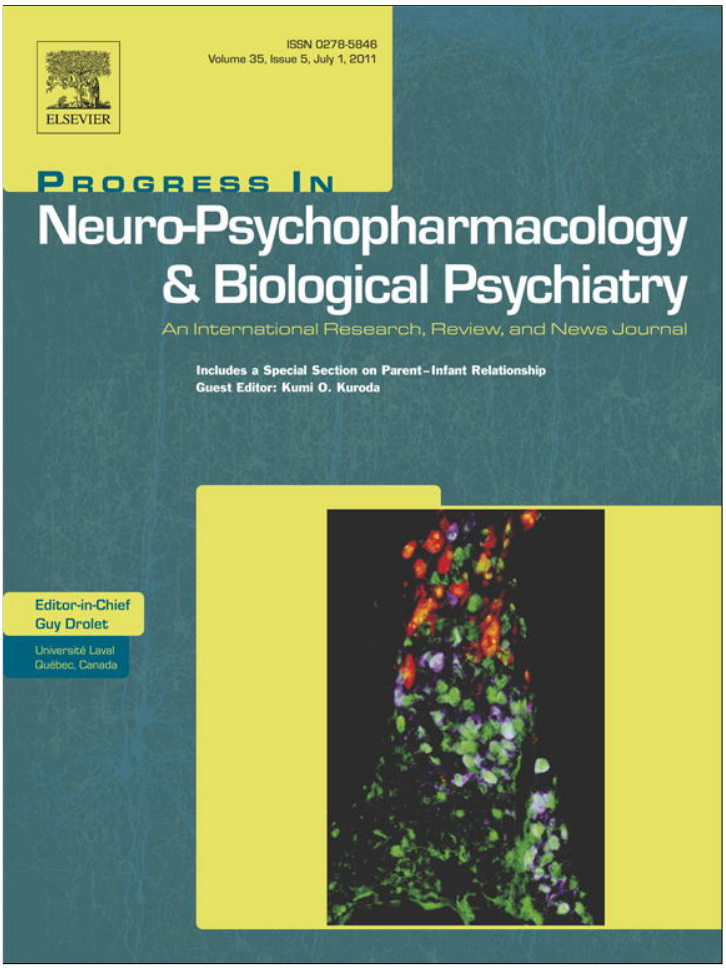

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Preface

Neurobiological basis of parent-infant relationship

This special issue deals with the brain mechanisms that mediate various aspects of parent–infant relationships. An effective mother–infant relationship is indispensable for all mammalian neonates, since they are dependent on maternal care for survival. Therefore the neural mechanisms supporting the mother–infant relationship should be conserved throughout mammalian evolution at least in their basic components. We can plausibly contribute to the understanding of the human parent–infant relationship in the future by studying the neural mechanisms using non-human mammalian models.

To maximize the likelihood of survival and well-being of the young, mammalian parents, especially mothers, are equipped with an innate motivation for nurturing the young, including nursing (the provision of mother's milk), thermoregulation and protection. These behaviors that may increase the probability of survival of the young are collectively called parental behaviors. Infants are also born with innate attachment behaviors to the parents: infants actively send signals and elicit effective parental care by following, clinging and calling/crying to the caregiver. These parental and attachment behaviors have an innate basis; still, each can be modified and developed by experiential factors during ontogeny.

The parent–infant relationship is a dynamic, reciprocal process. For example, nursing in humans can be dissected into a series of behaviors and responses from both sides (Fig. 1). Such mutually dependent relationships between mother and infant are apparently very complex. To be able to clarify mechanisms involved in these relationships, we may need to use two sequential approaches: first, reductionism that investigates each component as separately as possible, followed by the analysis of the dynamic interactive process.

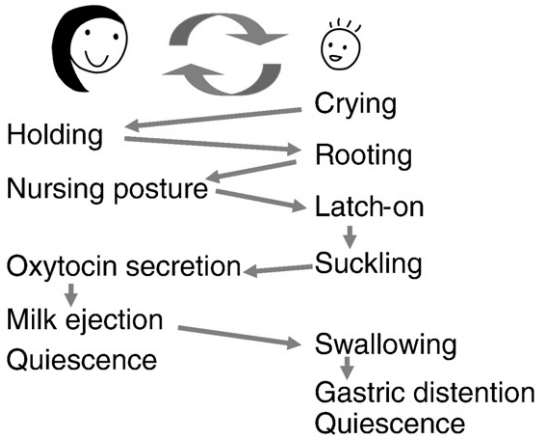

Fig. 1. Behavioral chain for nursing.

For convenience's sake, the parent–infant relationship will be subdivided into four factors here (Fig. 2):

(i) “Parental behavior” which gives rise to (ii) “influences on the offspring”, and

(iii) Infantile “Attachment behavior” which brings about (iv) “influences on the mother”.

