

The Cognitive Basis of Behavior in ASD: Implications for Learning & Intervention

UC Davis, M.I.N.D. Institute

August 2, 2007

Nancy J. Minshew M.D.

Director, Autism Center of Excellence

University of Pittsburgh

412 246-5485; autismrecruiter@upmc.edu

Research Studies

- High functioning individuals 5-55 years with autism or “Asperger disorder” IQ 80-120, speak in sentences, some med exclusions
- Through July 2012; no cost; participant payment; we pay airfare & hotel

INTERVENTION CHECKLIST:

Person Factors

- ✓ General level of function, FS IQ, VIQ, Vineland
- ✓ Language comprehension level, communication
- ✓ Flexibility-rigidity
- ✓ Impulsivity, overactivity
- ✓ Redirectability, motivation
- ✓ Social-emotional age, social tolerance
- ✓ Sensory issues
- ✓ Problem solving: identifies problems, plans, identifies failure, changes strategies, asks for help

INTERVENTION CHECKLIST:

Person Factors Cont'd

- ✓ Temperment
- ✓ Mood lability
- ✓ Aggression
- ✓ Seizures
- ✓ Tolerance of change (flexibility), rituals
- ✓ Obsessions, preoccupations, special interests

INTERVENTION CHECKLIST:

Environment Factors (All)

- ✓ Environmental structure/order/chaos
- ✓ Environmental noise, visuals, smells
- ✓ Autism skills of teachers; attitude of teacher
- ✓ Expectations of child=child abilities?
- ✓ Peer or adult bullying
- ✓ Transitions, lunchroom, playground, hallways, bus
- ✓ Changes in schedule, teachers, rooms, peers, etc

Quick Diagnosis of ASD in Verbal Individuals

- Strange or odd, reflecting social impairment
- Monotone voice, little to no facial expression
- Upset by change, rituals for doing things in set ways; little scripts; evolves into obsessions
- Obsessions w/ focus on facts or collections; memory for detail superb
- Clumsy, awkward

Quick Diagnosis of ASD in LFA

- Intermediate severity: echolalia, few scripted stereotyped sentences; socially isolated; self-stimulatory behavior; no imaginative play; difficulty with change; sensory issues.
- Most severe: essentially mute, no comprehension, no prosody, no adaptive behavior, ask the direct care staff to tell you who has autism vs non-autistic MR.

Common Principles of Neurology

- Brain disorders produce distinctive constellations of cognitive [thinking abilities] & neurologic [brain abilities] deficits, not a single deficit
- Multiple organ involvement is the rule in brain disorders not caused by brain damage- because they are caused by faulty genes and these genes are present in every cell in the body

Neurologic Approach to Deciphering Disease

Neurologists' approach to understanding disease is therefore to examine all impaired AND intact abilities to define the common characteristics that will identify the underlying disease process and its location in the brain.

Disease Processes

- Infectious disease
- Vascular disease
- Tumor or mass
- Toxins (signatures like carbon monoxide)
- Developmental processes

Developmental Processes

- Organogenesis (basic form of the nervous system)
- Neuronal proliferation
- Glial proliferation, migration
- Neuronal migration
- Neuronal organization
- Myelination

Genes and Multi-Organ Involvement

- 2.27 relative risk of autism diagnosis conferred by the CC genotype at MET receptor tyrosine kinase. MET signaling is involved in neocortical and cerebellar development, immune function, and gastrointestinal repair, consistent with the multi-organ symptoms reported in autism
- Need not invoke GI or immune disease as causing brain dysfunction; same gene may cause all.

Campbell et al. PNAS 2006, 45: 16834-16839

Investigating the Cause of Autism

Most research has focused on a single domain as the cause of the syndrome often predicting focal brain deficits. We hypothesized a multiple primary deficit model and a distributed neural network or neocortical neural systems disorder.

Investigating the Cognitive Basis

- What do their cognitive strengths have in common?
- What do their cognitive weaknesses have in common?

Answers to these questions provide insight into their thinking and the circuitry differences in the brain in autism.

