

Visual Processing in Autism: From Perception to Cognition

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Unique Characteristic of Within Domain Disturbances

Within each affected domain, there was a pattern of intact basic and impaired higher order abilities. This dissociation was characteristic, and was exemplified by the abstraction-EF domain.

The Profile of Intact & Impaired Abilities in High Functioning Autistic Individuals

Intact or Enhanced

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

Cognitive Weaknesses

- Complex Sensory
- Complex Motor
- Complex Memory
- Complex Language
- Concept-formation
- Face Recognition

Behavioral Example of Cognitive Profile: Rules Override Concepts

Bill is a young man with autism who decided to take figure skating lessons. His mother drove him to the rink several times a week. After a while, she decided to skate while he had his lessons. 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 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.”

Abstract Reasoning: Concept Identification & Concept Formation

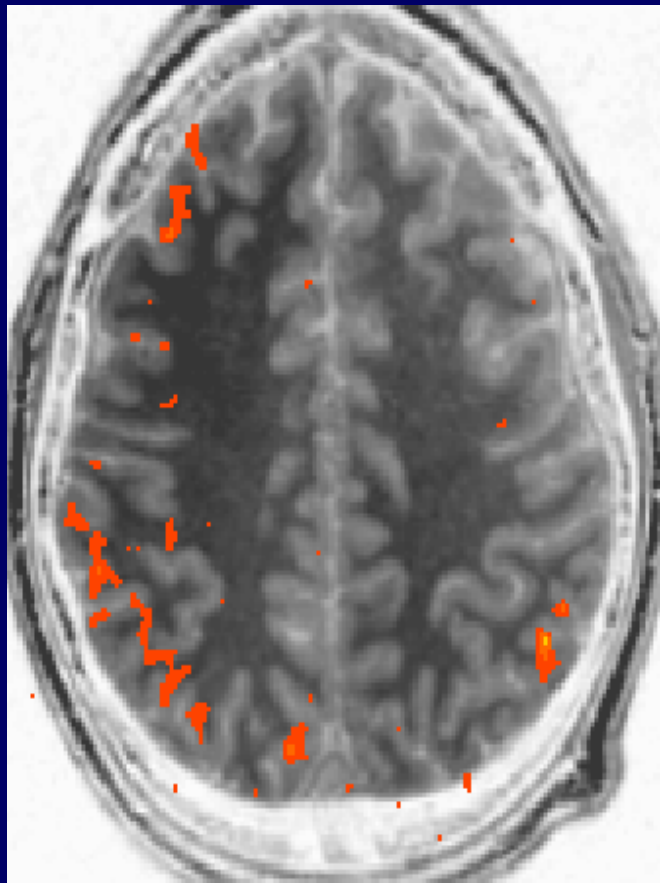
- 90 verbal individuals with autism >12 yrs
- 107 control volunteers
- Concept identification
 - Attribute identification
 - Rule-learning
- Concept formation
 - Self-initiated strategy
- Cognitive flexibility

Dissociation Between Concept Identification & Concept Formation in Autism

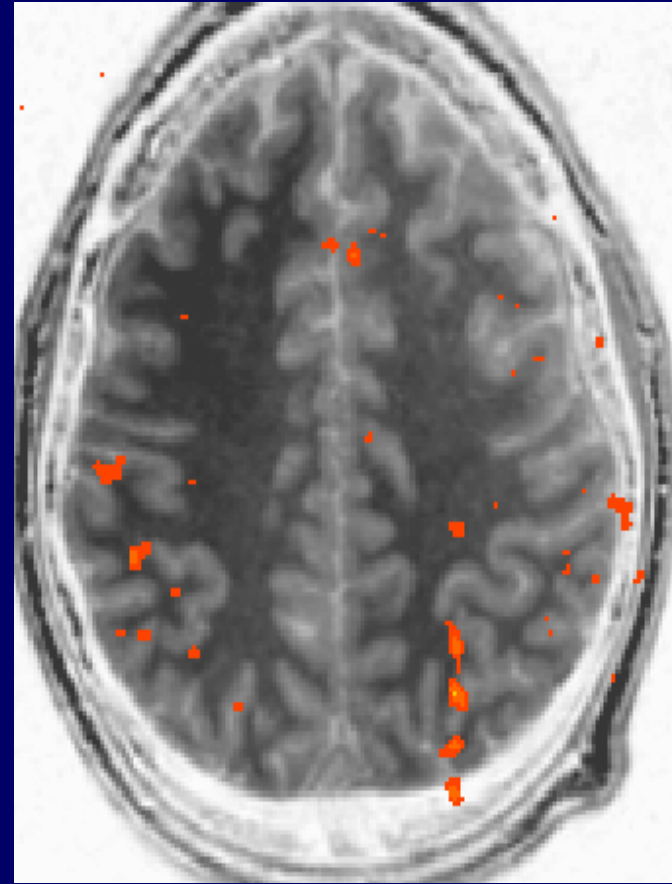
- *Intact* concept identification:
 - Attribute identification
 - Rule learning
- *Inflexible* with rules in changing contexts
- *Impaired* concept and strategy formation

fMRI Activation During a Spatial Working Memory Task

(Courtesy John Sweeney)



Healthy Group



Autism Group

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Common Features of fMRI Studies of Brain Connectivity in Autism

- Reduced inter-regional connectivity
- General underconnectivity with frontal cortex
- Increased right posterior activation-compensatory

Visual Domain: Seeing The Details

A predisposition toward seeing the details over seeing the whole was part of Kanner's early description of this syndrome.

