

Why is autism more common in males?

Simon Baron-Cohen
Autism Research Centre
Cambridge University

- **Psychology and Brain Scanning**

Sally Wheelwright, Nigel Goldenfeld, Jen Richler, Jen Connellan, Anna Bakti, Rosie Holt, Carrie Allison, Ed Bullmore, Howard Ring, Lindsay Chura, Meng-Chuan Lai, John Suckling, Amber Ruigrok, Dorothea Floris, Richard Bethlehem

- **Hormones and Genetics**

Bonnie Auyeung, Gerald Hackett, Kevin Taylor, Rebecca Knickmeyer, Emma Chapman, Svetlana Lutchmaya, Melissa Hines, Lindsey Kent, Frank Dudbridge, Erin Ingudomnukul, Alexa Pohl, Varun Warriar, Dwaipayan Adhya, Jason Carroll, Jack Van Honk

- **Cambridge-Denmark Study**

Michael V Lombardo, Bonnie Auyeung, Bhismadev Chakrabarti, Liliana Ruta, Bent Nørgaard-Pedersen, David Hougaard, Morsi Abdallah, Lars Melgard, Arie Cohen



CDC 2014: The link with sex

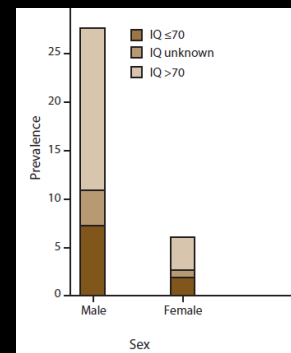
1/48 males

1/189 females

4:1 (m:f)

14.7 per 1,000

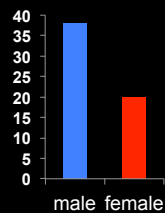
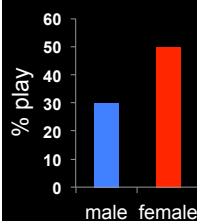
(1 in 68)



<http://1.usa.gov/1lpaDn>



Hines, 2003

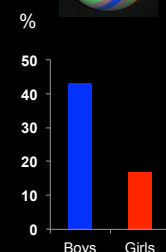
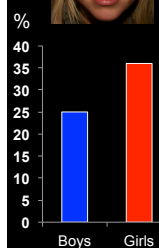