Discriminant Function Analysis: Domains Without Deficits³

Domain	Tests Passing Tolerance	Percent Correct	Kappa ¹
Attention	Letter Cancellation; Number Cancellation	66.70	0.33
Sensory Perception	Finger Tip Writing; Luria-Nebraska Sharp/Dull Tactile Scale item	64.40	0.29
Simple Language	K-TEA Reading; K-TEA Spelling WRMT-R Attack; Controlled Oral Word Association	71.20	0.42 ²
Simple Memory	CVLT Trial 1	65.20	0.30
Visuo-Spatial	WAIS-R Block Design	56.10	0.12

¹Kappa below .40 indicates poor agreement beyond chance

²Significant *Kappa* reflects superior performance by autistic subjects

³ Based on 33 individually age, IQ, gender matched pairs of subjects

Discriminant Function Analysis¹: Domains With Deficits

Domain	Tests Passing Tolerance	Percent Correct	Kappa
Motor	Grooved Pegboard; Trail Making A	75.80	0.52
Complex Language	K-TEA Reading Comprehension; Verbal Absurdities; Token Test	72.70	0.45
Complex Memory	Nonverbal Selective Reminding-Consistent Long Term Retrieval; WMS-R Story Recall-Delayed Recall; Rey-Osterrieth Figure-Delayed Recall	77.30	0.55
Reasoning	20 Questions; Picture Absurdities; Trail Making B	75.8	0.52

¹Based on 33 individually matched pairs of autistic & control subjects (Neuropsychologic Functioning in Autism: Profile of a Complex Information Processing Disorder, *JINS*, 3:303-316, 1997)

Intact or Enhanced Abilities & Deficits

Intact or Enhanced

- Attention
- Elementary Sensory
- Elementary Motor
- Simple Memory
- Formal Language
- Rule-learning
- Visuospatial processing

Cognitive Weaknesses

- Complex Sensory*
- Complex Motor
- Complex Memory
- Complex Language
- Concept-formation
- Face recognition

What Does This Mean About Cognition?

- Information acquisition intact
- Simpler processing & abilities are intact/enhanced
- Selective impairment in complex information processing across domains e.g. tasks that require an increase in the number of cognitive processes or brain regions for task performance

