Towards a unifying theory of ASD

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ANC, Cambridge, 10th Sept 2010
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The *autism puzzle*

* Deficit of facial identity recognition
  Langdell, 1978

* Preserved/Enhanced facial identity recognition of upside-down faces

* Deficit of facial emotion recognition
  Hobson et al., 1986

* Deficit of lip-reading and eye-direction detection
  De Gelder et al., 1991

• Deficit of eyes-reading
  Baron-Cohen et al., 1995
Facial processing

- Impaired processing of various facial aspects:
  - Visuo-auditory association
  - Global pattern
  - Facial dynamics: emotional gestures, eyes’ movements, lips’ movements

Gepner et al., *Child Neuropsychol*, 1996

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These deficits are present at the age of 3, and probably earlier.

Gepner et al., *Infant Behav*, 1994
Facial processing

- Identification of faces is rather based on details and high spatial frequencies
  
  Rondan et al., *Child Neuropsychol*, 2003
  Deruelle et al., *J Autism Dev Disord*, 2004

- Good analytic processing of faces at the expense of configural processing
  
  Deruelle et al., *Int J Psychol*, 2006
  Review by Dawson et al., 2005
  Confirmed by fMRI studies
Movement...
Visual perception of speed and direction of movements

Deficit in comparing two speeds, especially as speeds increase and directions become more complex and less foreseeable


Postural reactivity to environmental movement

Decreased visuo-postural reactivity

Gepner et al., *NeuroReport*, 1995

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FFT ratio (%)

Control subjects
AS
Autistic

eyes closed
peak angular velocity

Visuo-postural coupling disorders


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Oculomotor reactivity to visual motion

Moving lighting points (RDK)

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Hypo- or hyper-reactivity to (fast) movement

Gepner & Mestre, Trends Cogn Sci, 2002

Mestre et al., TIPA, 2002

See also: Spencer et al., 2000; Milne et al., 2002

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Motion mis-sight

Emotion mis-sight

E-Motion mis-sight

Gepner, *Devenir*, 2006

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Weak central coherence: Frith, Happé

Enhanced detail perception: Mottron

Imitation deficits: Rogers

Executive dysfunction: Hughes, Hill

Language impairments: Tager-Flusberg, Rapin

Mindblindness, empathizing deficit: Baron-Cohen
Anomalies of online perception and on time sensorymotor - integration of dynamic sensory stimuli
Self reports of adults with ASD/Asperger
“The constant change of most things never seemed to give me any chance to prepare myself for them.

The stress of trying to catch up and keep up often became too much, and I found myself trying to slow everything down and take some time out...”

Donna WILLIAMS, Nobody nowhere, 1992
Some of the problems autistics have with making eye contact may be nothing more than an intolerance for the movement of the other person’s eyes. One autistic person reported that looking at people’s eyes was difficult because the eyes did not stay still …

“Minor sensory processing deficits heightened my attraction to certain stimulation (e.g. airport’s doors), whereas a greater sensory processing defect might cause another child to fear and avoid the same stimulus…”

Temple GRANDIN, *Thinking in pictures*, 1997
« Gurcharan used to speak very fast and I sometimes found difficult to follow her … the rapid succession of her questions was intrusive, like the plic-ploc of the rain on my head, and it took some time to answer her… »

Daniel TAMMETT, *Born on a blue day*, 2006

Confirmed by Oram Cardy et al., 2005; Roberts et al., 2010
« For me, time seems to flow out rapidly, or in other terms, a non-autistic person sees me as living slowly. During a certain period of time a non-autistic person can digest more percepts than me because I am constrained to digest each object piece by piece. Time phenomenon is relative (to space), and strongly related to the number of distinct entities to process.

I like to compare eyes of autistic persons to the faceted eyes of insects: there are numerous different subtile details, but they are not integrated together… »

Van DALEN, Seeing with a mild autistic person’s eyes, 1994

Weak central coherence
Static detail perception

Urville, Gilles Tréhin

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I remember each frame of my journey in the helicopter
Enhanced local and static perception: «photographic» perception
Enhanced spatial memory and graphic abilities

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Early visual signs in ASD

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Family home movies

e.g. Sauvage; Teitelbaum; Dawson; Muratori…

First semester
- Gaze abnormalities: default of ocular pursuit of moving objects and persons
- Poor or no interest for moving games
- Peculiar interests for hands, details and static patterns
Second semester

*Deficit of gaze contact, impression of blindness*

- Swaying, self-sensory (visual, auditory, proprioceptive, vestibular) stimulation (e.g. hands or fingers flapping in front of the eyes...), other motor stereotypes, delayed motor milestones
The world is changing too fast for autistic people

So please, slow down!