Some of Kanner's Clinical Observations

- ❑ Appearance of a crack in the plaster
- ❑ Missing doll hat from the toys in his office
- ❑ “Yes” only meant to be put on his dad's shoulders
- ❑ Memory of the gowns each president's wife wore at the inaugural ball

An unusual focus on details that were often trivial

Early Studies Report “Local Processing Superiority”

- ❑ Children’s Embedded Figures Test
- ❑ Block design
- ❑ Visual Search

Mentally retarded autistic children exhibited superior performance relative to mental age-matched controls

Origin of Weak Central Coherence Theory

- ❑ Superior performance on tasks on which piecemeal processing provided an advantage
- ❑ Poor performance on tasks on which global processing (seeing the whole) was required
- ❑ Weak Central Coherence (WCC)- lack of innate drive to make sense of things

Recent Studies

Local Processing Not Superior

- ❑ Child & Adult Embedded Figures Test
- ❑ Block Design
- ❑ Visual Search

Recent studies have tended to report no difference between autism and matched control groups.

Recent Studies

Local Processing Not Superior

- ❑ Children's Embedded Figures Test
- ❑ Adult Embedded Figures Test
- ❑ Normal IQ groups w/ and w/o autism

Children: equivalent performance

Adults: autism group performed more poorly

Important Questions

- ❑ Why do lower IQ children with autism do far better on the CEFT?
- ❑ Why do the higher IQ adults do the worst?

Answers lie in understanding disturbances in brain connectivity in autism and, in turn, the cognitive processes that are used for these tasks at different ability levels and ages in autism.

Complex Figure Tests: Another Test of Local Processing Bias

Studies of local processing bias were extended to the analysis of the approach used for reproducing complex visual figures. The Rey Osterreith Complex Figure is commonly used.

Early studies: yes, maybe, no: no scoring methods

Recent reports: Schlooz et al. 2006 documented a detail oriented approach and reduced global approach using a objective scoring method.

Study of Complex Figure From Childhood to Adulthood in Autism

- ❑ Children (8-15 yrs): no difference in performance
- ❑ Adults (>15 yrs): increased piecemeal approach, reduced strategies or global elements

Consistent with reduced capacity for concept formation-problem solving and reduced connectivity with frontal lobes

Important Questions

- ❑ Why do lower IQ children with autism do far better on the CEFT?
- ❑ Why do the higher IQ adults do the worst?

Guess: More severely autistic children have increased local connectivity which supports automatic perception of details; higher IQ autistic adults have lost those local connections and rely on faulty strategies and slow processing capacity

A Micro-analysis of Visual Processing

- The preceding tests were rather coarse tests of visual processing that involve multiple cognitive processes.
- Other more refined approaches hone in on visual processing specifically and the predisposition for local or global bias and the various factors of the visual stimulus that can shift the process one way or the other



Fig. 1. Three snapshots of the eccentricity stimulus we used, taken at different times. The stimulus is comprised of flickering checks which are so size to take into account cortical magnification factor. A small fixation cross in the center is present at all times.

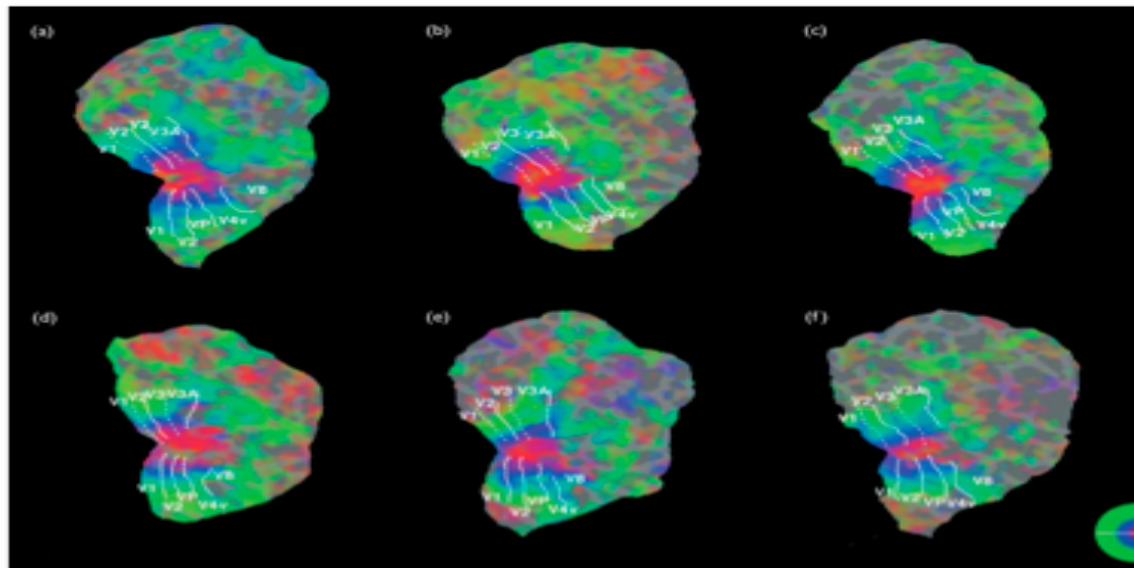


Fig. 2. Retinotopic eccentricity maps of three subjects with autism (a–c) and three controls (d–f). The data are represented in flattened cortical format, in six different right hemispheres. The location of visual cortical areas V1, V2, V3/VP, V3A, V4v and V8 is labeled for comparison; dotted white lines = upper vertical meridian, dashed white lines=lower vertical meridian, solid white lines=horizontal meridian. In this pseudocolor format (see logo on the bottom right), retinotopically specific modulation appear in red, green, or blue (centered approximately at eccentricities 1.5, 3.8 and 10.3°, respectively). It is scaled logarithmically, in accord with the cortical magnification factor.