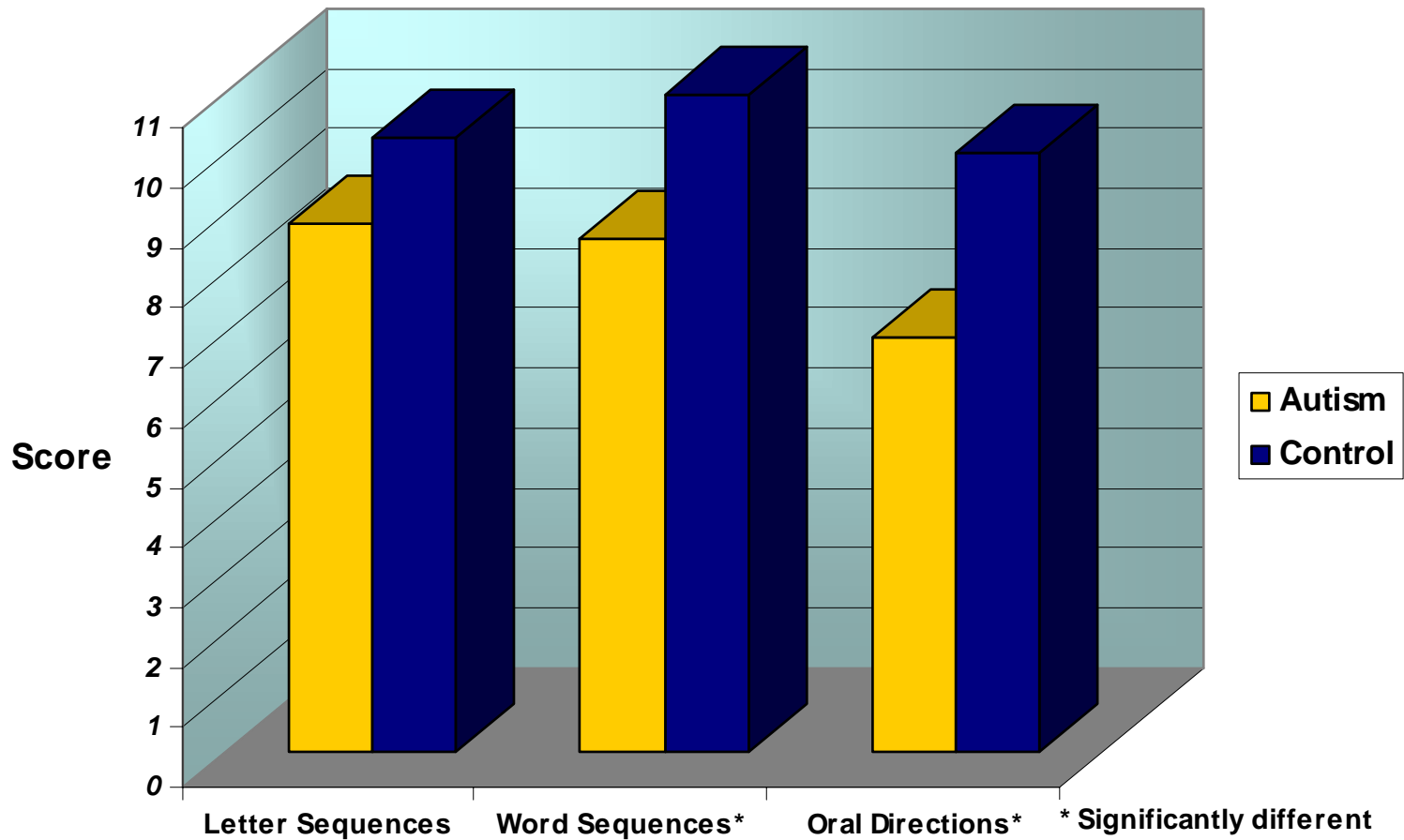
Complex Information Processing Model

- ✓ Not a General Information Processing Disorder or both simple and complex abilities would be impacted
- ✓ Not a Simple Information Processing Disorder or individuals with ASD would have dyslexia, dyscalculia, and visuospatial problems (see SLI)
- ✓ Despite title, this model though emphasizing complex information processing deficits also infers intact or enhanced basic skills.

Behavioral Example of Cognitive Profile in Autism: Details No Concepts

Jim was admitted for possible mania. He was agitated and had been sending money to television evangelists and became preoccupied with sin and being good, which he talked about constantly. The psychiatrists attempted daily to convince him to try lithium but he refused. His reason was that he took lithium on June 4, 1978 and he got a stomach ache. He went to the clinic and a scene ensued. Staff yelled at him. No amount of appeal worked to change his mind, until he was told and SHOWN there were now two forms of lithium - one was pink and one was blue. He took the bad blue before, but this time he would take the good pink. He immediately agreed to the medication. The deterioration in his behavior was the result of losing his job for asking a woman a question about her clothing, which was interpreted as sexual harassment. All structure was gone from his life. Socially-emotionally he was 3.

Detroit Learning Aptitude Test: Processing Demands of Complex Sentences



Dual task performance deficit in autism; (but matched performance in single task conditions)

Garcia-Villamizar & Della Sala, 2002 *Cognitive Neuropsychiatry*

Effect of dual task on memory span and tracking performance

	<i>Digit recall</i>		<i>Tracking performance</i>		<i>Mu score</i>
	<i>single</i>	<i>dual</i>	<i>single</i>	<i>dual</i>	
<i>People with autism</i> (<i>n = 16</i>)					
Mean	86.19	> 48.13	52.75	> 37.81	66.87
SD	7.55	16.77	10.47	8.22	10.74
<i>Controls (n = 16)</i>					
Mean	87.25	= 86.88	54.06	= 55.25	84.75
SD	4.81	7.58	14.61	7.39	11.52

Digit recall is expressed as a percentage of correct sequences.

Abstract Reasoning: Concept Identification & Concept Formation

- 90 verbal individuals with autism >12 yrs
- 107 control volunteers
- Concept identification
 - Attribute identification
 - Rule-learning
- Concept formation
 - Self-initiated strategy
- Cognitive flexibility
- Extent to which these were dissociable skills

Results in Non-Retarded Autistic Individuals

- Concept identification intact:
 - Attribute identification
 - Rule learning
- Inflexible in applying rules in changing contexts
- Concept and strategy formation impaired
- Bottom line: adaptive function in real life poor

Reasoning Guides Behavior Across Spectrum

- Rote training of concepts, first attributes then rules
- Difficulty generalizing outside original learning setting
- Rule-bound and difficulty considering context
- Difficulty in novel situations or any situation requiring spontaneous problem solving or strategy formation
- Do not acquire the concept formation abilities that allow flexible use of or development of new strategies in novel situations. No adaptive function or generalization of learned interventions.

Behavioral Example of Cognitive Profile: Rules Override Concepts

Bill is a young adult with autism who decided to take figure skating lessons. His mother drove to the rink several times a week. After a while, she decided to skate while he had his lesson. Bill performed his routine, but people learned to stay out of his way. He went where his program required him to go regardless of others. One day his mother forgot to note where Bill was and he ran her over, knocking her unconscious. The emergency team was called and she was given first aid and taken to the hospital. The next day she asked Bill why he did not come to her assistance, since he was an Eagle Scout with a first aid badge. He replied “It expired.”