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Benefits from slowing down biological movements

- Relatively good emotional and non emotional facial expressions recognition when facial gestures are presented dynamically and slowly on video
  
  Gepner et al., *J Autism Dev Disord*, 2001

- Facial expression recognition and facial/vocal induced imitation are enhanced when facial movements and vocal sounds are slowed down
  
  Tardif et al., *J Autism Dev Disord*, 2007

- Facial and body intentional imitation is improved when facial and body gestures are slowed down
  
  Lainé et al., *Enfance*, 2008

  Lainé et al., *under revision*
Benefits from slowing down verbal language

- Performances in phonemes categorization,
- words comprehension,
- sentence comprehension

are enhanced when verbal flow is slowed down

Tardif et al., *Parole*, 2002
Lainé et al., *Enfance*, 2009
Lainé et al., in *preparation*
The Temporo-Spatial Processing Disorders (TSPD) hypothesis

Gepner & Féron, Neurosci Biobehav Rev, 2009
What signature in the brain?
Effective connectivity (fMRI) during emotional facial gestures processing

Wicker, Fontlupt, Hubert, Tardif, Gepner, Deruelle, Soc Cogn Affect Neurosci, 2008
Functional brain anomalies
– under-connectivity (+++) or over-connectivity (+) between multiple cortical and subcortical areas, at rest and during simple and complex cognitive tasks

– local or distant neural hypo- or hyper-synchronization, at rest and during simple and complex cognitive tasks

Multi-system Brain Disconnectivity-Dissynchrony (MBD)

Gepner & Féron, Neurosci Biobehav Rev, 2009
Structural brain abnormalities

Multisystem Brain Disconnectivity-Dissynchrony (MBD)

Temporo-spatial processing disorders (TSPD)

Behavioral, motor and cognitive dysfunctions

- Slowed cognitive processing
- Executive dysfunction
- Imitation deficits
- Enhanced detail perception
- Weak central coherence
- Language impairments
- Mind-blindness
- E-Motion mis-sight
- Facial processing impairments
Structural brain anomalies
– genetic and environmental constraints
– brain growth abnormalities
– distributed anomalies
– developmental and compensatory mechanisms

Functional brain anomalies
– under-connectivity (+++) or over-connectivity (+) between multiple cortical and subcortical areas, at rest and during simple and complex cognitive tasks

– local or distant neural hypo- or hyper-synchronization, at rest and during simple and complex cognitive tasks

Multi-system Brain Disconnectivity-Dissynchrony (MBD)

Gepner & Féron, Neurosci Biobehav Rev, 2009
Genetic risk factors


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Environmental risk factors

- Parental psychiatric disorders (depression, schizophrenia)
- Pre-, peri- and post-natal infections, auto-immune diseases
- Chemical poisoning (heavy metals, valproic acid, thalidomide)
- Epigenetic alterations
  - Advanced paternal age
  - MeCP2 (Rett syndrome)
  - Anti-epileptic treatment
- Obstetric complications
- Advanced parental age
From Genes/Environment to Behaviors

Gepner & Féron, Neurosci Biobehav Rev, 2009
Conclusion and perspectives for treatment
Clinical Perspectives

Being very attentive *here and now* to the interactive sensory rhythm and flow (e.g. speed, intensity, energy) with autistic persons

Adjusting our *tempo* to that of the autistic person, and slow it down *more or less*

e.g. Chantal Lheureux-Davidse, 2004, 2010
Coming next

Measuring the impact of slowed sensory flows on young autistic children’s evolution

- Development of a software aimed at slowing down automatically, simultaneously and online the visual and auditory stimuli, without voice modification

- Test the impact of using this software on imitative, verbal and socio-cognitive abilities of 2-3 years old children with ASD (behavioral, oculometric and electrophysiologic measures)
Multi-centric essay and analysis of this software, with a common method
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