Unlocking Potential—One Child at a Time

Center for Neurodevelopmental and Imaging Research at Kennedy Krieger Institute

Research Update – 2019

Dear Families,

Thank you for participating in our research at the Center for Neurodevelopment and Imaging Research (CNIR)! Without dedicated families like you, we would not be able to conduct our research. We greatly appreciate all your efforts and hope you and your child enjoyed your participation.

We hope this year has been a good one for you. We have had a very productive year here at CNIR and are excited to send out this newsletter so we can update you on our progress.

CNIR is dedicated to better understanding the behaviors and brain circuits involved in neurodevelopmental disorders like attention deficit hyperactivity disorder (ADHD), autism and Tourette syndrome. Currently, we are working on several funded research projects, described in this newsletter, that address these disorders, with the goal of gaining a better understanding of the mechanisms that contribute to these disorders at a neurobiological level. The goal of our research is to improve identification and diagnosis of neurodevelopmental disorders and to develop novel therapies and effective interventions for children and adolescents with these disorders. For example, based on our research, we have developed a novel therapy for children with ADHD utilizing the age-old practice of tai chi.

We hope you find the results of our research presented in this newsletter as exciting as we do. We currently have five studies recruiting at CNIR and are always looking for new participants, so please feel free to share this newsletter with your family and friends.

Thank you again for your participation, and enjoy the newsletter!

Sincerely,
Stewart Mostofsky, MD
Director of the Center for Neurodevelopmental and Imaging Research

INSIDE THIS ISSUE:

PARTICIPATE IN RESEARCH

We are actively recruiting for ongoing studies. Email us at **CNIR@KennedyKrieger.org** or visit our website at **KennedyKrieger.org/CNIR** for more information.

Thank you for your participation!

Kennedy Krieger Institute
UNLOCKING POTENTIAL

What's New in Our Autism Research?

Imitation in Children With Autism

Many skills are learned by watching others and imitating their behavior. Children with autism tend to have difficulties with imitation, and some researchers believe these challenges with imitation could affect how children with autism learn social and physical skills.

One aspect of imitation that we are investigating is the difference between imitating movements performed one at a time and imitating multiple movements performed at the same time. Many sports-related movements, such as dribbling a basketball down a court, involve performing different motor movements at the same time. Teachers and therapists usually break a complex skill into separate pieces. Dribbling the basketball is taught first, with the child standing still. Once the child has mastered dribbling in place, the child can learn to perform the skill while also moving. By studying how children imitate movements shown one at a time and movements shown all at the same time, we hope to get a better understanding of the difficulties that children with autism have with imitating movements. This understanding may lead to better ways of teaching and providing therapy to children with autism.

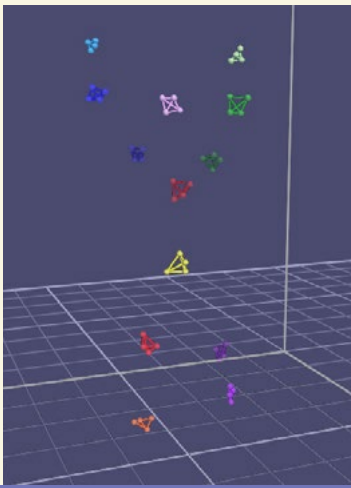
A second aspect of imitation that we are investigating is whether these difficulties are related to an inability to perform the movement or to a problem understanding what is seen. Handwriting is an example of how these aspects of imitation impact daily performance. Children may have difficulties with handwriting because they hold the pencil too tightly, are not able to hold the pencil correctly, or are not able to keep their writing on the line. These issues are related to their motor skills. Other issues may include reversing letters and having difficulty copying either from the board or from other written material. These are related to difficulties understanding what they see. Gaining a better understanding of these issues may lead to better instruction or therapy and a better use of technology to assist children with autism.

Learning Motor Skills by Dancing

If you had to operate a complex machine for the very first time in your life, how would you go about doing it? Chances are, you would first observe someone else do it, and then imitate what they have done. Throughout one's life, beginning at an early age, imitation is crucial for learning both motor movements and social skills.

We know from previous studies in our lab that children with autism spectrum conditions (ASC) have particular difficulties in what is called visual-motor integration—difficulty in making connections between others' observed movements (visual) and the children's own movements (motor). We think that part of the problem might have to do with the speed of processing. Perhaps, imitation performance would improve if the children could view others' movements and imitate them more slowly. To test this idea, we developed a training that requires the children to imitate an on-screen avatar's dance-like movements at various slow-motion speeds. We also take measurements before and after the training to examine any improvement in the children's imitation performance.