Related Executive Function Impairments: Adaptive Behavior

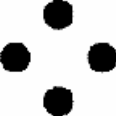
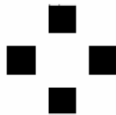
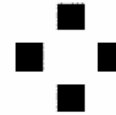
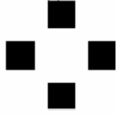





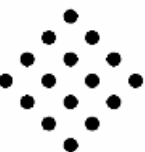
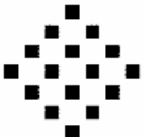
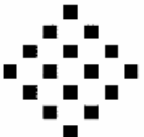



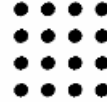


- Can't rely on them to identify problems or ask for help- the first requires concept formation and the latter is a strategy and then requires social contact- people will also get upset at their failure
- Need a review of systems approach & a reporter
- They will need external organizer & prioritization
- May not be able to handle as much as others
- Their approach to assignments may be to read everything- wont know how to reduce task

Visual Perception: Part-Whole Processing

- ✓ Observation support enhanced perception detail
- ✓ Tests like Embedded Figures & unsegmented block design add empiric support but not universal
- ✓ Some studies do not support local precedence
- ✓ Some studies do not support lack of global precedence
- ✓ Micro-analytic techniques separate out confusing factors and look just at local vs global processing

Local Processing Bias in Autism: The Next Level of Information Processing Analysis

A bias toward seeing the whole (global processing) over seeing the details (local processing) has long been debated as part of the basis for behavior in autism from resistance to change to obsessions with the details a few interests over concepts and a broad range of interests. Specialized methods are used to evaluate these perceptual biases.

	Prime	Same		Different		
F E W		Similar Configuration				
		Similar Elements				
M A N Y		Same		Different		
		Similar Configuration				
Similar Elements						

Local Processing Bias in Autism: The Next Level of Information Processing Analysis

- In verbal individuals with autism in this study, all had local processing bias but only some had global precedence.
- This variability needs to be compared to performance on cognitive tests including face recognition and to behavioral flexibility/rigidity and memory for details to begin to explain the variability typical of the autism spectrum.

Automatic Processing & Categorization Mechanisms

Cognitively the problem is with
prototype formation and
automatic processes
as opposed to conscious verbally
mediated reasoning.

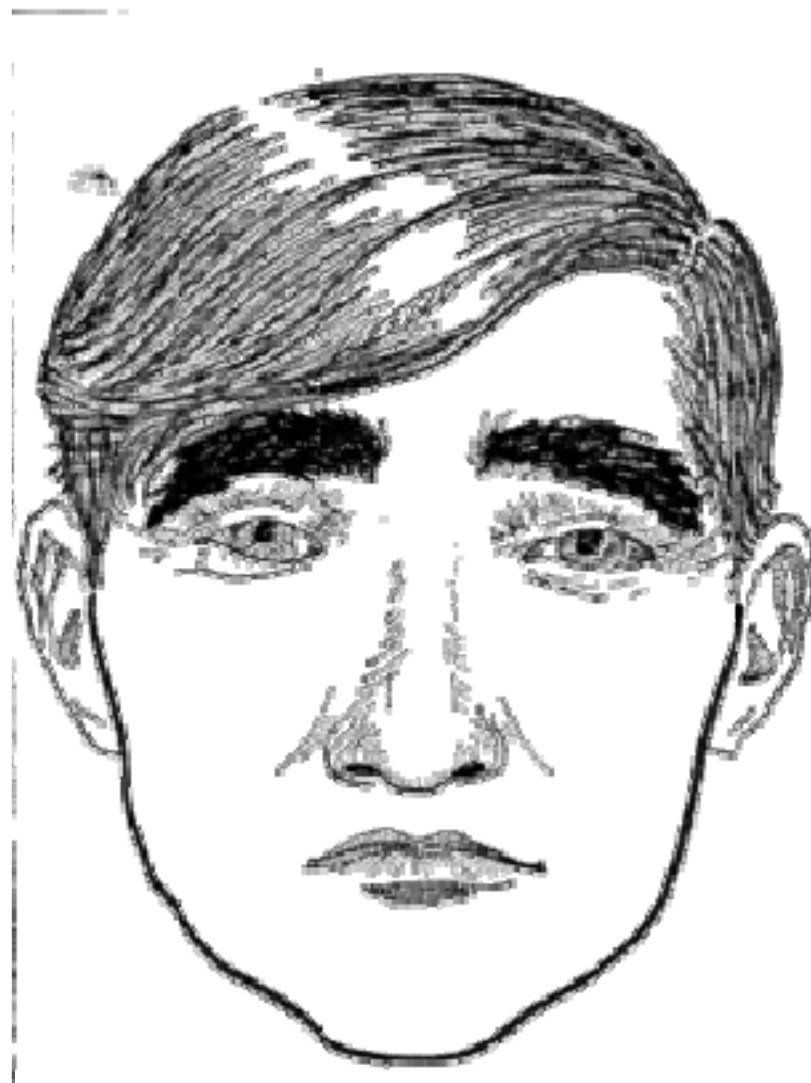
Pitt Infant and Toddler Development Center