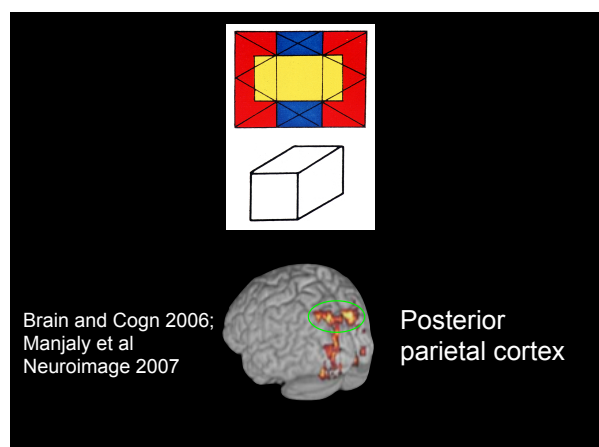
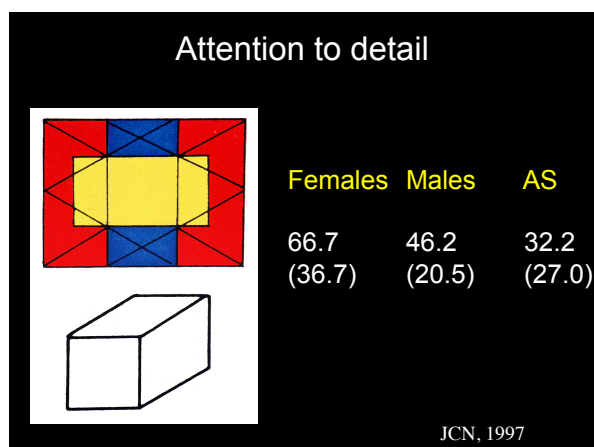
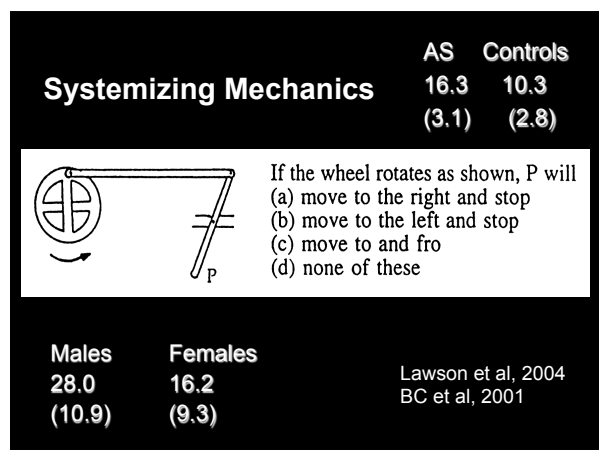
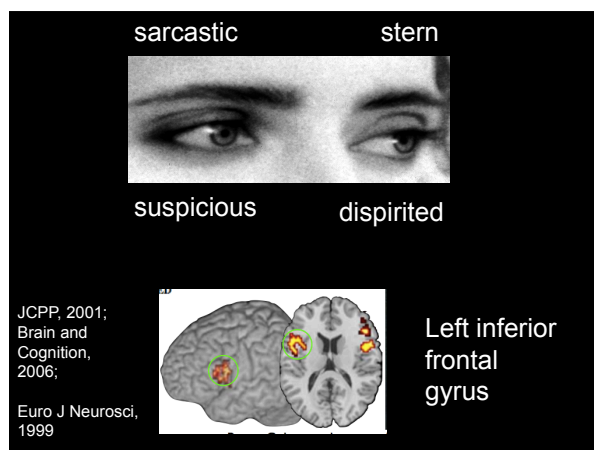
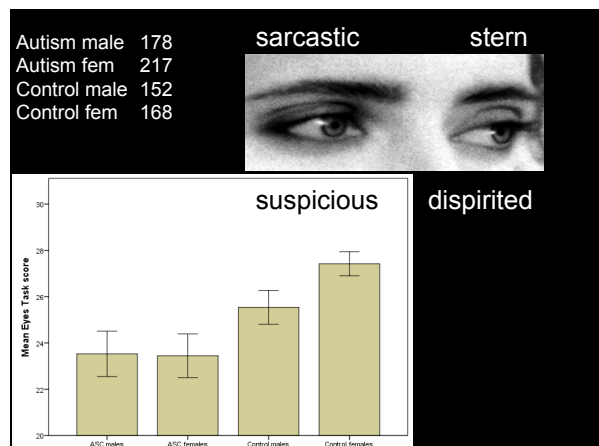
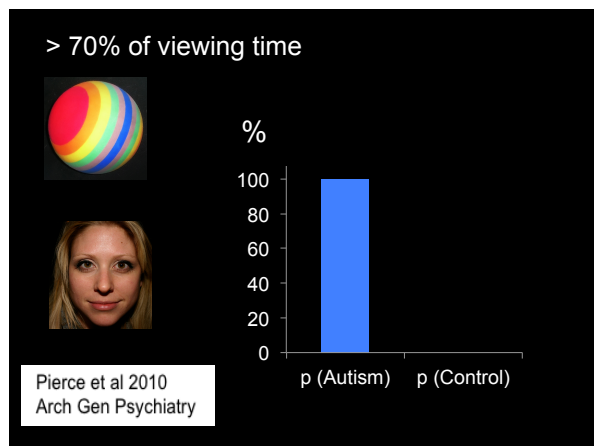
SEXUALLY