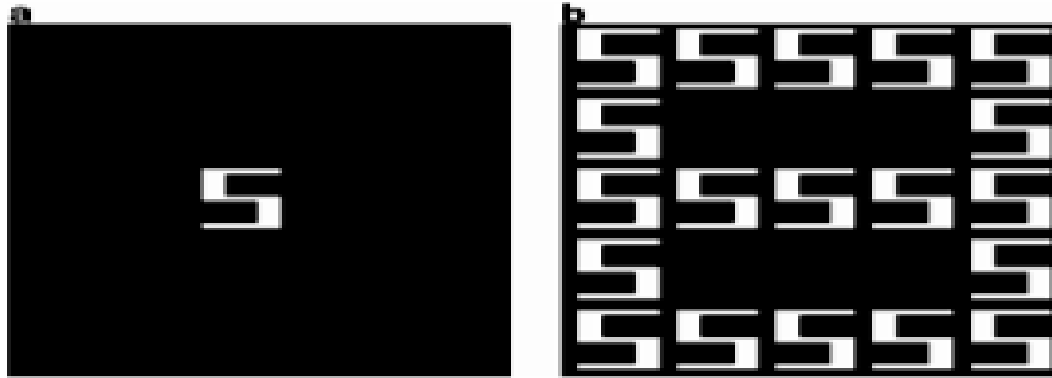


Figure 5 Example of stimuli used in the isolated and embedded task (5a: isolated and 5b: embedded)

Mottron et al., J. Child Psych. and Psychiatry, 2003

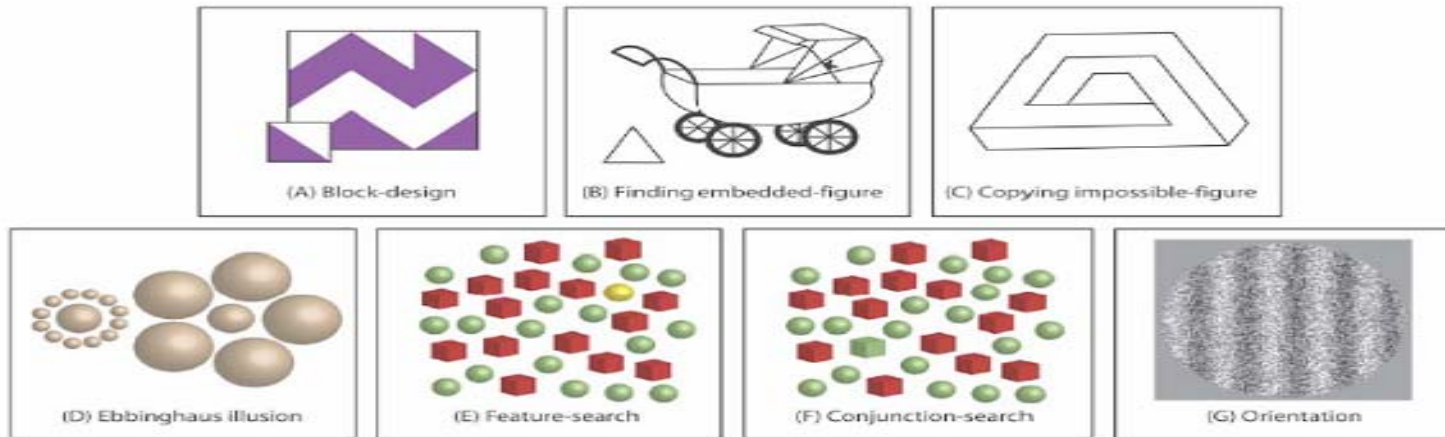
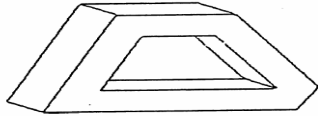


Figure 2. Tasks Used to Probe Perceptual Processing that Elicit Supranormal Performance in Observers with ASD

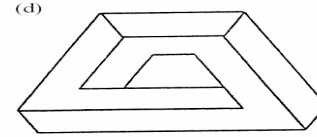
(A) Block Design subtest of the Wechsler intelligence test, (B) locating embedded figures, (C) copying of impossible figures. (D) Ebbinghaus illusion; the surrounding elements can make the (identical) central targets appear quite different. Some controversy surrounds whether autistic observers are susceptible to this illusion. (E and F) Autistic observers are faster and less error prone at finding the odd-man-out in cluttered displays whether the target is defined by a single feature as in (E) or by a conjunction of features as in (F). (G) Bertone et al. (2005) have reported that observers with ASD can tolerate higher levels of noise in determining the orientation of luminance-defined sine-wave gratings.

Dakin and Frith, 2005

- People with autism are less affected by impossible figures (Mattar et al., 1999)



Autistics = controls



Autistics faster than controls ($p < .01$)

- Children with autism tend to start drawing from the local feature (Booth, et al., 2003).

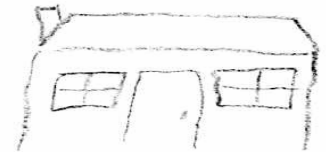
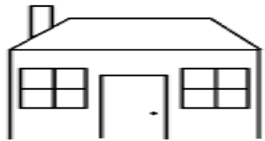


Fig. 1

a. Face discrimination



b.