As you can see in the pictures, we use two special camera systems—X-Box Kinect and Vicon (used in movies like "Doctor Strange" and "Ted")—to track the children's movements. These systems not only help us more precisely understand the nature of imitation impairments, but also make the dance-imitation game more engaging for the children. To date, we have designed the dance sequences used in the training and started collecting data. In collaboration with experts in computer vision, we are working on developing a metric to assess the children's imitation performance using the data we gather from our special camera systems. We hope the findings of this study will inspire future behavioral interventions that help improve motor imitation and social skill learning in children with ASC.



Coordinated Movements and Social Skills in Autism

Imagine going for a walk with a friend. It is quite possible that, over time, you'll start walking in step with each other. Coordinating the timing of our movements with others comes naturally to most of us and is a very important part of our social interactions. Previous studies show that when two people move at the same time, they suddenly feel closer and want to help each other more.

In this study, we are asking two questions: Does coordinating the timing of movements come naturally to children with autism spectrum conditions (ASC) as well? And if so, is it related to the social-communicative issues that children with ASC experience?

To answer these questions, we designed a video game featuring a monkey character collecting some food by repeatedly making a specific arm movement (see the picture). We ask the children to also collect food for the monkey by doing the same arm movements. We track the children's movements using XBox Kinect camera technology (a special depth camera).

Using this depth information, we calculate how closely the children matched the timing of their movements to that of the monkey's.

The initial results show that children with ASC coordinate far less than their typically-developing peers. Moreover, it seems like better coordinators are more likely to have better social-communicative skills, as measured by standardized tests such as the Autism Diagnostic Observation Scale (ADOS-2). These findings offer promising avenues for designing behavioral assessment and intervention techniques that can be presented to the children in the form of a short, fun game and applied inexpensively in family homes.

Inferior Parietal Lobe in Autism

Sometimes we describe a really busy airport as a hub: Many planes arrive from seemingly everywhere, depart to seemingly everywhere, and of course, are the source of many travel delays! Our brains also have areas that are similar to hubs, in that they connect a diverse assortment of signals throughout the brain. Brain connectivity is essential for the things we do every day. In our lab, we can measure brain connectivity by taking hundreds of pictures of the brain using magnetic resonance imaging (MRI). We are interested in how connectivity of the brain hub contributes to motor skill memory in children, with a particular focus on children with autism.

Learning and executing everyday actions like tying our shoes or controlling our handwriting can be challenging for children with autism. Currently, we are testing how the connectivity of a brain area known as the inferior parietal lobe, or IPL for short, contributes to these everyday motor skills. The IPL is a hub in the truest sense: It receives crucial sensory information from our eyes, bodies and environment, and sends this information to other parts of our brain that use this sensory information to develop plans for moving. And given that the IPL is a hub, it is functionally relevant for many aspects of human behavior, including cognition, social skills and communication.

Previous research suggests that the IPL is important in how we plan movements to accomplish action goals, including how we handle tools and other objects that are part of the motor behavior. For example, it is involved in how we use our hands and fingers to make cutting movements with a pair of scissors. Stroke patients with damage to their IPL often have difficulty demonstrating their memory for motor skills when tested using pantomime gesture, or miming of action, which is typically done using their hands and fingers. Using this information, our lab has developed a movement-planning exam that asks children to gesture to represent familiar movements such as using a chalkboard eraser or waving goodbye to a friend. Just how the IPL is connected to other parts of the brain may be related to how children with autism perform on these skilled movements.