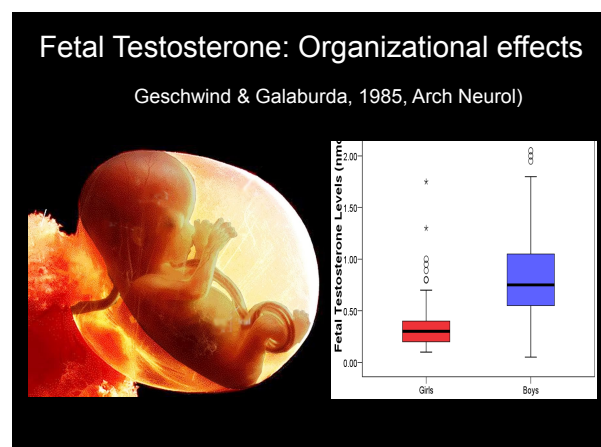
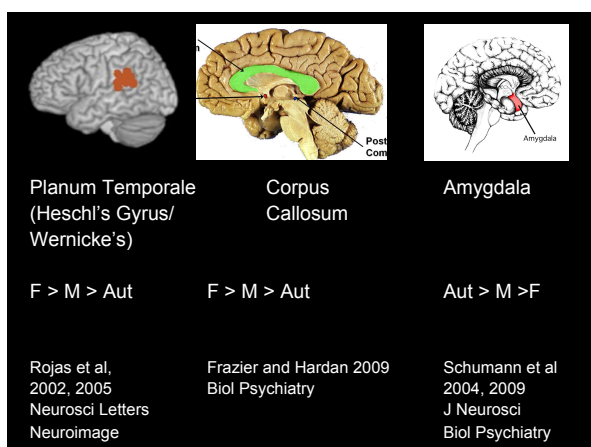
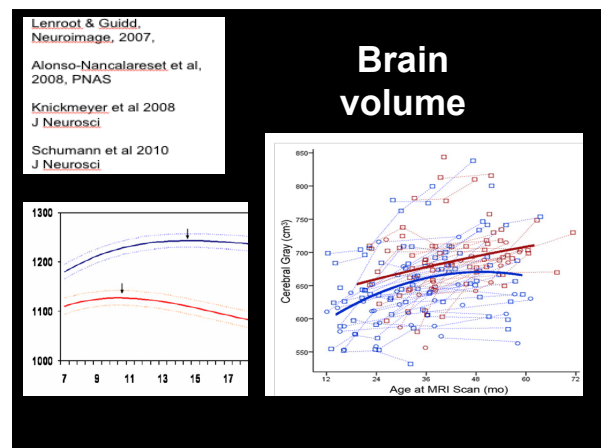
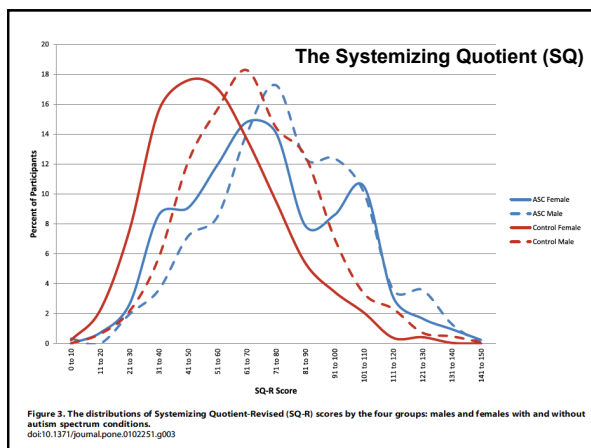
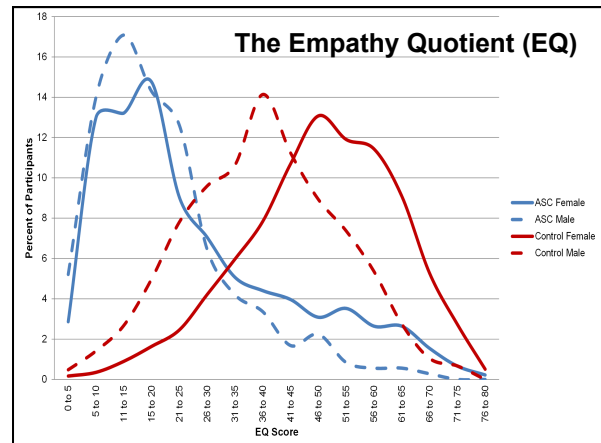
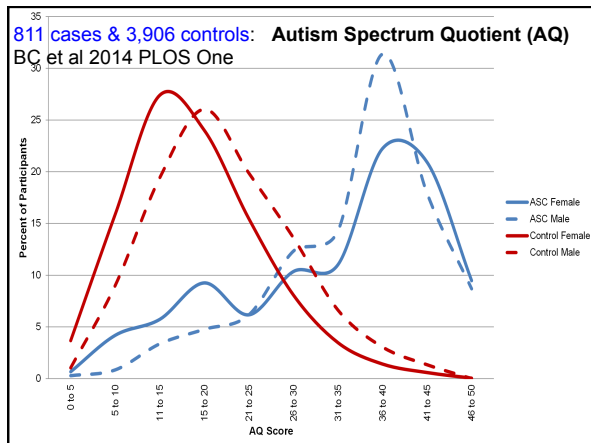
Infant Behavior & Development 23 (2000) 212-218

