Published in final edited form as:

Neuroscience. 2013 June 3; 239: 1–2. doi:10.1016/j.neuroscience.2012.10.022.

INTRODUCTION TO ‘STEROID HORMONE ACTIONS IN THE CNS: THE ROLE OF BRAIN-DERIVED NEUROTROPHIC FACTOR (BDNF)’

H. E. Scharfman,

The Nathan Kline Institute for Psychiatric, Center for Dementia Research, 140 Old Orangeburg Road, Building 35, Orangeburg, NY 10962, United States, Tel: +1-845-398-5427; fax: +1-845-398-5422. hscharfman@nki.rfmh.org

E. A. Kramár,

University of California at Irvine, Department of Anatomy and Neurobiology, 837 Health Sciences Road, Irvine, CA 92697, United States, Tel: +1-949-824-9358. ekramar@uci.edu

V. Luine, and

Hunter College and The Graduate Center of CUNY, Department of Psychology, 695 Park Avenue, New York, NY, 10065, United States, Tel.: +1-212-772-4223; fax: +1-212-772-5620. vlumine@hunter.cuny.edu

D. P. Srivastava

Centre for the Cellular Basis of Behaviour, Department of Neuroscience, Institute of Psychiatry, King's College London, London SE5 8AF, United Kingdom, Tel.: +44(0)2078485412. deepak.srivastava@kcl.ac.uk

Historically there have been many discussions of the growth-associated actions of estrogen, progesterone and androgen in the periphery based on their critical functions related to reproduction. For example, the initial surge in estrogen during the first stages of pregnancy is critical to the growth of the uterus, placenta and fetus. During each ovarian cycle, a surge in 17 β -estradiol at the middle of each cycle leads to maturation of the ovarian follicle and its release from the ovary. The other gonadal steroids are equally as important in growth and growth-associated actions in peripheral tissues.

What has become increasingly clear is that these same “reproductive” or “gonadal” steroids are also critical to the development of the CNS and the types of plasticity that occur in the adult CNS. For example, a neonatal surge in androgen in the male is converted to 17 β -estradiol and shapes the brain and behavior for the lifetime (Lenz et al., 2012). In puberty and adulthood, estrogen, progesterone and androgen modify neuronal and synaptic plasticity such as remodeling of the dendritic tree and synapse structure, generation of neurons in the adult hippocampus, and the suggested cellular correlate of learning – long-term potentiation (LTP) (Cooke and Woolley, 2005; Galea et al., 2008; Smith et al., 2009; Ooishi et al., 2012). Thus estrogen, progesterone and androgen influence diverse areas of the brain and spinal

cord, and have diverse targets – including neurons and astrocytes, as well as CNS vasculature.

Given the remarkable influence of steroid hormones on brain development and plasticity, it should be no surprise that many reports in the literature show interactions between steroids and a family of growth-associated proteins, the neurotrophins. Neurotrophins were given their name because of their critical role in the developing CNS and now it is clear that they also are important in adulthood, where they are critical to the maintenance of neurons, and both neuronal and synaptic plasticity. Although there are several members of the neurotrophin family, this special issue is focused primarily on brain-derived neurotrophic factor (BDNF) because of the wealth of data implicating BDNF and its receptor trkB in the actions of steroid hormones. While published data support a role for nerve growth factor, neurotrophin-3, and neurotrophin 4/5 in growth and plasticity, the majority of data that relate to steroids involves BDNF and trkB. Notably, the literature not only documents the effects of estrogen, progesterone and androgen in the actions of BDNF (and vice versa) but there also is a great deal of evidence that other steroid hormones are relevant, such as glucocorticoids and thyroid hormones. Interestingly, some of the studies of glucocorticoids and BDNF may not be widely known to investigators focused on other steroid hormones and BDNF. Likewise, the remarkable relationship between androgen and BDNF in the avian brain or the spinal cord seems to be cited rarely in studies about progesterone, BDNF and neuroprotection, or estrogen, BDNF and synaptic plasticity in the hippocampus. Therefore, it is timely to bring together what is known from diverse areas of neuroscience, and ideal for the IBRO journal *Neuroscience* that brings together neuroscience from all areas of the world. Moreover, while great progress has been in understanding the role of steroids and BDNF, these studies highlight that the interactions between these factors in shaping brain function, under normal or pathological conditions, are complex. Therefore, by presenting these reviews together in a Special issue of *Neuroscience*, it is hoped that not only will they provide a comprehensive overview of our current state of knowledge, but that they will help direct future studies aimed at dissecting the relationship that steroid hormones and BDNF play in the CNS. Five steroid hormones or steroid hormone families are highlighted – estrogen, progesterone, androgen, glucocorticoids and thyroid hormone – each with several articles from leaders in the field.

Abbreviations

BDNF	brain-derived neurotrophic factor
LTP	long-term potentiation.

REFERENCES

- Cooke BM, Woolley CS. Gonadal hormone modulation of dendrites in the mammalian CNS. *J Neurobiol.* 2005; 64:34–46. [PubMed: 15884004]
- Galea LA, Uban KA, Epp JR, Brummelte S, Barha CK, Wilson WL, Lieblich SE, Pawluski JL. Endocrine regulation of cognition and neuroplasticity: our pursuit to unveil the complex interaction between hormones, the brain, and behaviour. *Can J Exp Psychol.* 2008; 62:247–260. [PubMed: 19071993]

3. Lenz KM, Nugent BM, McCarthy MM. Sexual differentiation of the rodent brain: dogma and beyond. *Front Neurosci.* 2012; 6:26. [PubMed: 22363256]
4. Ooishi Y, Kawato S, Hojo Y, Hatanaka Y, Higo S, Murakami G, Komatsuzaki Y, Ogiue-Ikeda M, Kimoto T, Mukai H. Modulation of synaptic plasticity in the hippocampus by hippocampus-derived estrogen and androgen. *J Steroid Biochem Mol Biol.* 2012; 131:37–51. [PubMed: 22075082]
5. Smith SS, Aoki C, Shen H. Puberty, steroids and GABA(A) receptor plasticity. *Psychoneuroendocrino.* 2009; 34(Suppl. 1):S91–S103.