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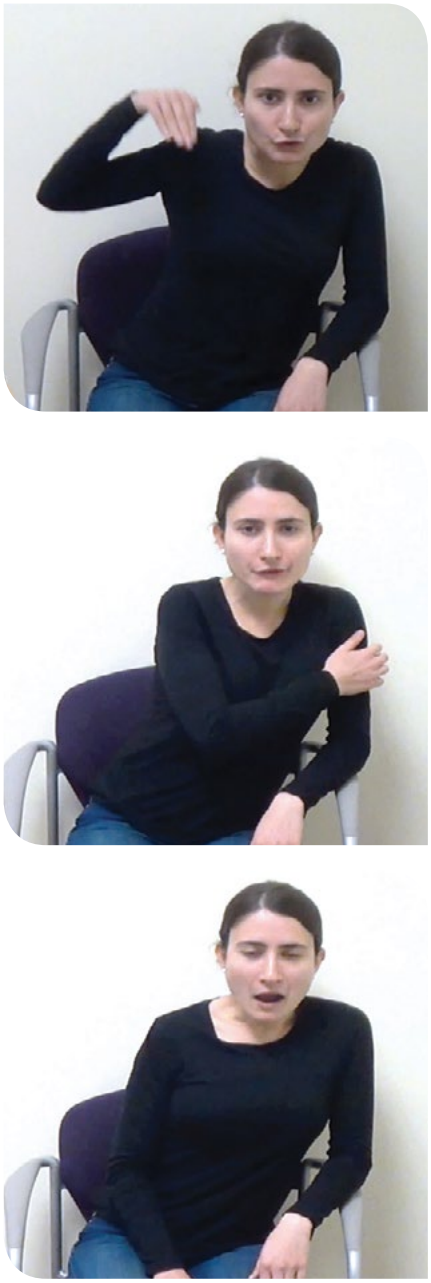
Currently, we have measured IPL connectivity in more than 100 children scanned with MRI. We found that connectivity to the rest of the brain was similar for both the right and left hemispheres of the IPL. Interestingly, one particular zone of both the right and left hemispheres of the IPL was related to how children performed gestures. Gesture accuracy was related to greater connectivity with areas related to vision and body sensation, along with other areas related to the outflow of motor commands. Moreover, for a subset of areas, connectivity was specifically relevant to gesture ability in children with autism. Because the IPL is a hub that cares about many aspects of human behavior, in the near future, we will try to understand if IPL motor skills connectivity is related to other behavior features of children with autism, including social and communicative function.

Does Mirroring Others Improve Social Interactions for Those With Autism?

Have you ever noticed a roomful of people starting to yawn contagiously, one after the other? How about feeling the urge to itch yourself when you see someone else scratching an itch? Most of us have the tendency to spontaneously mimic other people's actions. It is possible that this helps us understand other people's emotions and thoughts, and therefore facilitates communication and social interactions.

We know that a primary characteristic of autism spectrum conditions (ASC) is nontypical social engagement, including decreased responsiveness to conversation partners. We think that a decreased tendency to mimic other people's actions might partly explain the social and communicative difficulties that children with ASC are facing. To explore this further, we are currently conducting a task investigating how children with and without ASC differ in their tendency to mimic the hand gestures and body movements of a social partner.

In this task, children watch a video of a narrator who tells them an engaging 10-minute story. As the narrator tells the story, she does certain things—like yawning, scratching her arm and gesturing—to emphasize parts of the story. (See the images for examples.) The children are asked to repeat the story as best as they can remember. We are interested in seeing how much of these actions the children mimic—for example, whether they also yawn contagiously, scratch themselves or gesture to express the story. So far, we are halfway through data collection. An initial look into the data shows that children with ASC might, indeed, mimic others less than their typically-developing peers. However, we need to collect more data before we can make strong conclusions. These findings could broaden our understanding of social engagement in ASC and typically-developing children, and help us develop new behavioral therapies that focus on improving these aspects of communication.



Top to bottom: The narrator explains "zooming under the bed" with her hand gesture, scratches her arm and yawns.

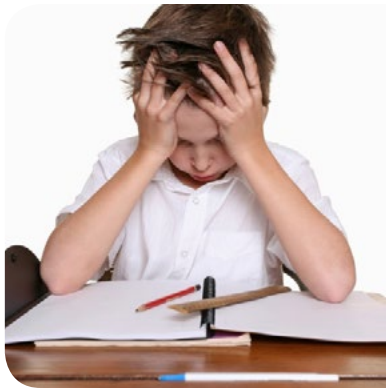
What's New in Our ADHD Research?

Frustration Tolerance in Children With ADHD

Frustration is a normal and developmentally appropriate part of life for children and adolescents (and even for adults, too!). Frustration refers to an emotional response to blocked goal attainment (i.e., having something get in the way of one's goal). However, some children become frustrated more often and more severely than others, leading to disruptive irritability, which can become problematic.

At CNIR, Dr. Karen Seymour and her team are examining the behaviors, brain structures and functions associated with irritability and poor frustration tolerance in children with ADHD compared to typically-developing children. Dr. Seymour's prior work has shown that, compared to typically-developing controls, children with ADHD have poorer frustration tolerance (i.e., they're more likely to quit a frustrating task), and that difficulties with emotion regulation contribute to the later development of depressive symptoms in children with ADHD.