Sex differences in human neonatal social perception

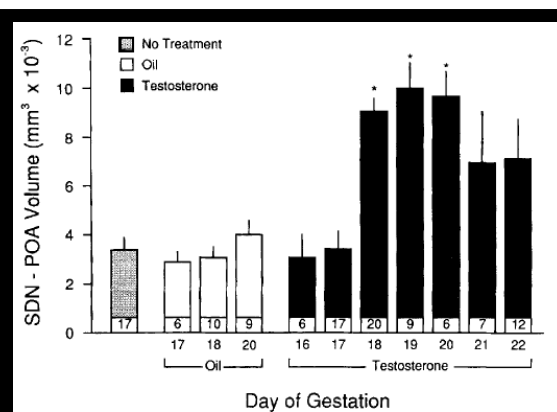
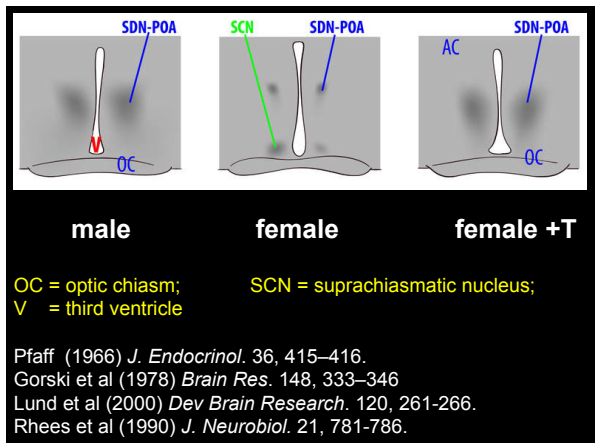
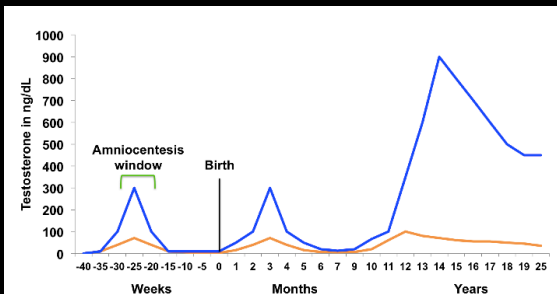
Jennifer Connellan^a, Simon Baron-Cohen^{a,*}, Sally Wheelwright^a, Anna Batki^a, Jag Ahluwalia^b



