

UC Davis

UC Davis Previously Published Works

Title

Family Life on the Prairie

Permalink

<https://escholarship.org/uc/item/3f68s5vw>

Journal

Frontiers in Neuroscience, 4(DEC)

ISSN

1662-4548

Author

Bales, Karen L

Publication Date

2010

DOI

10.3389/fnins.2010.00169

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, available at <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Peer reviewed



Family life on the prairie

Karen L. Bales*

Department of Psychology, University of California, Davis, CA, USA

*Correspondence: klbales@ucdavis.edu

A commentary on

The impact of early life family structure on adult social attachment, alloparental behavior, and the neuropeptide systems regulating affiliative behaviors in the monogamous prairie vole (*Microtus ochrogaster*)

by Todd H. Ahern and Larry J. Young. (2009) *Front. Behav. Neurosci.* 3:17.

The prairie vole has become a flagship species for the biomedical exploration of the neurobiology of social bonding (Carter et al., 1995; Young et al., 2005). It is a species native to the prairies of Midwest North America, and adults show social “monogamy” – a suite of behaviors including the formation of an emotional pair-bond with an adult partner; shared care of offspring including male care, and in this case, care by older offspring as well; and maintenance of territories (Carter and Getz, 1993). Research on prairie voles and closely related polygynous species such as meadow and montane voles has illuminated the role of oxytocin and vasopressin as key neuropeptides regulating social behavior, and particularly their role in the formation of selective social bonds (Witt et al., 1990; Winslow et al., 1993; Insel and Hulihan, 1995; Young et al., 2005).

Early experiences of various kinds (early handling, separation from the mother, early abuse, etc.) have long been studied by psychobiologists, most famously by Levine (Levine, 1957; Levine and Lewis, 1959) and Denenberg (Denenberg et al., 1962; Denenberg and Whimbey, 1963). It was something of a revelation when Meaney and colleagues, rather than manipulating early experience, began examining natural variation in maternal behavior of rat mothers, and showing long-lasting effects of this early experience on behavior, stress regulation, and neuropeptide systems (Francis et al., 1999; Meaney, 2001; Meaney and Szyf, 2005).

Ahern and Young (2009) take this research one step farther by exploring the long-term consequences of ethologically relevant variations in family structure in prairie voles. Wild prairie voles display several types of family structure in which young voles are reared, including single mother families, biparental families, and cooperative groups in which older offspring help rear the pups (Carter and Getz, 1993). In a very thorough series of experiments, Ahern and Young compare offspring of single mothers to those of biparental pairs on many outcome measures. Offspring raised by single mothers received less licking from their parent, were left alone in the nest more often, and weighed less upon weaning. Females raised by single mothers showed lower levels of interest in infants, were more exploratory, and took longer to form a pair-bond than daughters raised by both parents. On the other hand, males raised by single mothers took longer to form a pair-bond but showed no changes in alloparenting or anxiety/exploratory behavior. While females raised by single mothers had higher oxytocin gene expression in the paraventricular nucleus, there were few other changes in neuropeptides or in their receptors.

These sets of results are fascinating for a number of reasons. First and most obvious are the sex differences in response to early environment, in which females appear to be more sensitive to the absence of their father during development. Prairie voles have often been shown to be very responsive to changes in early environment, with single injections of neuropeptides (Bales and Carter, 2003; Bales et al., 2004c) or even differences in husbandry (Bales et al., 2007) having long-term effects on social behavior. However, in most of these studies (as in some adult studies as well) males were the more sensitive sex (Bales et al., 2004a, 2006). The results of this study may suggest either that the behaviors measured here are dependent on redundant systems in males (Bales et al., 2004b) but not females, or alternatively, suggest that being reared by a single mother is not producing

early adversity for male offspring in the same way that it is for females.

This leads us to another important question – what exactly does being raised by a single mother signal to a young prairie vole? Can this be viewed as a model of early adversity, or is this rather signaling that habitat conditions are favorable enough for a single mother to be able to raise offspring by herself? If cooperative groups were to be studied, would we expect extra care by alloparents to lead to increased pair-bonding – or would it signal that habitat is saturated and pups should be more anxious and less likely to form a pair-bond?

Finally, this leads us to think about our interpretations of behavioral outcomes for this species. The authors suggest that some of the behavioral characteristics displayed by offspring raised by single mothers (slower formation of pair-bonds, etc.) show some parallels to human psychopathology, particularly borderline personality disorder. At first glance this is a somewhat curious comparison. Since single mother families are a natural (and common) variation in family structure in voles, would not offspring produced by these mothers be both within the “normal” realm of variation, as well as potentially adapted to certain types of environment? What is “good” social behavior for a prairie vole vs. “poor” social behavior, and would not those vary depending on circumstances? Is borderline personality disorder itself merely a variation on human social behavior that is sometimes maladaptive in modern Western society? All of these questions might be relevant in considering interpretation of these behavioral changes.

