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Early Life Experiences Affect Adult Delayed-Type Hypersensitivity in Short and Long Photoperiods

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Environmental experiences during development provide animals with important information about future conditions. Siberian hamsters are photoperiodic rodents that dramatically adjust their physiology and behavior to adapt to seasonal changes. For example, during short winter-like days, hamsters enhance some components of immune function putatively to cope with increasing environmental challenges. Furthermore, early life stress alters the developmental course of the immune system. Overall, immune function is typically suppressed in response to chronic stress, but responses vary depending on the type of stress and components of immune function assessed. This led us to hypothesize that delayed-type hypersensitivity (DTH), an antigen-specific, cell-mediated immune response, would be differentially modulated in hamsters that underwent early life maternal separation (MS) in either short or long photoperiods. At birth, hamsters were assigned to either short (SD; 8 h light/day) or long (LD; 16 h light/day) photoperiods and either daily 3 h MS, daily 15-min brief maternal separation (BMS), or no manipulation from postnatal day 2 through 14. In adulthood DTH was assessed. Hamsters reared in short days enhanced DTH responses. MS and BMS attenuated DTH responses in both short and long days. However, BMS long-day female hamsters did not suppress pinna swelling, suggesting a protective effect of female sex steroids on immune function. As is typical in short days, reproductive tissue was regressed. Reproductive tissue mass was also decreased in long-day MS female hamsters. Furthermore, MS altered photoperiod-induced changes in body mass. Taken together, these findings suggest that manipulations of early life mother-pup interactions in Siberian hamsters result in physiological changes and suppressed cell-mediated immunity. (Author correspondence: fonken.1@osu.edu).

Keywords: Delayed-type hypersensitivity, Immune, Maternal separation, *Phodopus sungorus*, Photoperiod, Sex differences

INTRODUCTION

Early life experiences can profoundly affect the growth and development of animals (McEwen, 2008). Adult disease and risk factors for poor health are embedded biologically during developmentally sensitive periods, during which time the brain is more reactive to wide-ranging positive and negative environmental signals (Johnson, 2005). Early experiences can prepare individuals for unstable, high-stress conditions; however, this can place individuals on a trajectory where the benefits of short-term survival may come at a significant cost to longer-term health (Shonkoff et al., 2009).

Because some seasonal stressors, such as low temperatures and food scarcities, are generally predictable, nontropical individuals have evolved mechanisms to determine time-of-year by attending to day length (photoperiod). Photoperiodic information from the lateral eyes is transduced into a physiological signal via the secretion of the nocturnal pineal hormone melatonin, with the duration of nighttime melatonin production being proportional to the duration of the night (Foster et al., 2007; Reiter, 1993). Siberian hamsters (*Phodopus sungorus*) are photoperiodic rodents that undergo dramatic physiological and behavioral changes in response to different seasons (Hoffmann, 1973; Pyter & Nelson, 2006). In the laboratory, season-specific characteristics of Siberian hamsters are recapitulated by manipulating photoperiod. In temperate and boreal regions, winter decreases energy availability, increases thermoregulatory demands, as well as increases mortality and the risk of infection and disease (Lee & McDonald, 1985). During summer when energy availability is comparatively abundant and environmental conditions are relatively mild, hamsters invest in reproduction, whereas during the challenging energetic conditions of fall and winter, hamsters shunt energy away from reproductive activities to

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