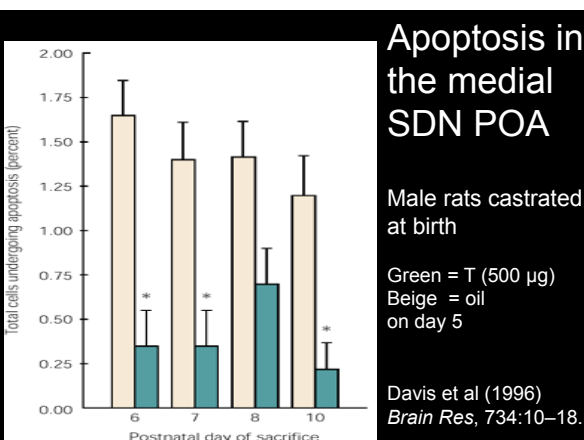
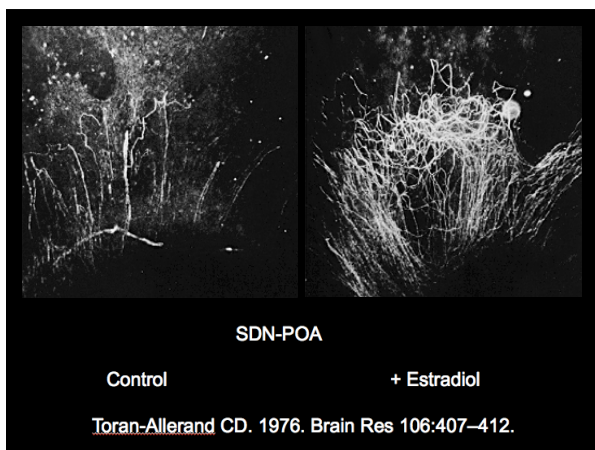




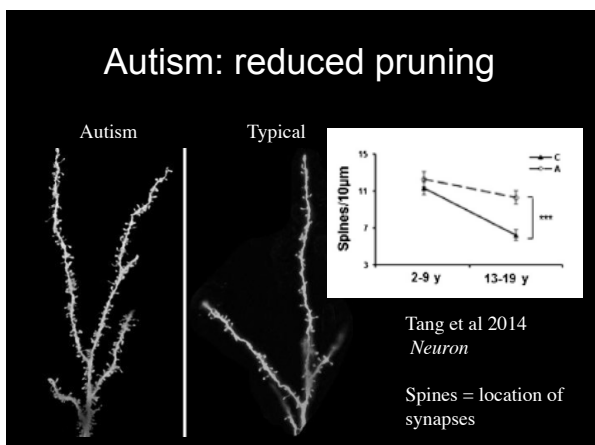
Amniocentesis and the 'masculinization programming window' 12-19 weeks in pregnancy (n = 619)