Preliminary data from Dr. Seymour's current study has examined brain structures associated with behavioral measures of poor frustration tolerance in children with ADHD. Results have shown that in children with ADHD, quitting the frustrating task was associated with smaller subcortical regions in the brain, including the putamen and hippocampus. In contrast, in typically-developing children, quitting the task was associated with smaller volumes in cortical regions including the medial prefrontal cortex and right dorsolateral prefrontal cortex.



These results suggest that in children with ADHD, subcortical structures involved in emotional processing may be more related to poor frustration tolerance than in typically-developing children, while in typically-developing children, cortical regions involved in attention and inhibiting and regulating responses may be more important in frustration tolerance than in children with ADHD. These preliminary results have important implications for treatment because currently, the only evidence-based treatments for ADHD focus on behavioral or medication management of the core symptoms of inattention, hyperactivity and impulsivity. But our results support the need for training in core emotion regulation skills as well as instruction in emotion identification and self-regulation techniques to target emotional processing deficits in children with ADHD.

Adolescent Outcomes for Girls and Boys With ADHD

We are currently undertaking our lab's first longitudinal study, "Adolescent Changes in Brain and Behavior in Boys and Girls with ADHD." We all know children go through lots of changes as they enter adolescence, but how does this look for kids diagnosed with ADHD? Many difficulties, such as impaired social relations and academic difficulties, may emerge and worsen during adolescence; therefore, we believe it is so important to understand ADHD-associated changes in brain and behavior during this sensitive period. We are also interested in how there may be differences between girls and boys. Our previous research has shown a pattern of sex-based differences in school-age children with ADHD—both in brain structure and in their patterns of response control. These differences may prove to be important in outcomes for girls vs. boys with ADHD as they enter adolescence.

So far, some preliminary results have found that, among individuals with ADHD, problems with emotional control in childhood can predict adolescent co-occurring internalizing problems (anxiety) in girls and externalizing problems (ODD) in both girls and boys. We hope to continue collecting this longitudinal data over the next couple of years, and to be able to analyze data from three different time points!

Mindful Movement in ADHD

It's no secret that mindfulness and embodied practices such as yoga and tai chi have enjoyed a steady stream of successes, both in research and in popular media. Many of these embodied practices cultivate sustained attention and the inhibition of distractions and task-irrelevant behaviors—factors that are definitional to the diagnosis of attention deficit hyperactivity disorder (ADHD). We are continuing a trial of eight weeks of tai chi classes for children with ADHD, and the response from parents and kids alike has been very positive. Preliminary data analysis has also shown positive trends in behavioral changes. Because of these promising results, we decided to offer a continuous, year-round trial of tai chi and mindful-movement training for children with ADHD. Mindful-movement training consists of embodied practices such as physical body and emotional body scans, yoga, walking and seated meditations, as well as tai chi. These embodied practices allow children the space to check in with themselves emotionally and physically, so that they may become more self-aware. We work to balance individual discovery with arts-integrative activities that engender a sense of teamwork. Going beyond parent and child reports, we are working to identify neural, physiologic and behavioral changes that will help us understand the underlying mechanisms supporting the benefits of mindfulness and embodied practices.

Sensory in Sensitivity in Tourette Syndrome

We have started collecting data in our Tourette syndrome (TS) study! It has long been recognized that people with TS often report that a sensory "urge," such as an itchy throat, contributes to the need to complete a tic, such as throat clearing. This generally provides temporary relief. These children also may often experience more generalized difficulty ignoring faint, repetitive tactile stimuli. An example of this may be a child being bothered by a tag in his or her shirt. The goals of this study are to evaluate and compare tactile sensitivity in children with Tourette syndrome and in typically-developing children, and determine whether impaired tactile adaptation is associated with urge severity and tic severity. We are in the early stages of data collection for this study, so stay tuned for updates!

At the Center for Neurodevelopmental and Imaging Research, we'd like to thank our families and research participants for assisting us with our studies.

Email us at **CNIR@KennedyKrieger.org** or visit **KennedyKrieger.org/CNIR** for more information.

This research is funded in part by support from donors and friends of CNIR. If you'd like to learn more, please contact Jen Doyle in the Office of Philanthropy at **DoyleJ@KennedyKrieger.org** or **443-923-4324**.