- Abilities that adults take for granted that normally develop in infancy and toddlerhood:
- For example:
 - ✓ Our abilities to recognize faces and emotional expressions
 - ✓ Our abilities to understand the difference between basic categories in the world— cats, dogs, lions ...



Which of these is the best example of a dog?































Which of the
following two faces
looks more familiar
to you?

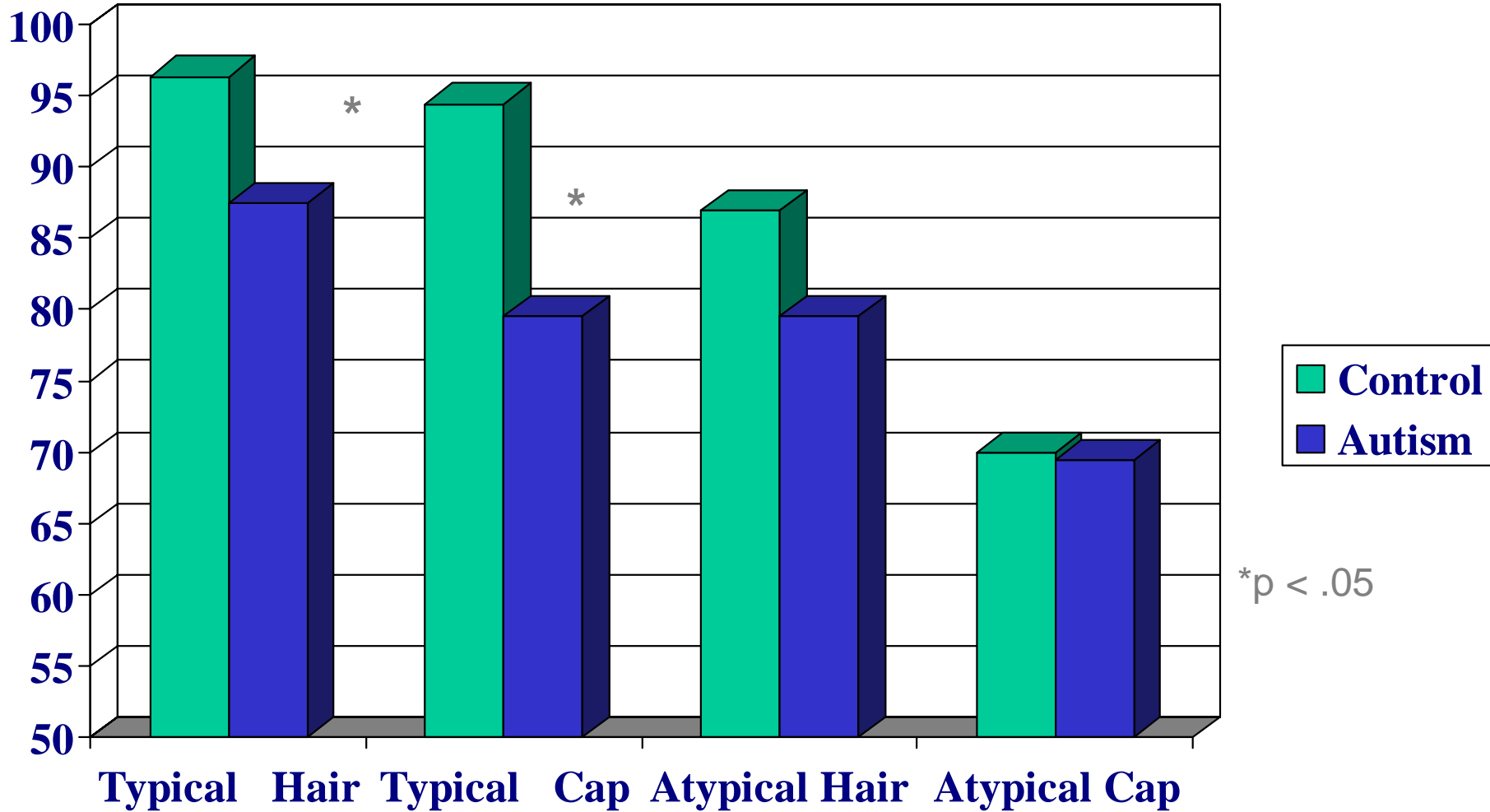