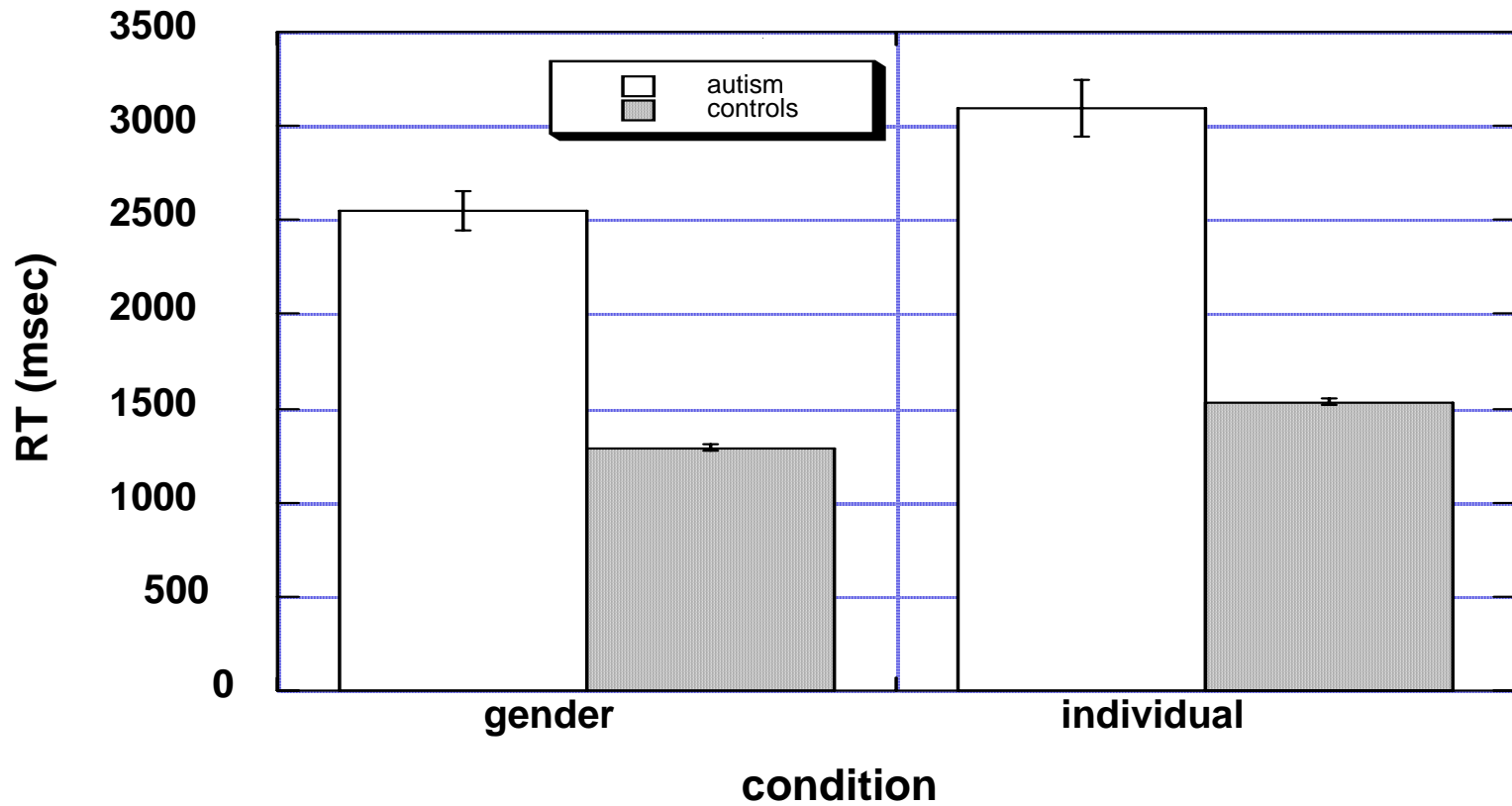
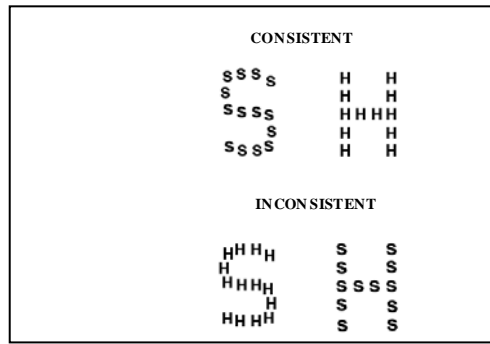
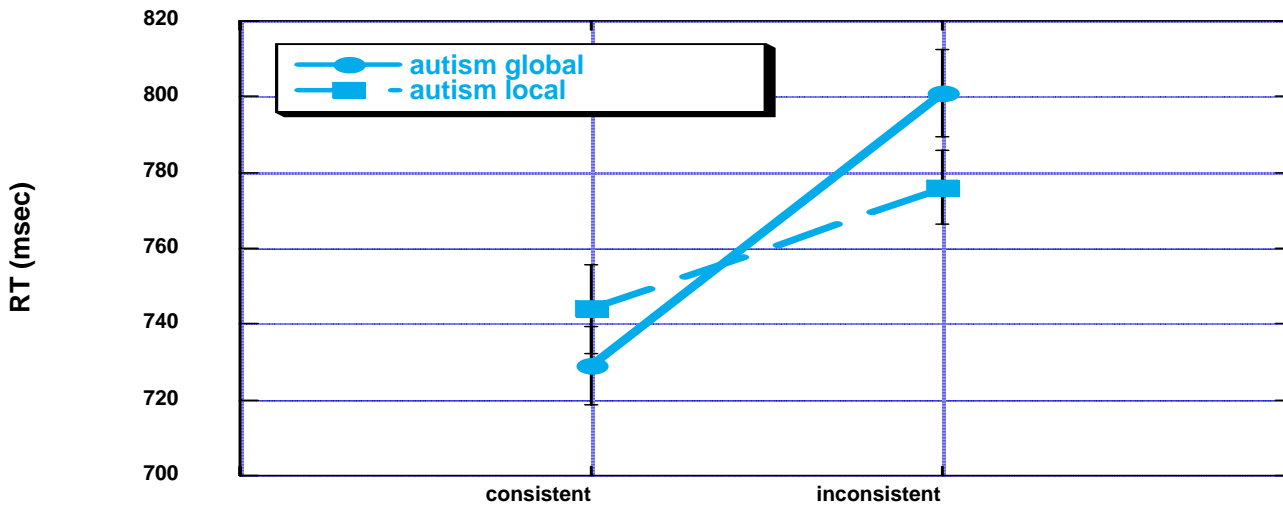
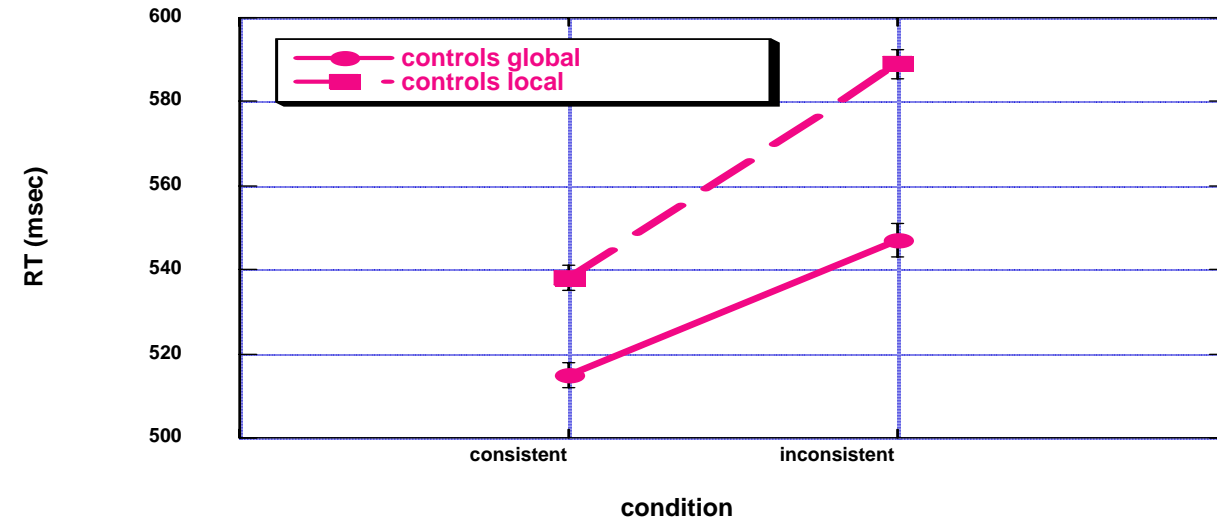


