The neuroscience of motherhood

Pregnancy and lactation can have significant long-lasting effects on the neurobiological processes in female mammals. These effects sometimes include changes in the brain’s neurochemical sensitivity, its substrates, and hormonal regulation, as well as possible shifts in behaviour such as maternal instinct and perceived anxiety. Dr Robert Bridges, working at Tufts University in North Grafton, MA, has conducted extensive research in the field of neuroscience, particularly in relation to reproductive biology. His latest work focuses on how the reproductive experience of pregnancy and lactation affects brain connectivity and activity later in life.

Motherhood can be a both challenging and fulfilling experience for women and female mammals, which often leads to huge emotional and life-related changes. Yet pregnancy and lactation have been found to affect more than just a mother’s life circumstances, leading to a number of remarkable changes in brain chemistry and connectivity, as well as hormone secretion patterns and behaviours. The study of neuroscience in relation to reproductive experience is truly fascinating, as it aims to better understand the changes in the brain that take place in a woman after pregnancy and lactation. Dr Bridges has dedicated most of his career to investigating these dynamics and his findings have helped to shed light on some of the biological effects of reproductive experiences on the brain of female mammals.

NEUROPLASTICITY: HOW THE BRAIN ADAPTS THROUGH LIFE
The brain is an ever-changing organ, wired to constantly re-organise itself throughout life, forming new neural connections in reaction to life experiences and maturation. Neuroplasticity is the quality of the brain that allows neurones in the brain to adjust their activity and structure in response to changes in the body or the surrounding environment.

While many of these connections are formed during childhood and adolescence, the brain keeps changing and adapting throughout adulthood, particularly in response to significant environmental changes and life events. These changes can be prominent or minor and can occur during or after a number of more or less life-altering events, including strokes or major physical injury, as well as traumas or dramatic changes in lifestyle. Whether we are acquiring new skills or recovering from serious bodily harm, the brain is in constant evolution; and the experience of pregnancy is no different.

BEHAVIOURAL CHANGES IN MOTHERHOOD
Dr Robert Bridges conducted extensive research into the biological dynamics associated with reproductive experiences such as pregnancy and lactation. Dr Bridges found that motherhood results in a long-term increase in maternal behaviours, which is typically a direct result of the experience.
Dr Bridges’ work has helped to shed light on some of the biological effects of reproductive experiences on the brain of female mammals

MOTHERHOOD AND THE BRAIN

Research conducted by Dr Bridges suggests that reproductive experience often has a transformative and significant effect on the brain and biological states of female mammals, affecting a number of hormonal, immunological and neural processes. In both women and rats, a prior reproductive experience can result in enhancements in dopaminergic activity, or secretion of dopamine, a neurotransmitter that results in feelings of reward, well-being, and energy. Following the experience of an earlier motherhood, this increase in dopaminergic activity appears to contribute to reductions in the secretion of prolactin (PRL), a pituitary protein known for enabling the production of milk in mammals. The responses of the brain to prolactin also appeared to be enhanced in mothers that were well beyond the end of nursing. Dr Bridges’ studies on rats found that in experienced mothers, peripheral and neurochemical levels. Behaviourally, previously parous mothers (who have already had offspring) display enhanced maternal care towards young, a so-called “maternal memory”, as well as reductions in anxiety. The neurochemical shifts include reductions in pituitary prolactin hormone release, an increase in neural sensitivity to prolactin stimulated gene expression, and increases in neural dopamine release and actions. Prior parity also results in reductions in neural opiate sensitivity as measured by the reduced ability of opioids to interfere with maternal care in females with greater reproductive experience.

UNDERSTANDING REPRODUCTIVE BIOLOGY

Pregnancy and lactation can be truly transformative experiences for female mammals, in terms of life circumstances, as well as biological, hormonal and brain activity. A mother’s brain changes and adapts, as a result of her experience of pregnancy and in order to face the new challenges that come with motherhood.

