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Potential Explanation of the Reported Association between Maternal Smoking and Autism

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Kalkbrenner et al. (2012) reported a positive association between maternal smoking and higher functioning autism syndrome disorder (ASD) subtypes. Other studies had previously reported associations between maternal smoking and ASD (St. Pourcain et al. 2011) and between maternal smoking and attention deficit hyperactivity disorder (Langley et al. 2012). Kalkbrenner et al. (2012) concluded that the association warrants further research. No explanation for an association between autism and maternal smoking has been established, so I would like to suggest one.

Baron-Cohen (2002) proposed that one cause of autism is exposure to high levels of intrauterine testosterone; I recently noted that if the mother is the source of the testosterone, many of the established risk factors for autism may be interpreted as confirmation for this hypothesis (James 2012). Stress causes women to secrete adrenal androgens including testosterone; thus, any maternal-stress-related risk factor for autism may be interpreted as supporting Baron-Cohen's hypothesis (Baron-Cohen 2002). Some of the many risk factors are well established, having been identified by Gardener et al. (2009) in a comprehensive meta-analysis, for example, advanced parental age at birth, maternal use of prenatal medications, maternal bleeding, gestational diabetes, being firstborn, and having a mother who was born abroad. I have identified other risk factors using a less rigorous criterion, namely, risk factors that had been reported as statistically significant more than once (James 2012). These included low birth weight, short duration

of gestation, maternal obesity, mother in a technical occupation, lack of breastfeeding, race, and increasing time trend. No previous explanation had been offered for all of these risk factors collectively.

Evidence suggests that the risk factor reported by Kalkbrenner et al. (2012)—maternal smoking—may increase maternal testosterone levels. For example, androgen levels are reportedly high in women who smoke (Kaergaard et al. 2000; Pölkki and Rantala 2009; Sowers et al. 2001), and this has been specifically reported in pregnant women (Toriola et al. 2011). One may infer that maternal smoking (like the other risk factors for autism cited above) is positively associated with increased levels of intrauterine testosterone and thus—invoking the hypothesis of Baron-Cohen (2002)—with autism.

Beaudet (2012) has recently proposed a category of autism that he designated as a milder, more homogeneous form in which the mean IQ is higher. This category is more subject to the recent reported increase in autism and to environmental, as contrasted with genetic, factors. The data of Kalkbrenner et al. (2012) suggest that the association of autism with maternal smoking is confined to higher-functioning autism subtypes. Thus, I suggest that their data could be explained by the high levels of testosterone associated with maternal smoking.

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REFERENCES

- Baron-Cohen S. 2002. The extreme male brain theory of autism. *Trends Cogn Sci* 6:248–254.
- Beaudet AL. 2012. Preventable forms of autism? *Science* 338:342–343.
- Gardener H, Spiegelman D, Buka SL. 2009. Prenatal risk factors for autism. *Br J Psychiatry* 195:7–14.
- James WH. 2012. A potential explanation of some established major risk factors for autism. *Dev Med Child Neurol* 54:301–305.
- Kaergaard A, Hansen AM, Rasmussen K, Andersen JH. 2000. Association between plasma testosterone and work-related neck and shoulder disorders among female workers. *Scand J Work Environ Health* 26:292–298.
- Kalkbrenner AE, Braun JM, Durkin MS, Maenner MJ, Cunniff C, Lee LC, et al. 2012. Maternal smoking during pregnancy and the prevalence of autism spectrum disorders using data from the Autism and Developmental Disabilities Monitoring Network. *Environ Health Perspect* 120:1042–1048.
- Langley K, Heron J, Smith GD, Thapar A. 2012. Maternal and paternal smoking during pregnancy and risk of ADHD symptoms. *Am J Epidemiol* 176:261–268.
- Pölkki M, Rantala MJ. 2009. Smoking affects women's sex hormone-regulated body form [Letter]. *Am J Publ Health* 99:1350.
- Sowers M, Beebe J, McConnell D, Randolph J, Jannausch M. 2001. Testosterone concentrations in women aged 25–50 years: associations with lifestyle, body composition and ovarian status. *Am J Epidemiol* 153:256–264.
- St. Pourcain B, Mandy WP, Heron J, Golding J, Smith GD, Skuse DH. 2011. Links between co-occurring social-communication and hyperactive-inattentive trait trajectories. *J Am Acad Child Adolesc Psychiatry* 50:892–902.
- Toriola AT, Väärasmäki M, Lehtinen M, Zeleniuch-Jacquotte A, Lundin E, Rodgers KG, et al. 2011. Determinants of maternal sex steroids during the first half of pregnancy. *Obstet Gynecol* 118:1029–1036.