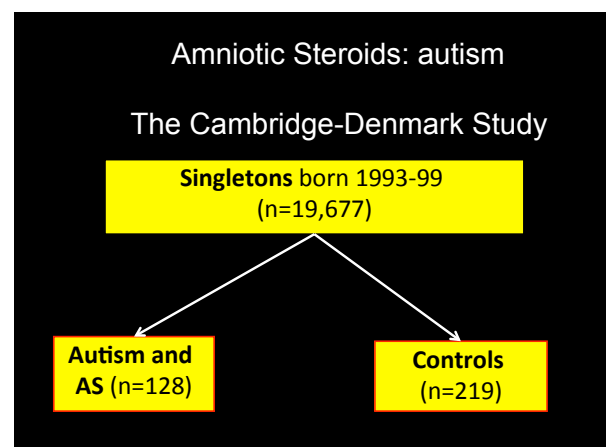
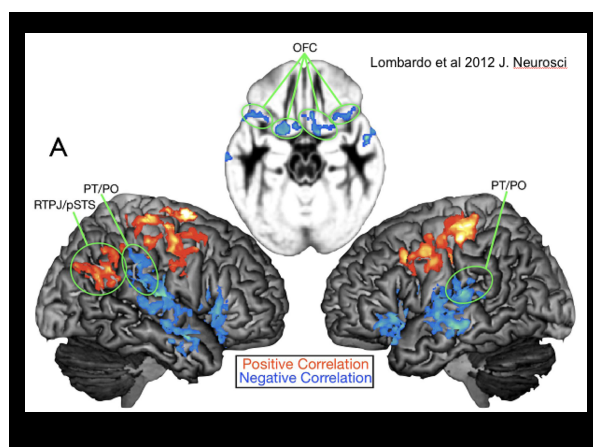
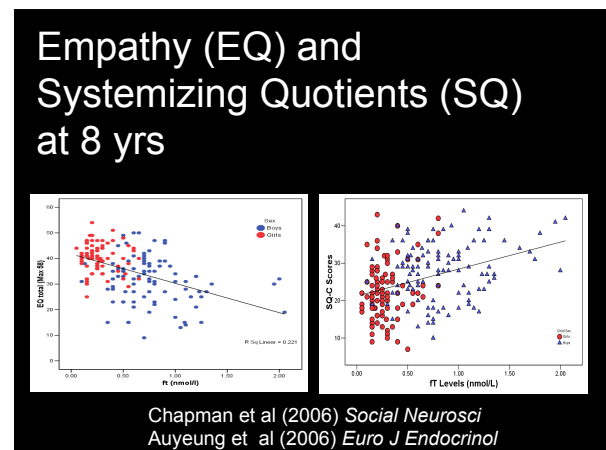
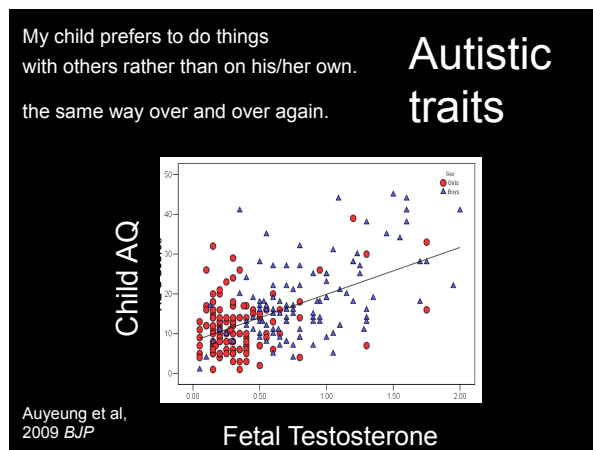
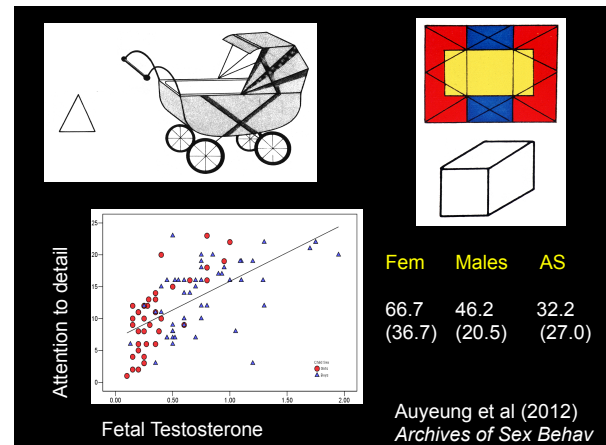
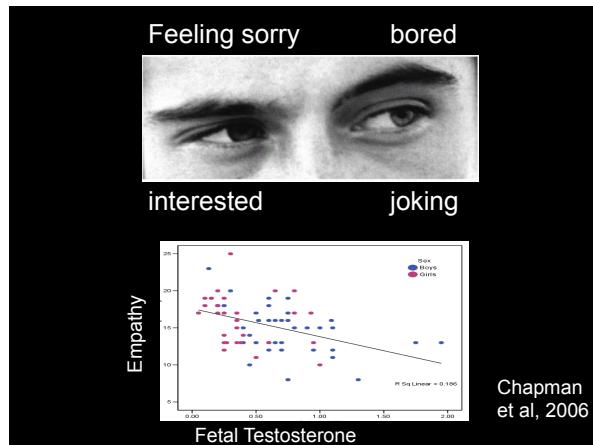
Rheese et al (1990) *J. Neurobiol.* 21, 781-786.



