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Sex differences in human neonatal social perception

+Jennifer Connellan, +Simon Baron-Cohen, +Sally Wheelwright,
+Anna Batki, and Jag Ahluwalia*

+Departments of Experimental Psychology and Psychiatry
Autism Research Centre
Cambridge University, Downing Street, Cambridge, CB2 3EB, UK

* Neonatal Intensive Care Unit
Addenbrooke's Hospital, Hills Road
Cambridge CB2 2QQ

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Abstract

Sexual dimorphism in sociability has been documented in humans. The present study aimed to ascertain whether the sexual dimorphism is a result of biological or socio-cultural differences between the two sexes. 102 human neonates, who by definition have not yet been influenced by social and cultural factors, were tested to see if there was a difference in looking time at a face (social object) and a mobile (physical-mechanical object). Results showed that the male infants showed a stronger interest in the physical-mechanical mobile whilst the female infants showed a stronger interest in the face. The results of this research clearly demonstrate that sex differences are in part biological in origin.

Female superiority in sociability has been documented in humans. Thus, girls and women show greater eye contact than age-matched males (Hall, 1985); superior social understanding and sensitivity to emotional expressions (Baron-Cohen, Jolliffe, Mortimore & Robertson, 1997; Baron-Cohen, O'Riordan, Stone, Jones & Plaisted, 1999; Happe, 1995; Rosenthal, Hall, DiMatteo, Rogers & Archer, 1979); and better comprehension of social themes in stories (Willingham & Cole, 1997). It is unclear if this is the result of differences in styles of parenting towards the sexes or of biological factors (Hines & Green, 1991; Kimura, 1987). Here we demonstrate beyond reasonable doubt that these differences are, in part, biological in origin.

There are 4 reasons for suspecting that sexual dimorphism in sociability is biological. (1) The amount of eye-contact shown by infants at 12 months of age is inversely correlated with prenatal testosterone (Lutchmaya, Baron-Cohen & Raggett, submitted), and prenatal testosterone is higher in males than females. (2) Children with the neurogenetic condition of autism show reduced attention to people's faces and eyes (Leekam, Baron-Cohen, Brown, Perrett & Milders, 1997; Phillips, Gomez, Baron-Cohen, Riviere & Laa, 1996; Swettenham et al., 1998). This is relevant because (3) Autism is predominantly a male condition (APA, 1994), suggesting their defining social impairment is sex-linked in some way. (In high-functioning autism, for example, the male:female ratio may be approximately 10:1). (4) Individuals with the chromosomal anomaly of Turner's Syndrome who inherit their only X chromosome paternally are more sociable than those who inherit a maternal X chromosome (Skuse et al., 1997). Irrespective of the biological

basis of the sexual dimorphism in sociability, at a psychological level strong sex differences are found in social (folk psychology) and non-social (folk physics) intelligence (Baron-Cohen, 2000a; Baron-Cohen, 2000b; Baron-Cohen & Hammer, 1997).

One way to test if the female superiority in sociability is of biological origin is to study neonates. The youngest children who until now have been tested and found to show sexual dimorphism in sociability are 12m of age (Lutchmaya et al., submitted). Previous studies have demonstrated that neonates show a face preference effect (Fantz, 1963; Johnson & Morton, 1991) but these sample sizes are typically too small to have the power to detect a sex difference if there was one present.

102 neonates (58 female, 44 male) completed testing, drawn from a larger sample of 154 randomly selected neonates on the maternity wards at the Rosie Maternity Hospital, Cambridge. 51 additional subjects did not complete testing due to extended crying, falling asleep, or fussiness, so their data were not used. The mean age of the final sample tested was $x = 36.7$ hrs ($sd = 26.03$). Their mean gestation age was $x = 39.7$ weeks ($sd = 1.31$). The mean birth weight was $x = 3472.1$ g ($sd = 444.8$), and $n = 40$ had been born by Caesarean section, with the remainder ($n = 62$) by normal delivery. All babies had an Apgar score at 5 minutes of > 9 .

Method

Infants were presented with a face and a mobile separately, in a randomised order. (See Figure 1). Testing was carried out at the mother's bedside or in the neonatal nursery, at the Rosie Hospital, the choice of location depending on which was quietest. Overhead lighting was held constant. The subject lay on his or her back in their crib or on the parent's lap, care being taken that the parent's face could not be seen by the infant. The face stimulus was of author JC. Her hair was tied back, she wore no make-up or jewellery, and the face was positioned 20 cms above the subject. She adopted a positive, pleasant emotional expression, whilst remaining silent. Movement of her head was natural, whilst continuously facing the infant.