Dr Bridges’ work substantially contributes to the scientific understanding of reproductive biology and neuroscience. In the future, this could help to shed light on the biological dynamics behind a number of post-partum or hormone-related disorders in women, consequently assisting in the development of more effective treatments.

When and how did you first start being interested in the neuroscience of reproductive experiences?

My interests in neuroscience and behaviour emerged during my undergraduate education at Earlham College. As a biology major, I became very interested in exploring the biological basis of behaviour. My specific interests in maternal behaviour and reproductive biology developed as a graduate student in the laboratory of Dr. M. X. Zarrow in the BioBehavioral Sciences Program at the University of Connecticut. My behavioural and neuroendocrine skills were further honed during my postdoctoral trainings at the Institute of Animal Behavior at Rutgers University and at the UCLA Brain Research Institute and as a young faculty member at Harvard Medical School.

What have you found to be the most prominent changes in terms of female mammals' brain activity after pregnancy and lactation?

The most striking long-term changes in the adult female following pregnancy and lactation occur at both hormonal and neurochemical levels. Behaviourally, previously parous mothers (who have already had offspring) display enhanced maternal care towards young, a so-called “maternal memory”, as well as reductions in anxiety. The neurochemical shifts include reductions in pituitary prolactin hormone release, an increase in neural sensitivity to prolactin stimulated gene expression, and increases in neural dopamine release and actions. Prior parity also results in reductions in neural opiate sensitivity as measured by the reduced ability of opioids to interfere with maternal care in females with greater reproductive experience.

What do you feel have been your most important findings so far, and why?

Our most significant research findings are that the normal states of pregnancy, birth, and lactation exert long-term effects on the adult female’s behavioural, neuroendocrine, and neurochemical states. These findings emphasise the fact that the female’s brain can profoundly change in association with motherhood and that these changes appear long-lasting. In addition to identifying these specific changes in the female’s behavioural and neurochemical states, our prior research demonstrated that prolactin and placental lactogens act in specific brain sites to stimulate maternal care. Together, these research findings advance our understanding of the biological basis and consequences of motherhood.

How could your fascinating field of research best inform medical practice in future?

Our research raises the question of how shifts in neurochemical sensitivities may impact the treatment of women with drugs that affect the dopaminergic and opioidergic systems. Drug dosing may need to be tailored more to the woman’s reproductive history. The research also impacts our understanding of addiction tendencies, since female rats become more tolerant of opiates with increased reproductive experience. Likewise, that maternal experience alters subsequent behaviour and neural connectivity could affect treatment approaches for anxiety and depression. Finally, understanding how reproductive history affects endocrine activity will help enhance our understanding of endocrine-mediated diseases, including breast cancer.

What are your next steps in terms of research and investigation?

Future research will focus on which specific molecules and brain regions are modified by the female’s reproductive history. Presently, we are investigating whether the behavioral changes produced by prior maternal experience are mediated by changes in the brain oestrogen receptor system. Moreover, in collaboration with the Cognitive Neuroscience and Reproductive Biology Laboratory at the University of Massachusetts Medical School, we plan to examine how motherhood modifies neural connectivity in brain regions associated with maternal care and reward. Finally, we will examine how the neural prolactin receptor system may be involved in the expression of maternal memory.

Dr Bridges received his BA from Earlham College and PhD from the University of Connecticut. He was a postdoctoral fellow at Rutgers Institute of Animal Behavior and UCLA’s Brain Research Institute before joining the faculty at Harvard Medical School in 1978. He moved to Tufts University in 1990 where he is currently full professor.

CONTACT

Robert S. Bridges, Ph.D.
Professor, Department of Biomedical Sciences
Cummings School of Veterinary Medicine at Tufts University
200 Westboro Road
North Grafton, MA 01536, USA
E: robert-bridges@tufts.edu
T: +1 508 839 7985
W: http://vetprofiles.tufts.edu/faculty/robert-bridges