Fig. 2

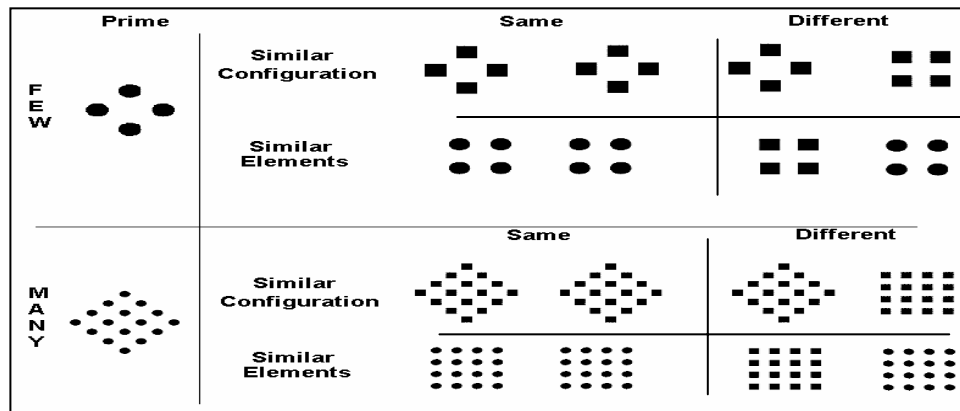
a.



b.



