviors that are essential for social functioning.

Tanaka, J., Bartlett, M., Movellan, j., Littlewort, G., and Lee-Cultura, S. (2010). Face-Face-Revolution: A game in real-time facial expression recognition. Demo, *Vision Sciences Society Conference*, Naples, FL, May.

Cockburn, J., Bartlett, M., Tanaka, J., Movellan, J., Pierce, M., and Schultz, R. (2008). SmileMaze: A tutoring system in real-time facial expression perception and production for children with autism spectrum disorder. *Intl Conference on Automatic Face and Gesture Recognition, Workshop on Facial and Bodily expressions for Control and Adaptation of Games.*

On the Way: Automatic Problem Solving Expression Recognition

Gwen Littlewort, Linda Phan, Judy Reilly, and Marian Bartlett, UC San Diego and SDSU



There has been growing recognition of the importance of adaptive tutoring systems that respond to a student's emotional and cognitive state. However, little is known about children's facial expressions during a problem solving task. What are the actual signals of boredom, interest, confusion, or uncertainty in real, spontaneous behavior of students? The field also is in need of spontaneous datasets to drive automated recognition of these states.

TDLC researchers have measured behavior and collected a dataset of 50 children ages 3-9 during a set of problem solving tasks. Figure 1 shows a set of facial movements automatically measured using the computer expression recognition toolbox (CERT). Shown is a time-warped average over 50 videos of 9 children in a haptic problem solving task. As the children solved the problem, chin raise and corrugator (brow lower) movements decreased, while zygomatic (smile) increased. Individual facial responses were ballistic rather than linear. This research builds the foundation for automated tutoring systems that sense the state of the student and adapt accordingly.

Littlewort, Phan, Reilly and Bartlett (in prep). Automated measurement of children's facial expressions in problem solving.

Recognizing Images Using Fixations

Garrison Cottrell, Christopher Kanan, UCSD

Humans acquire visual information serially using eye movements. High-resolution information is acquired in the foveal region of the retina, and lower-resolution information is provided in the retinal periphery. This requires that we look at relevant or interesting regions of a scene. This is in stark contrast to the predominant approach in computer vision, which processes images in their entirety. Christopher Kanan and Garrison Cottrell, scientists in the UCSD Department of Computer Science and Engineering, recently published a model in the *IEEE Conference on Computer Vision and Pattern Recognition* (*CVPR*) that acquires information serially in a manner similar to people.

The model, called NIMBLE, learns features from natural images, which exhibit properties that are qualitatively similar to neurons found in early visual cortex. NIMBLE then uses simulated eye movements to acquire information. As information is acquired over time, the system becomes more confident of what it is looking at. NIMBLE looks at features that are statistically rare in the world, as they are more likely to be useful for discriminating among categories. Kanan and Cottrell found that their relatively simple approach performs as well as, or even better than, state-of-the-art methods in computer vision in object, face, and flower recognition tasks.

Kanan, Christopher M. & Cottrell, Garrison W. (2010). Robust classification of objects, faces, and flowers using natural image statistics. In *Proceedings of the Computer Vision and Pattern Recognition Conference (CVPR-2010)*.

NIMBLE acquires information serially using simulated fixations. **Left**: After acquiring a single fixation, shown as the green box, NIMBLE is somewhat confident about the correct category. **Right**: After acquiring 10 fixations, NIMBLE is very confident of who the person is.

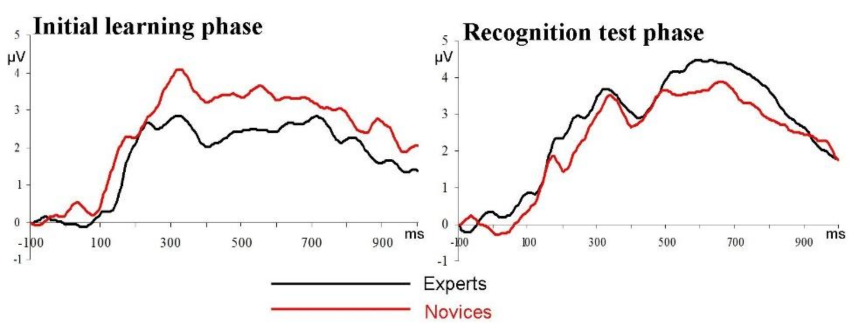
Ah, to be an Expert

Tim Curran, University of Colorado

It is generally accepted that being an expert improves our perceptual processes and also changes how quickly and successfully we learn and remember objects associated with our expertise. However, until now no systematic study had been performed to investigate just how perceptual expertise facilitates memory. Now PI Tim Curran and Post-doctoral Fellow Grit Herzmann have completed just such an investigation into these learning and memory processes. Using event-related potential (ERP) components that directly tapped into the brain activation that is associated with learning and remembering visual objects, they measured the behavioral performance and ERPs of car experts and car novices while they both learned and recognized pictures of cars.

The study revealed that expertise led to more accurate memory performance for cars and also facilitated the retrieval of information associated with the newly-learned cars. Experts learned new cars and subsequently-remembered cars with less effort than novices, as indexed by lower brain activation. Experts were also more successful at recognizing learned cars during recognition testing accompanied by retrieval of episodic and semantic details, as indicated by a stronger parietal old/new effect taken as a marker of memory retrieval.

Also using a subordinate matching task developed in Isabel Gauthier's lab at Vanderbilt, the researchers determined the relationship between memory processes and subordinate level recognition. Superior abilities for learning and for recognizing objects of expertise were positively related to better subordinate recognition performance. These results show that perceptual expertise sharpens the ability to discriminate between objects of expertise. This occurs not only on the perceptual level, as seen in the better subordinate matching, but also in memory, where representations are more detailed, distinct, and easier to retrieve. Thus this work advances knowledge within the fields of perceptual expertise, recognition memory, and learning processes. The study has given rise to a collaboration between the Curran lab and that of Virginia de Sa at UC San Diego, an expert in applying machine learning to Brain-Computer Interfaces. This collaboration will investigate "readiness-to-learn" as measured by brain waves.



Event-related potentials showing lower brain activation for experts (black) than novices (red) during the initial learning phase (left) and higher brain activation for experts than for novices during the recognition test phase (right).