This scheme can be extended in two ways; firstly to mother–fetus/embryo interaction (italicized items in Fig. 2). In this case, any action of the fetus or fetal-originated tissue (including placenta-produced hormones) can be classified into (iii). Secondly, “mother” can also be extended to father, or to any other conspecific caregiver.

This categorization is rough and is not intended to set one phenomenon exclusively into one category. In the behavioral chain for nursing (Fig. 1), maternal holding is the response to the infant's cry, but also one of the active behaviors of the mother. Likewise, milk letdown reflex is the response to infants' suckling stimulus, but also includes active mechanisms in the maternal brain.

This categorization is designed to make it easy to specify which mechanism of the whole mother–infant relationship is the primary focus of a given experiment. Let's take an example of the effects of an infant's cry on maternal brain activities as measured by functional magnetic resonance imaging. Although this experiment uses an infant's cry (iii) as a stimulus, such experimental settings do not investigate the mechanism in the infant's brain required for producing the cry, but instead study the mechanism of maternal responses (iv). Therefore this experiment is classified into (iv) rather than (iii). Similarly, the effect of maternal deprivation on the future parenting style of the offspring will be classified into (ii), as the independent variable is the amount of maternal care received by the infant, and the dependent variable is the parenting output of the infant as an adult. The mechanism of this effect will be sought in the infant's brain.

In the present special issue of Progress in Neuro-Psychopharmacology and Biological Psychiatry, six groups of scientists describe these aspects of parent–infant relationships in various mammalian species. First, two articles focus on the mother–fetus/embryo relationship during pregnancy: Douglas's review highlights the bi-directional communication (i–iv) between embryo and mother beginning as early as the peri-implantation period (ii), and the effect of maternal stress on pregnancy outcome (ii); the review by Brunton & Russell outlines pregnancy-induced adaptations in maternal physiology and stress responses (iv), as well as reviewing the possible mechanisms of fetal programming (ii) by maternal stress in pregnancy. Then for postpartum mother–infant interactions, Saltzman & Maestripieri provide a critical overview of current understanding of the neuroendocrine control (e.g., by estrogens, progestogens, prolactin, oxytocin and serotonin) of primate maternal behavior (i). Kuroda and colleagues focus on the neuroanatomy and

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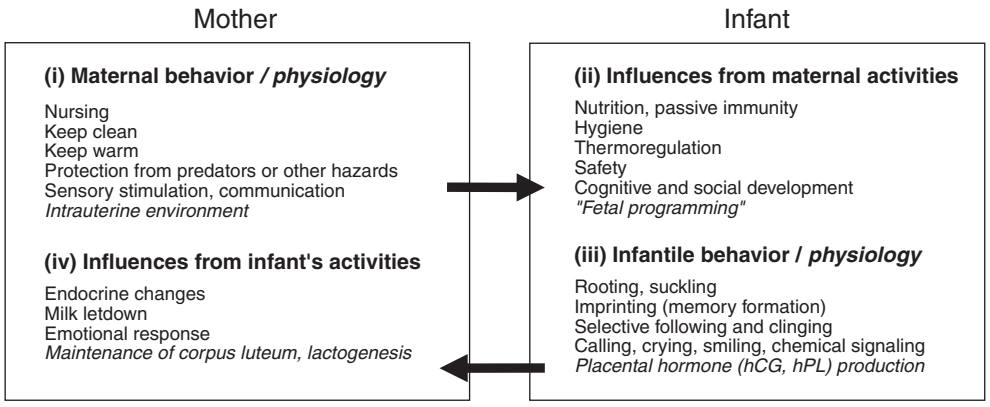

Fig. 2. Four components of mother–infant (conceptus) interactions.

molecular mechanisms of parental behavior (i) in laboratory rats and mice, with special emphasis on technical issues of studies using genetically modified mice. Mogi and colleagues cover the aspect (ii), maternal influences on the infants' development, by describing the effects of early weaning in rodents, dog, and pig. They also mention (iii) and (iv) that various pup stimuli, such as the ultrasonic vocalizations of mouse pups, reinforce mother–infant bond formation. Finally Swain's article concentrates on structural as well as functional magnetic resonance imaging studies in human parents' brain; by a thorough review of previous studies on parental brain activity in response to an infant's cry or smile (iv), the author presents a cortico-limbic network model in which infant stimuli evoke emotional response, motivation and reward, ultimately organize parenting responses.

The organization of this review issue is meant to complement the format used in "The Parental Brain: Neurobiology, Behaviour and the Next Generation" Conference in 2010, including the plenary lectures of Barry Keverne, Michael Meaney and Tracy Bale. Please refer, therefore, to the coming proceedings of this conference, which will be published in three different journals of *Stress*, *Journal of Neuroendocrinology*, and *Neuroendocrinology* in 2011.

We hope this special issue of Progress in Neuro-Psychopharmacology and Biological Psychiatry will trigger attention and interest in this exciting research field of parent–infant relationships, and will prompt the reader to revisit its clinical relevance to mental health of both parents and offspring.

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