a. Microgenesis stimuli

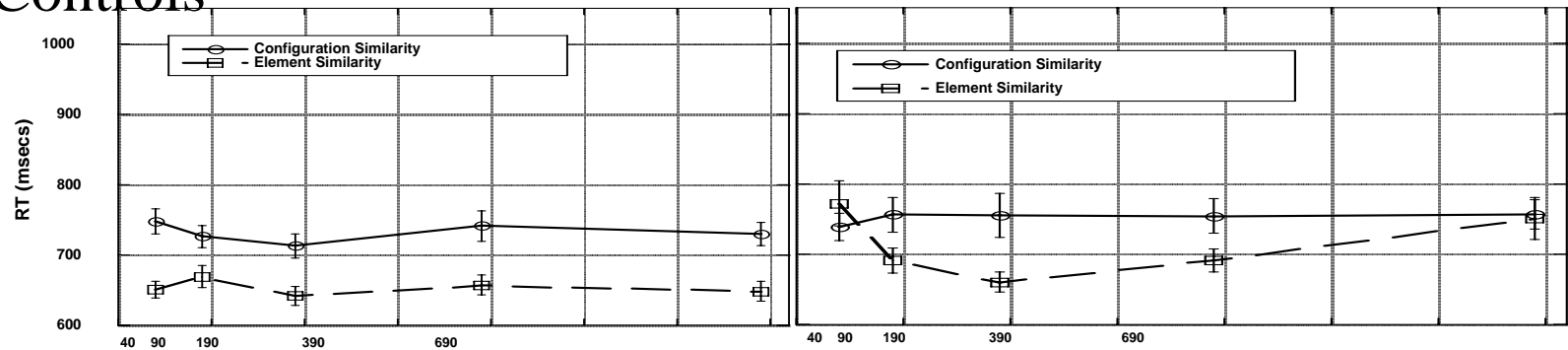


b. Group means

Few elements

Many elements

i. Controls



ii. Autism

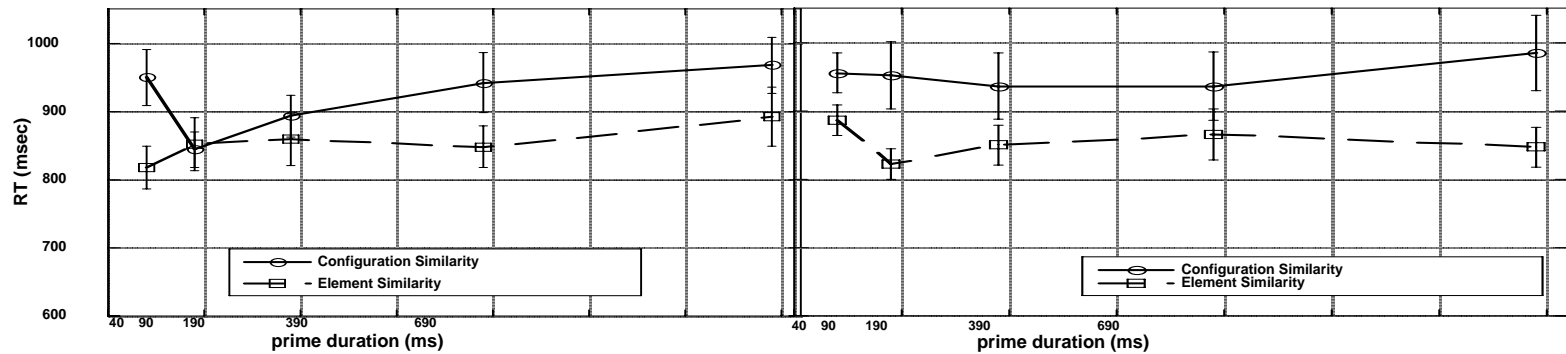


Fig. 4

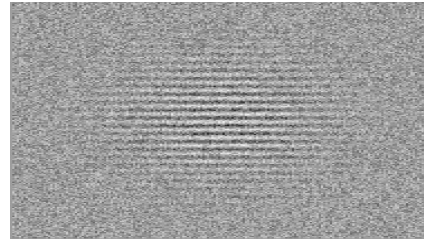
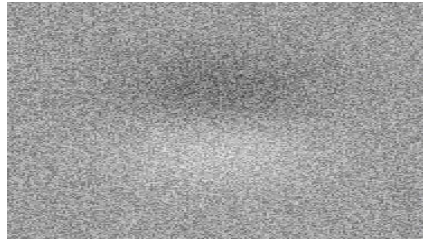
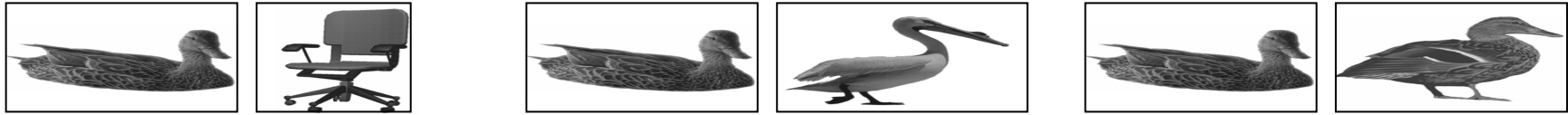