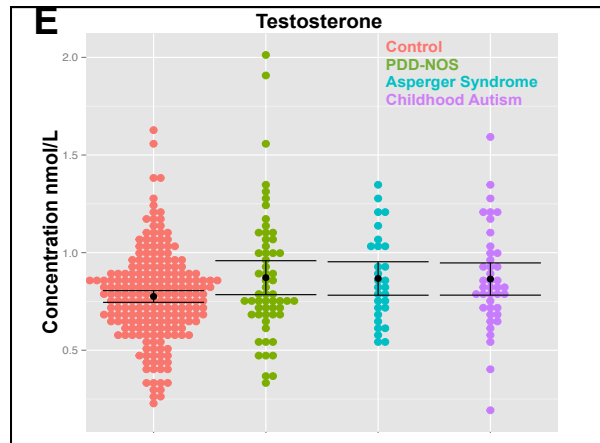
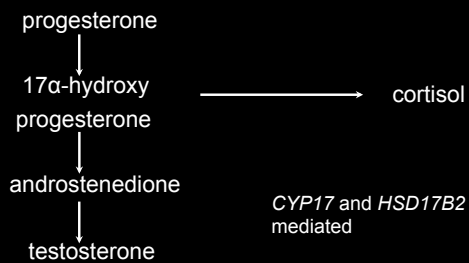
Apoptosis in the medial SDN POA



Autism: reduced pruning



$\Delta 4$ -sex steroid pathway



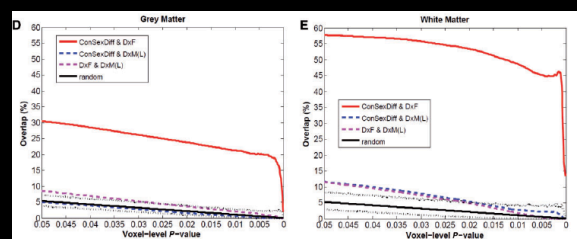
Females with autism

- hirsutism, irregular menstrual cycle, delayed menarche, severe acne
- Polycystic Ovary Syndrome (PCOS)
- tomboyism, 2D:4D ratio

(Knickmeyer et al 2006; Ingudomnukul et al, 2007; Manning et al, 2001; Swettenham et al 2006; Noipayak, 2009; Lai et al, 2013; Pohl et al, 2014)

Females with autism: VBM

Spatial overlap with sexual dimorphism



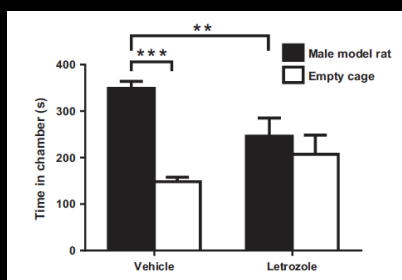
Biological sex affects the neurobiology of autism

Meng-Chuan Lai,^{1,2,*} Michael V. Lombardo,^{1,*} John Suckling,² Amber N. V. Ruigrok,¹ Bhismadev Chakrabarti,^{1,*} Christine Ecker,² Sean C. L. Dineen,² Michael C. Craig,² Declan G. M. Murphy,² Edward T. Bullmore,^{1,2} MRC AIMS Consortium¹ and Simon Baron-Cohen^{1,2}

Brain, 2013

Prenatal hyperandrogenic environment induced autistic rat offspring

Xin-Jie Xu^{a,b,c}, Hong-Feng Zhang^{a,b,c}, Xiao-Jing Shou^{a,b,c}, Jin Li^{a,b,c}, Wei-Song-Ping Han^c, Rong Zhang^{a,b,c,*}, Ji-Sheng Han^{a,b,c,*}



Conclusions

- Autism may be an extreme of typical male development, in highly specific ways
- Fetal steroids are associated with specific aspects of typical sexual dimorphism, are elevated in autism, and may be important in the aetiology of autism
- Need to study females with autism next, as well as other male-biased neurodevelopmental conditions

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NLM Foundation
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