SEX DIFFERENCES IN SOCIAL AND EMOTIONAL BEHAVIOR IN MICE:
HOW, WHY AND WHEN.

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Sexual selection theory [5] predicts that the behavioral strategies in coping with social and environment challenges would differ in males and females when a discrepancy in parental investment exists - as it is in all mammalian species. The intertwined but separate issues addressing proximate and evolutionary questions should always be considered in biological research; thus, when addressing the question of sex differences in emotional and defensive behavior we should consider the proximate mechanisms (e.g., genetic and hormonal basis) and the adaptive significance of such behavioral diversity (i.e., ultimate causation). I address here three main issues on sex-related differences in social and emotional behavior in mice: 1) basic sex differences in house mice; 2) proximate and ultimate causes of such differences, and 3) the interfering effects of hormonally active chemicals.

Although strain differences exist, male and female house mice show clear differences in their social behavior and emotional responses [9]. Male mice are indeed territorial and aggressive to other males, while females are generally tolerant and socially oriented to other females. However, our studies in wild-trapped mice have shown that the timing and context of aggression and its targets appear to differ in females and males and the social organization of female mice appears to be more complex and variable than the clear-cut territorial dominance observed among males. Females appear to become aggressive after short periods of cohabitation with a male and direct attacks mostly towards other females, except during lactation when males are also attacked [8]. A number of studies have revealed higher levels of locomotor activity, sometimes associated by lower anxiety, in female relative to male mice, which show higher levels of novelty seeking, though many factors (such as strain, housing procedures, age, experience, reproductive state) can affect these behaviors. Different housing procedures, as means to provide different social environment, differentially affect male and female mice. We have shown that living alone for a short period or with same-sex siblings (brothers or sisters) may have a different psychosocial relevance for the two genders while not affecting any physiological indexes of stress in male and female mice [6]. Common developmental manipulations may have differential carry-over effects in adult males or females; establishing unisexual groups of mice at different age (before or after puberty) induced several behavioral and physiological alterations in males but not in females, with the exception of lower corticosterone level in both male and female housed together with unrelated conspecifics after weaning or as subadults [3].

In mice, as in other mammals, non reproductive behaviors have been described to show sex differences in quantity of performance expressed rather than being present in one sex and absent in the other [1]. Although some of these sex differences reflect activational effects of estradiol and testosterone in the blood of adult males and females, differential actions of gonadal steroids during the perinatal period play a crucial role in organizing the sexual dimorphism in behavior and its underlaying neural substrates [4]. However, gonadal hormones are not the only mechanism mediating the development of sexual dimorphism; genetic mechanisms, independent by hormonal action, may trigger sexual differentiation of brain and behavior [2]. The environment also (e.g., maternal behavior) appears to have an
important impact on the dimorphism and differentiation of the CNS, thus influencing behavior.

As steroid hormones are a critical element of the process of sexual differentiation of brain and behavior in higher vertebrates, exposure to endocrine active compounds (EACs) that mimic, antagonize or in other ways interfere with these hormonal signals at sensitive developmental stages in the life cycle is likely to impact subsequent neuroendocrine and behavioral functions. Results from our and other laboratories indicate that developmental exposure to low doses of EACs affect the sexual differentiation of non reproductive behavioral systems in mice, such as explorative, emotional and cognitive behaviors. Here I present our ethological investigations of the effects of maternal exposure during pregnancy and/or lactation to the estrogenic chemical bisphenol A (BPA) at a concentration within the range of human exposure and not patently teratogenic (10-40 ug/kg), on behavior and neural circuits of male and female offspring [7]. A consistent effect of the maternal exposure to BPA is that in different experimental settings, while a sex difference was observed in the control group, exposure to BPA decreased sex differences of several behavioral responses. Males and females showed differing sensitivities to the estrogenic chemical exposure. More specifically, maternal exposure to BPA mostly affected female mice on exploration, emotional and cognitive behaviors, and maternal behavior, while males were more sensitive to BPA as far as the development of aggression and social interactions. Post-natal exposure appears sometime produce wider effects than fetal (prenatal) exposure on several responses, though possible confounding effects of cross fostering procedure should be considered. In the conceptual frame of evolutionary theory, sex-differences in behavior are thought to reflect adaptive differences of behavioral strategies in coping as resulting from sexual selection. Longitudinal studies on effects of endocrine disrupting chemicals should be carried out in order to evaluate in which context, and with what intensity, eliminating or reversing sex differences could have relevance to population dynamics, and whether behavioral alterations occur in systems influencing reproductive success and thus individual fitness.

Reference list
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