REFERENCES

- Ahern, T. H., and Young, L. J. (2009). The impact of early life family structure on adult social attachment, alloparental behavior, and the neuropeptide systems regulating affiliative behaviors in the monogamous prairie vole (*Microtus ochrogaster*). *Front. Behav. Neurosci.* 3, 1–19. doi: 10.3389/fnins.2010.00169
- Bales, K. L., Abdelnabi, M., Cushing, B. S., Ottinger, M. A., and Carter, C. S. (2004a). Effects of neonatal oxytocin manipulations on male reproductive potential in prairie voles. *Physiol. Behav.* 81, 519–526.

- Bales, K. L., and Carter, C. S. (2003). Developmental exposure to oxytocin facilitates partner preferences in male prairie voles (*Microtus ochrogaster*). *Behav. Neurosci.* 117, 854–859.
- Bales, K. L., Kim, A. J., Lewis-Reese, A. D., and Carter, C. S. (2004b). Both oxytocin and vasopressin may influence alloparental behavior in male prairie voles. *Horm. Behav.* 45, 354–361.
- Bales, K. L., Kramer, K. M., Lewis-Reese, A. D., and Carter, C. S. (2006). Effects of stress on parental care are sexually dimorphic in prairie voles. *Physiol. Behav.* 87, 424–429.
- Bales, K. L., Lewis-Reese, A. D., Pfeifer, L. A., Kramer, K. M., and Carter, C. S. (2007). Early experience affects the traits of monogamy in a sexually dimorphic manner. *Dev. Psychobiol.* 49, 335–342.
- Bales, K. L., Pfeifer, L. A., and Carter, C. S. (2004c). Sex differences and effects of manipulations of oxytocin on alloparenting and anxiety in prairie voles. *Dev. Psychobiol.* 44, 123–131.
- Carter, C. S., DeVries, A. C., and Getz, L. L. (1995). Physiological substrates of mammalian monogamy: the prairie vole model. *Neurosci. Biobehav. Rev.* 19, 303–314.
- Carter, C. S., and Getz, L. L. (1993). Monogamy and the prairie vole. *Sci. Am.* 268, 100–106.
- Denenberg, V. H., Ottinger, D. R., and Stephans, M. W. (1962). Effects of maternal factors upon growth and behavior of the rat. *Child Dev.* 33, 65–71.
- Denenberg, V. H., and Whimbey, A. E. (1963). Infantile stimulation and animal husbandry: a methodological study. *J. Comp. Physiol. Psychol.* 56, 877–878.
- Francis, D., Diorio, J., Liu, D., and Meaney, M. J. (1999). Nongenomic transmission across generations of maternal behavior and stress responses in the rat. *Science* 286, 1155–1158.
- Insel, T. R., and Hulihan, T. J. (1995). A gender-specific mechanism for pair bonding – oxytocin and partner preference formation in monogamous voles. *Behav. Neurosci.* 109, 782–789.
- Levine, S. (1957). Infantile experience and resistance to physiological stress. *Science* 126, 405.
- Levine, S., and Lewis, G. W. (1959). The relative importance of experimenter contact in an effect produced by extra-stimulation in infancy. *J. Comp. Physiol. Psychol.* 52, 368–369.
- Meaney, M. J. (2001). Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. *Annu. Rev. Neurosci.* 24, 1161–1192.
- Meaney, M. J., and Szyf, M. (2005). Environmental programming of stress responses through DNA methylation: life at the interface between a dynamic environment and a fixed genome. *Dialogues Clin. Neurosci.* 7, 103–123.
- Winslow, J. T., Hastings, N., Carter, C. S., Harbaugh, C. R., and Insel, T. R. (1993). A role for central vasopressin in pair bonding in monogamous prairie voles. *Nature* 365, 545–548.
- Witt, D. M., Carter, C. S., and Walton, D. M. (1990). Central and peripheral effects of oxytocin administration in prairie voles (*Microtus ochrogaster*). *Pharmacol. Biochem. Behav.* 37, 63–69.
- Young, L. J., Murphy Young, A. Z., and Hammock, E. A. (2005). Anatomy and neurochemistry of the pair bond. *J. Comp. Neurol.* 493, 51–57.

Received: 05 August 2010; accepted: 27 August 2010; published online: 08 December 2010.

Citation: Bales KL (2010) Family life on the prairie. *Front. Neurosci.* 4:169. doi: 10.3389/fnins.2010.00169

Copyright © 2010 Bales. This is an open-access article subject to an exclusive license agreement between the authors and the Frontiers Research Foundation, which permits unrestricted use, distribution, and reproduction in any medium, provided the original authors and source are credited.