Fig. 5

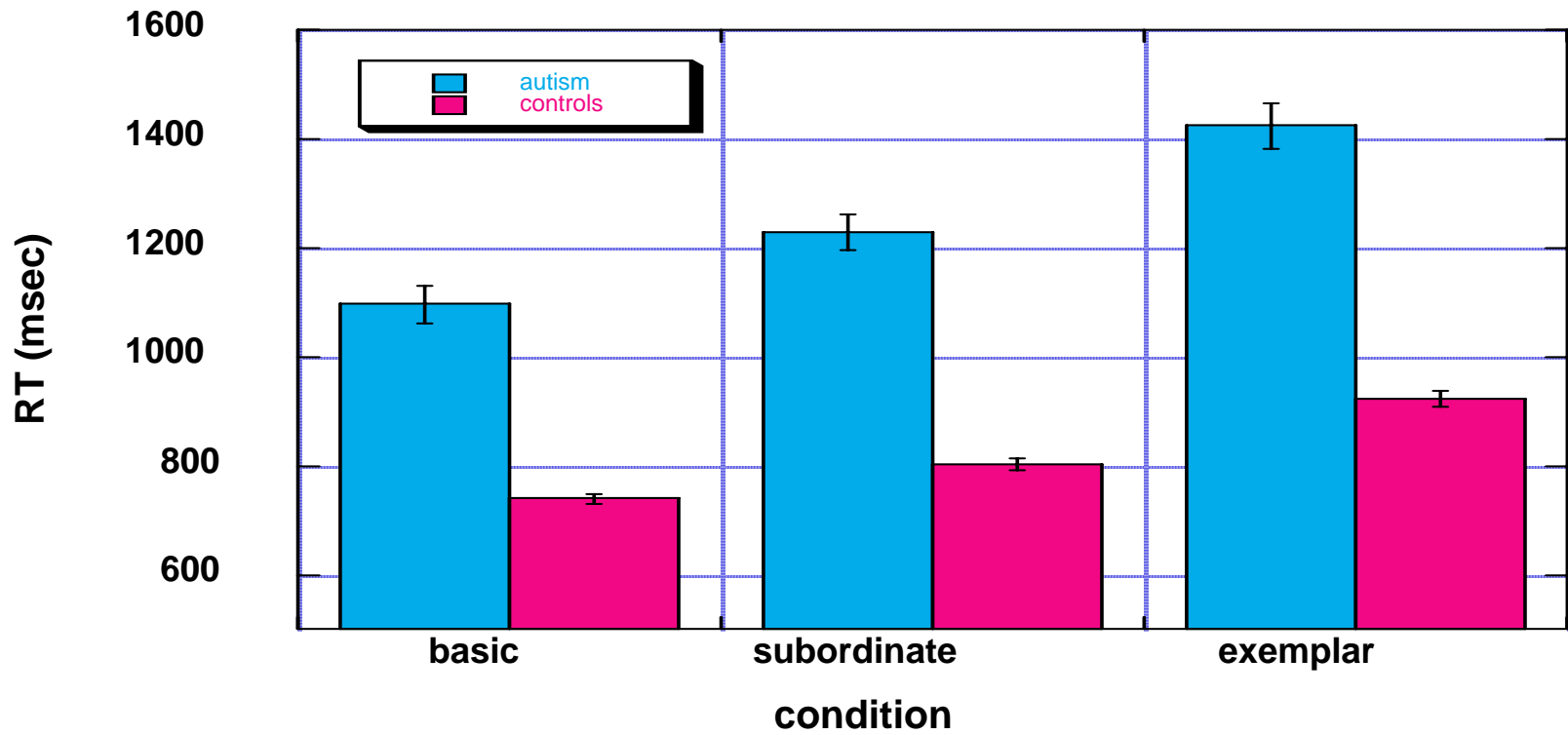
a. Common Objects

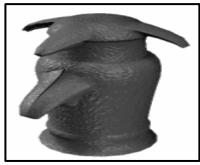


Basic

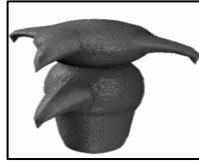
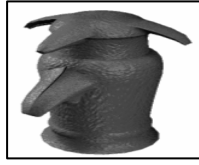
Subordinate

Exemplar



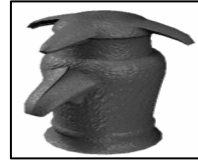


Basic

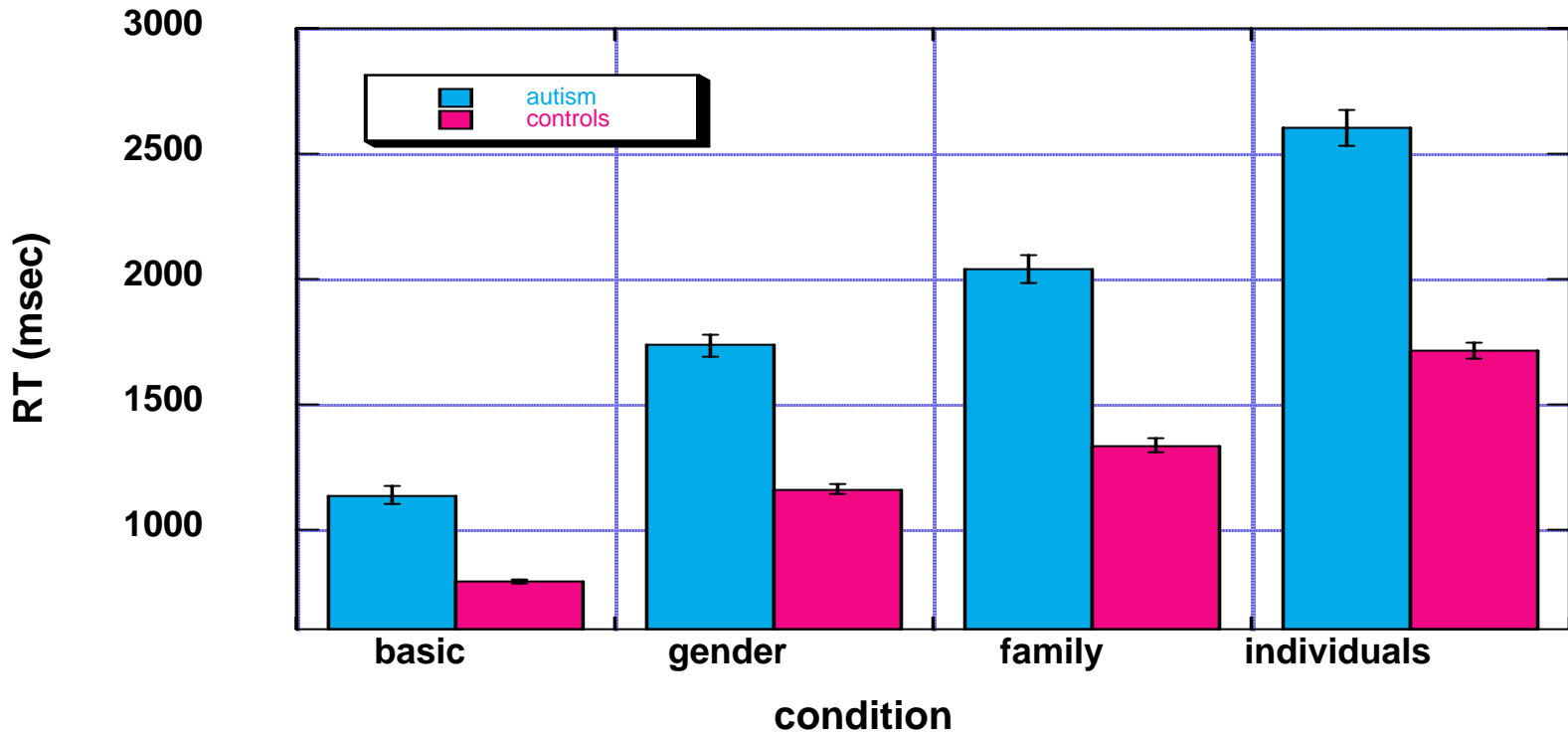
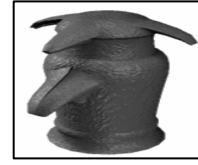