1



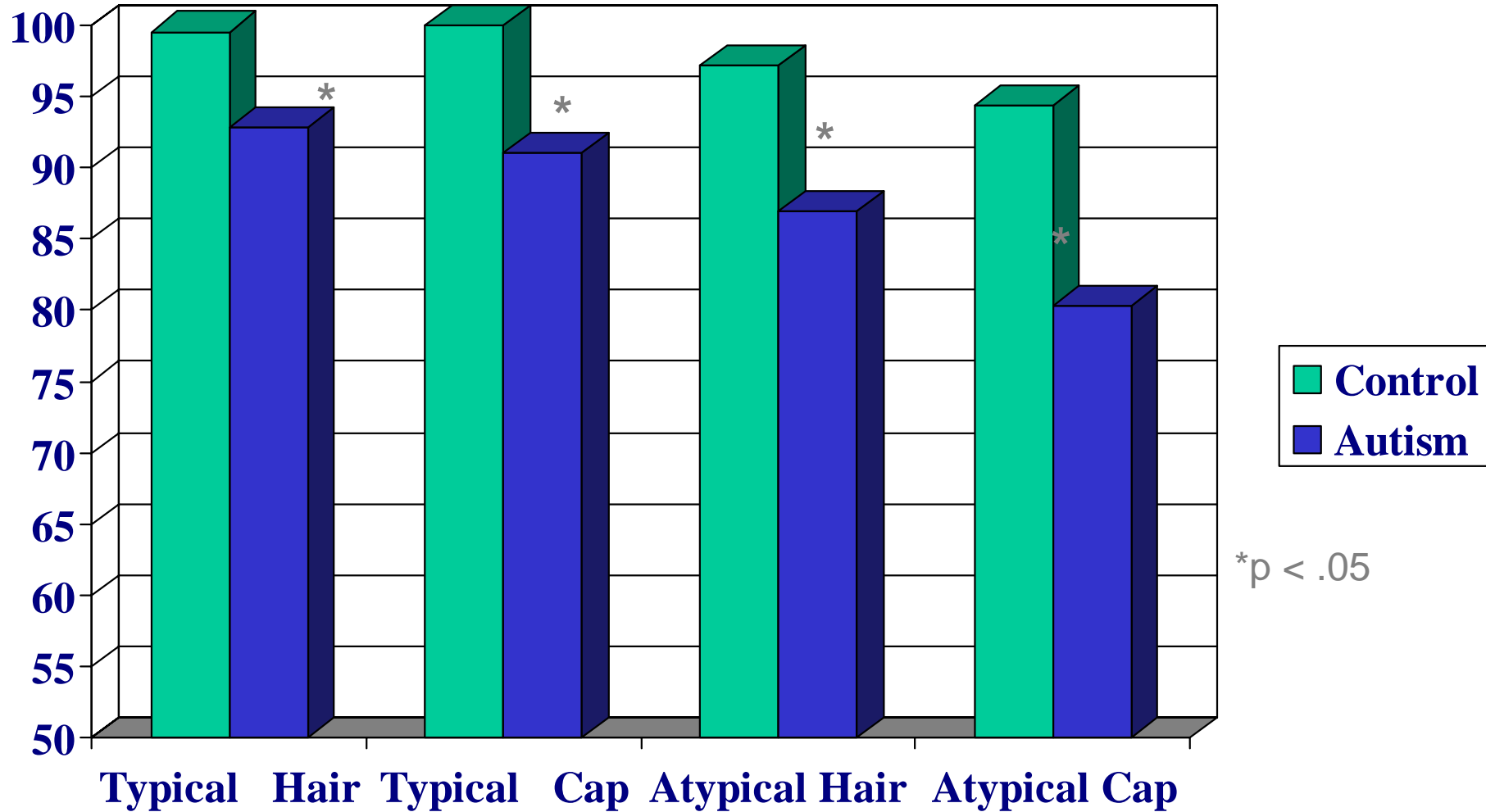
2

Gender Categorization 5- to 7- Year- Old Children

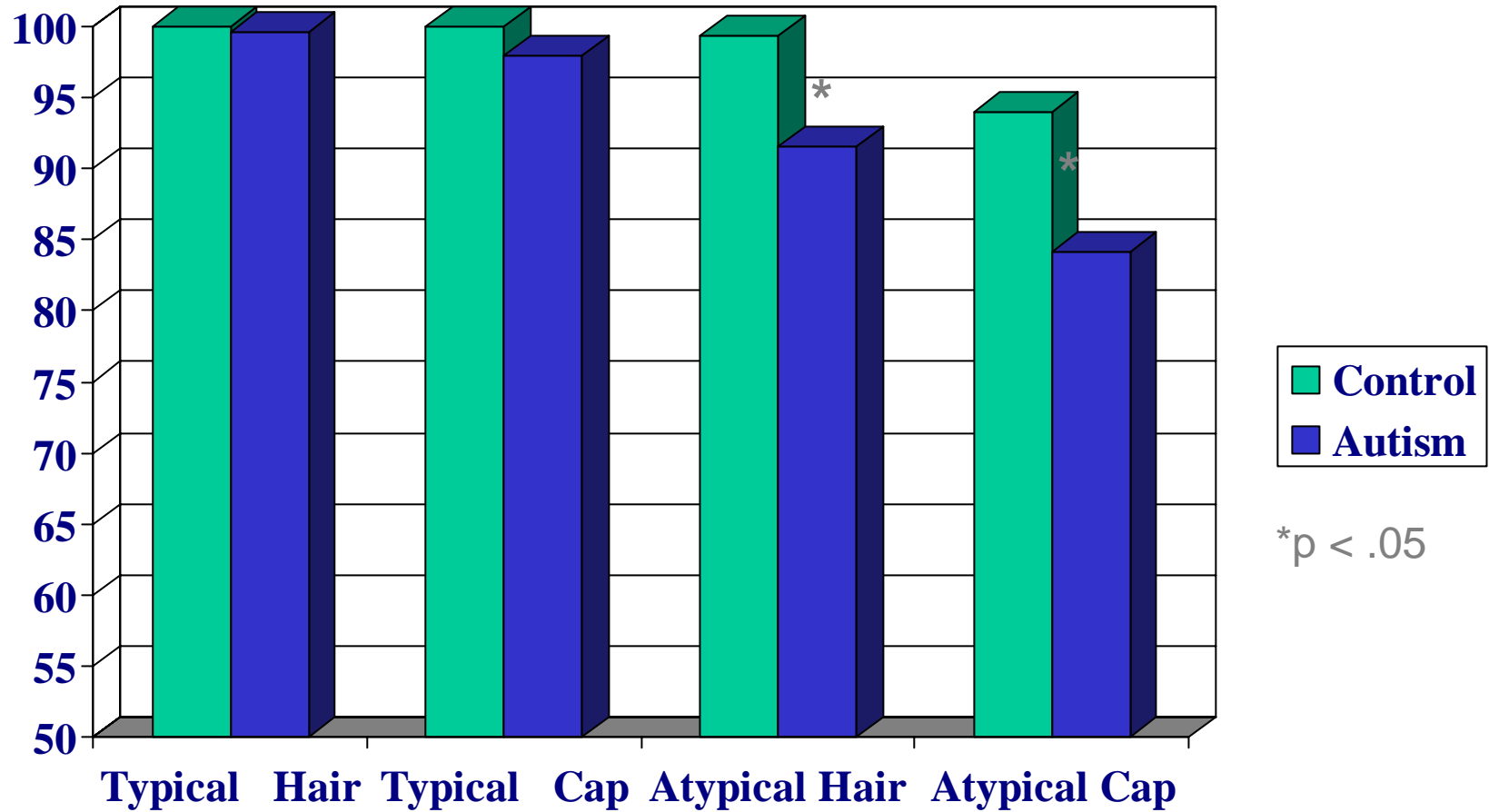


Strauss, M.S. et al., Child
Development (under revision)

