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Psychoneuroendocrinology 27 (2002) 285–298

www.elsevier.com/locate/psyneuen

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# The impact of prenatal stress, fetal alcohol exposure, or both on development: perspectives from a primate model

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## Abstract

The question of whether psychosocial stress during pregnancy (alone or in combination with fetal alcohol exposure) has negative consequences for offspring has not been clearly established in human studies. In this article, we present an overview of three prospective longitudinal studies. Using rhesus monkeys as subjects, a noise or hormone stressor, alone or in combination with moderate level alcohol solution, was presented daily during different stages of pregnancy. Prenatal stress resulted in lighter birth weights in two of three studies, and males from the alcohol plus noise stress condition had reduced birth weights. There were no significant effects of any of the prenatal treatments on gestation duration. Both prenatal stress and moderate fetal alcohol exposure reduced attention span and neuromotor capabilities of offspring during the first month of life, while early gestation prenatal stress, during the period of neuronal migration, emerged as a period of enhanced vulnerability for these effects. Under conditions of challenge, prenatally stressed monkeys showed more disturbance behaviors and reduced locomotion and exploration as well as altered hypothalamic–pituitary–adrenal (HPA) axis reactivity to stress. Fetal alcohol exposed monkeys also showed increased HPA axis activity in response to stressful conditions. Finally, altered patterns of alcohol consumption

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*Keywords:* Prenatal stress; Fetal alcohol; Primate; HPA axis; Neuroimaging

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## **1. Introduction**

Increased substance use and abuse as well as violence in everyday American family life has resulted in a growing concern about the effects of prenatal alcohol exposure and psychosocial stress during pregnancy on child outcome. That consumption of large quantities of alcohol during pregnancy causes harm to the fetus is well-established (Clarren and Smith, 1978). There are limited data, however, on whether moderate level alcohol consumption has harmful effects on offspring and whether prenatal psychosocial stress exacerbates these effects (Jacobson and Jacobson, 1999). We present an overview of three prospective studies designed to examine the effects of prenatal disturbances (specifically, prenatal stress and/or fetal alcohol exposure) on offspring behavior and physiology in nonhuman primates. The direction of our research program has been influenced by the proliferation of research on the construct of stress, along with the growing concern that stress might influence alcohol or other drug consumption (Piazza and Le Moal, 1996).

It is a relatively new idea that if a pregnant woman is exposed to stressful events in everyday life, her offspring might be at risk for learning, behavioral and/or emotional disorders (see Paarlberg et al., 1995; Wadhwa, 1998, for reviews). Implicit are two critical notions: (1) that prenatal influences, such as stress to the mother or maternal alcohol consumption, contribute to child outcome by interacting with numerous other factors in a complex mutually-interacting process; and (2) that exposure to prenatal stress and/or alcohol could alter an individual's developmental trajectory through altered early brain development.

We approach the first concept with the view that prenatal stress and/or alcohol exposure are not singular causes of deficit, but rather probabilistic contributors. As such, prenatal events are considered risk factors interacting in a complex process with a host of other factors embedded within the context of the developing child, which influence concurrent and later outcome. This viewpoint is held broadly by developmental psychologists (see Cicchetti and Rogosch, 1996; Rutter and Sroufe, 2000; Sameroff, 2000, for reviews). For example, Sameroff found that the more risk factors in the environment, the greater the prevalence of clinical symptoms in preschoolers, as well as at 13 and 18 years of age (Sameroff et al. 1987, 1998; Sameroff, 2000). Thus, according to this probabilistic multi-causality approach to human development, prenatal stress and/or alcohol exposure can be associated with a variety of developmental outcomes, given the variability in other biological, psychological, and environmental factors which could enhance or detract from positive adaptation (Boyce et al., 1998).

A second concept underlying our research program is the notion that the environment of the mother during the prenatal period can have an effect on early fetal brain

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