Insert figure 1 here

The mobile was carefully matched with the face stimulus for 5 factors: (a) Colour ('skin colour'). (b) Size and (c) Shape (a ball was used). (d) Contrast (using facial features pasted onto the ball in a scrambled but symmetrical arrangement, following previous studies (Johnson & Morton, 1991)). (e) Dimensionality (to control for a nose-like structure, a 3cm string was attached to the centre of the ball, at the end of which was a smaller ball, also matched for 'skin colour'). The mobile itself was attached to a stick 1m in length, and was held above the infant's head, at the same viewing distance (20cm). The mobile moved with mechanical motion, since any movement of the larger ball caused the smaller ball to move contingently.

Once the infant was in a state of alert inactivity, a trial began. To be included, an infant had to be looking at the stimulus for at least 3 seconds. The stimulus was presented for a maximum of 70 seconds. During this time, a second experimenter filmed the infant's eye movements. If the infant cried, the trial was suspended, and then re-started so that the total presentation time of the stimulus still amounted to 70 seconds. If the infant completed > 53 seconds (i.e. 75% of the target time), and then became distressed, the trial was not restarted. Thus, the stimulus was presented for a maximum of 70 seconds, and a minimum of 53 seconds. Looking time was calculated as a proportion of total looking time. Care was taken not to film any information that might indicate the sex of the baby.

The videotapes were coded by two judges who were blind to the infant's sex, to calculate the number of seconds the infants looked at each stimulus. A second observer (independent of the first pair and also blind to the infants' sex) was trained to use the same coding technique for 20 randomly selected infants to establish reliability. Agreement, measured as the Pearson correlation between observers' recorded looking times for both conditions, was 0.85, $p = 0.0001$.

For each baby, a difference score was calculated by subtracting the percent of time spent looking at the mobile from the percent of time they spent looking at the face. Each baby was classified as having a preference for (a) the face (difference score of +20 or higher), (b) the mobile (difference score of -20 or less), or (c) no preference (difference score of between -20 and +20). A 20% cut-off was arbitrarily selected to define a substantive

difference in the baby's interest in the two stimuli. (Selecting other arbitrary cut-offs of 30% or 40% does not affect the results, reported next.)

Table 1 shows the number of babies that fell into each of the 3 categories. A chi-square test demonstrated that there was a significant association between sex and stimulus preference (chi-square = 8.3, df = 2, p = 0.016). Examining the cells that contribute most to the chi-square result suggests that the significant result is due to more of the male babies, and fewer of the female babies, having a preference for the mobile than would be predicted. In other words, male babies tend to prefer the mobile, whereas female babies either have no preference or prefer the real face. This result is supported by considering the mean percent looking times for male and female babies (see Table 2). A repeated measures ANOVA, comparing percent looking times for males and females for the face and mobile, found that neither the main effect of sex [$F(1, 100) = 1.03, p > 0.3$] or of stimulus type [$F(1, 100) = 0.10, p > 0.7$] were significant. There was, however, a significant sex x stimulus type interaction [$F(1, 100) = 5.28, p = 0.02$]. The interaction was investigated using t tests which demonstrated that males looked significantly longer at the mobile than females did ($t = 2.3, df = 100, p = 0.02$) and also that females looked longer at the real face than at the mobile ($t = 2.4, df = 100, p = 0.02$). The results from the ANOVA were replicated when the age and weight of the baby, and the length of gestation were entered as covariates.

insert tables 1 and 2 here

In summary, we have demonstrated that at 1 day old, human neonates demonstrate sexual dimorphism in both social and mechanical perception. Male infants show a stronger interest in mechanical objects, whilst female infants show a stronger interest in the face. The male preference cannot have simply been for a moving stimulus, and both stimuli moved. Rather, their natural motion differed, the face with biological motion, the mobile with physico-mechanical motion. Naturally, these results apply to males and females averaged over a group, and not to all individuals. At such an age, these sex differences cannot readily be attributed to postnatal experience, and are instead consistent with a biological cause, most likely neurogenetic and/or neuroendocrine in nature.

