

# the COGNITIVE ANALYSIS & BRAIN IMAGING LABORATORY

## KEY OUTCOMES TO DATE

- Better understanding of the neural structures and connective patterns that underlie cognitive functions
- State-of-the-art images of differences in brain structure
- Enhanced knowledge of why children with neurodevelopmental disorders tend to have difficulties with numerical and visuospatial thinking
- Evidence of possible common neurocognitive bases for those difficulties in several populations of children with different genetic disorders
- Emerging pictures of the relationship of cognitive impairments to behavioral and psychiatric disorders
- Progress toward the identification of new interventions that reduce or eliminate challenges for children with genetically based disorders

### A research lab with a new approach

**T**he Cognitive Analysis and Brain Imaging Laboratory at the UC Davis M.I.N.D. Institute investigates genetically based neurodevelopmental disorders. The lab is distinct in that it adopts a cognitive neuroscience approach to such disorders by combining the analytical methods of cognitive psychology with current brain imaging techniques to arrive at more complete explanations of the cognitive impairments manifested by children with chromosome 22q11.2 deletion syndrome, fragile x syndrome and similar conditions. The lab's goal is to use that explanatory knowledge to design multimodal interventions that reduce, or even eradicate, those impairments.

### The assessments

Children who visit the lab for research studies participate in two main types of assessments. One is cognitive analysis, involving computer games that test the functioning of specific brain circuits under different conditions and predict characteristic patterns of performance. (See examples of the analytical tests at [cabil.mindinstitute.org](http://cabil.mindinstitute.org).)

The other assessment involves safe, radiation-free and state-of-the-art neuroimaging methods—functional magnetic resonance imaging, voxel based morphometrics and diffusion tensor fiber tracking—to characterize changes in the brain's neural structure, connectivity and function. In collaboration with other labs, genetic analyses are also conducted to more fully explain the biological basis of the atypical patterns of brain and cognitive development.

### Led by a specialist in cognitive neuroscience

*Tony J. Simon* is an associate professor of psychiatry and behavioral sciences. His research focuses on the neural basis of cognitive impairments that result in mental retardation, developmental disabilities and psychopathology. Building on his influential theory of the visuospatial foundations of numerical competence, Simon investigates how dysfunction in specific neurocognitive processing systems, such as attention and spatial cognition, can generate a range of cognitive and behavioral impairments.

## ABOUT GENETICALLY BASED NEURODEVELOPMENTAL DISORDERS

Research at the Cognitive Analysis and Brain Imaging Laboratory includes children ages 7-to-14 with a genetically based disorder such as:

**Chromosome 22q11.2 deletion syndrome**, also called velocardiofacial syndrome and DiGeorge syndrome, is caused by the deletion of a small segment of the long arm of chromosome 22 and is linked to over 180 physical, psychological and behavioral anomalies. Children with the syndrome experience some degree of developmental delay and learning difficulties. Most of these children have at least some of the following physical conditions: congenital heart defects, cleft palate or velopharyngeal insufficiencies, immune deficiencies or neonatal hypocalcemia. Likewise, most of them are at increased risk for some of the following behavioral and psychological disorders: attention deficit hyperactivity disorder, autism spectrum disorders, oppositional-defiant disorder, obsessive-compulsive disorder and schizophrenia.

**Fragile X syndrome** is the most common cause of inherited cognitive impairment. Its outcomes range from learning disabilities to more severe cognitive or intellectual disabilities. It is the most common known cause of autism. Symptoms also can include characteristic physical and behavioral features, delays in speech and language development and learning difficulties in numerical and mathematical domains.

**Turner syndrome** is a chromosomal condition that describes girls and women with common features that are caused by complete or partial absence of the second sex chromosome. The syndrome occurs when one of the two X chromosomes normally found in females is missing or contains certain structural defects. Almost all people with Turner syndrome have short stature and loss of ovarian function, but the severity of these problems varies considerably amongst individuals. Learning difficulties in spatial, numerical and mathematical domains are common.

**Williams syndrome** is characterized by mild to moderate mental retardation or learning difficulties, a distinctive facial appearance and a unique personality that combines overfriendliness and high levels of empathy with anxiety. The most significant medical problem associated with the syndrome is cardiovascular disease caused by narrowed arteries. By age 30, the majority of individuals with the syndrome have diabetes or pre-diabetes and mild to moderate sensorineural hearing loss. Compared with strengths in verbal expression and auditory memory, individuals with Williams syndrome exhibit considerable weakness with spatial and numerical cognition.

### About the UC Davis M.I.N.D. Institute

The UC Davis M.I.N.D. (Medical Investigation of Neurodevelopmental Disorders) Institute is a unique, collaborative center bringing together parents, scientists, clinicians and educators for research on autism, fragile X syndrome, learning disabilities and other neurodevelopmental disorders.

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