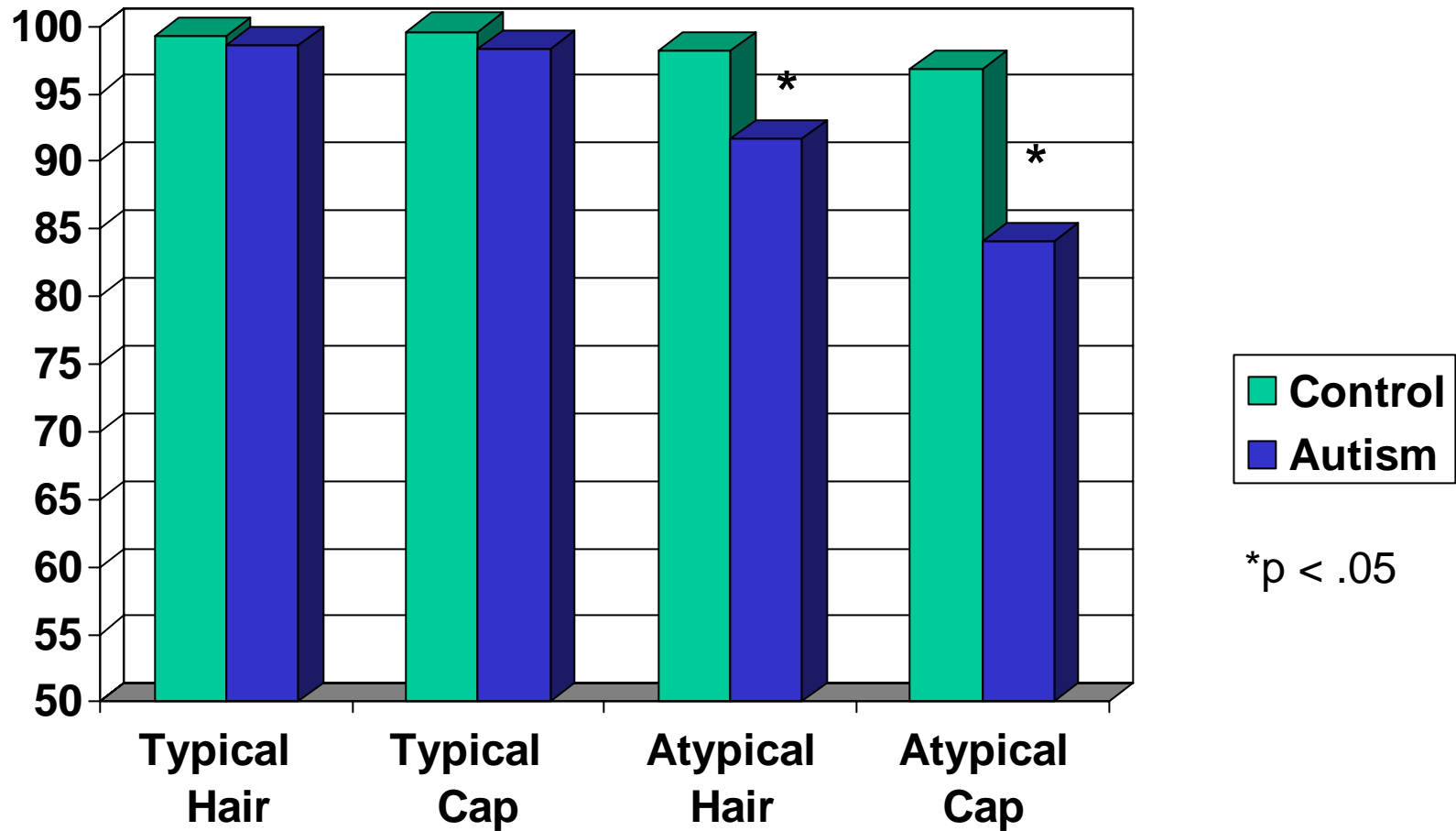
Gender Categorization 8- to 12- Year Old Children



Gender Categorization 13- to 17- Year Old Teenagers



Gender Categorization Adults



Difficult discrimination for 1/3 of people with autism



Dr. Nancy Minshew
Pittsburgh



Dr. Geraldine Dawson
Seattle



TYPICAL

SOMEWHAT TYPICAL

ATYPICAL

Conclusions

- Individuals with autism have difficulty with categorizing atypical exemplars of categories
- While categorization improves with development, adults with autism never reach the “expertise” abilities of controls
- These deficits are seen with both faces (e.g., gender discrimination) and object categorization
- The inability to form prototypical representations of categories also impacts facial recognition skills so that distinctive faces are not remembered better than typical faces
- A lack of facial prototypes can also be seen in their not perceiving “average” or prototypical faces as attractive.

Research Studies

- High functioning individuals 5-55 years with autism or “Asperger disorder” IQ 80-120, speak in sentences, some med exclusions
- Through July 2012; no cost; participant payment; we pay airfare & hotel