Figure 1: Photographs of the stimuli used

Table 1: Number (and percent) of neonates falling into each preference category

	Face preference	Mobile preference	No preference
Males (n = 44)	11 (25.0%)	19 (43.2%)	14 (31.8%)
Females (n = 58)	21 (36.2%)	10 (17.2%)	27 (46.6%)

Table 2: Mean percent looking times (and standard deviation) for each stimulus

	Face	Mobile
Males (n = 44)	45.6 (23.5)	51.9 (23.3)
Females (n = 58)	49.4 (20.8)	40.6 (25.0)

References

- APA. (1994). DSM-IV Diagnostic and Statistical Manual of Mental Disorders, 4th Edition. Washington DC: American Psychiatric Association.
- Baron-Cohen, S. (2000a). Autism: deficits in folk psychology exist alongside superiority in folk physics. In S. Baron-Cohen, H. Tager Flusberg, & D. Cohen (Eds.), Understanding Other Minds: Perspectives from autism and developmental cognitive neuroscience, (2nd ed.,): Oxford University Press.
- Baron-Cohen, S. (2000b). The cognitive neuroscience of autism: implications for the evolution of the male brain. In M. Gazzaniga (Ed.), The Cognitive Neurosciences, (2nd ed.,): MIT Press.
- Baron-Cohen, S., & Hammer, J. (1997). Is autism an extreme form of the male brain? Advances in Infancy Research, 11, 193-217.
- Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: evidence from very high functioning adults with autism or Asperger Syndrome. Journal of Child Psychology and Psychiatry, 38, 813-822.
- Baron-Cohen, S., O'Riordan, M., Stone, V., Jones, R., & Plaisted, K. (1999). Recognition of faux pas by normally developing children and children with Asperger Syndrome or high-functioning autism. Journal of Autism and Developmental Disorders, 29, 407-418.
- Fantz, R. (1963). Pattern vision in newborn infants. Science, 140, 296-7.
- Hall, J. A. (1985). Nonverbal sex differences. Baltimore: Johns Hopkins University Press.

Happe, F. (1995). The role of age and verbal ability in the theory of mind task performance of subjects with autism. Child Development, 66, 843-855.

Hines, M., & Green, R. (1991). Human hormonal and neural correlates of sex-typed behaviours. Review of Psychiatry, 10, 536-555.

Johnson, M., & Morton, J. (1991). Biology and cognitive development: the case of face recognition. Oxford: Blackwell.

Kimura, D. (1987). Are men's and women's brains really different? Canadian Psychology, 28, 133-147.

Leekam, S., Baron-Cohen, S., Brown, S., Perrett, D., & Milders, M. (1997). Eye-Direction Detection: a dissociation between geometric and joint-attention skills in autism. British Journal of Developmental Psychology, 15, 77-95.

Lutchmaya, S., Baron-Cohen, S., & Raggett, P. (submitted). Foetal testosterone and eye contact at 12 months. , University of Cambridge.

Phillips, W., Gomez, J.-C., Baron-Cohen, S., Riviere, A., & Laa, V. (1996). Treating people as objects, agents, or subjects: How young children with and without autism make requests. Journal of Child Psychology and Psychiatry, 36, 1383-1398.

Rosenthal, R., Hall, J. A., DiMatteo, M. R., Rogers, P. L., & Archer, D. (1979). Sensitivity to nonverbal communication: The PONS test. Baltimore: Johns Hopkins University Press.

Skuse, D., H, James, R., S, Bisop, D., V, M, Coppin, B., Dalton, P., Aamodt-Leeper, G., Bacarese-Hamilton, M., Cresswell, C., McGurk, R., & Jacobs, P., A. (1997). Evidence from Turner's syndrome of an imprinted X-linked locus affecting cognitive function. Nature, 387, 705-708.

Swettenham, J., Baron-Cohen, S., Charman, T., Cox, A., Baird, G., Drew, A., Rees, L., & Wheelwright, S. (1998). The frequency and distribution of spontaneous attention shifts between social and non-social stimuli in autistic, typically developing, and non-autistic developmentally delayed infants. Journal of Child Psychology and Psychiatry, *9*, 747-753.

Willingham, W. W., & Cole, N. S. (1997). Gender and fair assessment. Hillsdale, New Jersey: Erlbaum.