Family

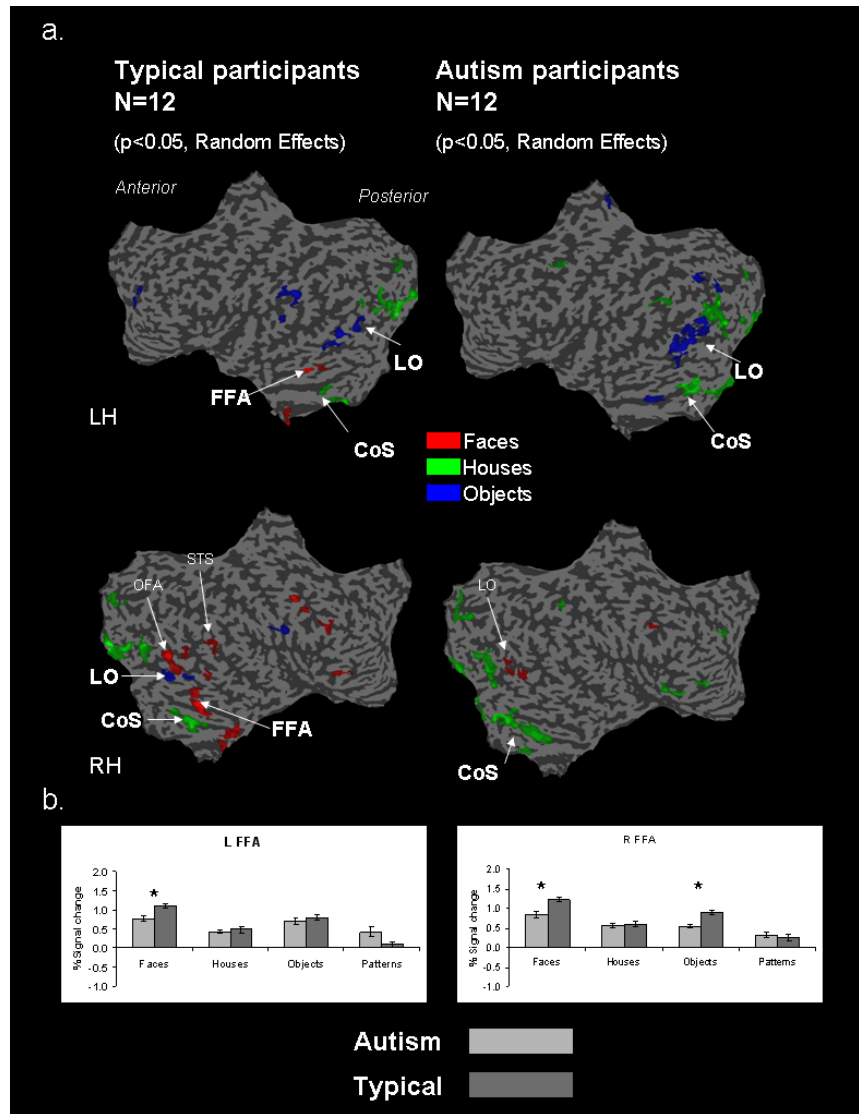
Gender

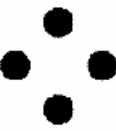
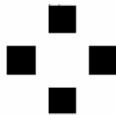
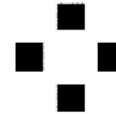
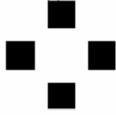






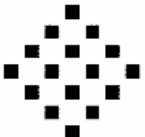
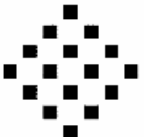




Individual



Humphreys et al., 2008



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