Behaviour of laboratory mice is altered by light pollution within the housing environment

TA Bedrosian*, CA Vaughn, ZM Weil and RJ Nelson

Department of Neuroscience, Ohio State University Wexner Medical Center, 636 Biomedical Research Tower, 460 W 12th Avenue, Columbus, OH 43210, USA
* Contact for correspondence and requests for reprints: Bedrosian.2@osu.edu

Abstract

Environmental light-dark cycles play an important role in behavioural and physiological processes. It is essential that laboratory vivaria be designed to properly control the light conditions in which laboratory mice are housed; however, this is not universally the case. Some laboratory vivarium doors are designed with windows, which allow light from the hallways to leak into the housing space during the rodents’ dark phase. Personnel entering and exiting the housing space during the dark phase can also create excessive light leak from brightly illuminated hallways. In this study, we investigated the hypothesis that exposure to dim light at night, as commonly experienced in many laboratory rodent housing spaces, alters mouse (Mus musculus) behaviour. We specifically analysed patterns of locomotor activity, anxiety- and depressive-like responses. Exposure to dim (5 lux) light at night altered home-cage locomotor activity and increased anxiety and some depressive responses among laboratory mice. These results suggest that light conditions can alter mouse behaviour and potentially influence experimental outcomes. Increased care should be taken to properly control light-dark conditions for laboratory animals.

Keywords: animal welfare, anxiety, behaviour, circadian, depression, mouse

Introduction

Environmental factors can influence experimental results and well-being of laboratory animals. The artificial light-dark cycle is one variable that should be strictly controlled in laboratory experiments. In mammals, light is detected by photoreceptors located in the retina. One population of these cells, called intrinsically photosensitive retinal ganglion cells, contains a photopigment called melanopsin that is most sensitive to blue wavelength light (Panda et al 2005; Schmidt et al 2011). When activated in the presence of light, melanopsin-expressing cells project directly to the suprachiasmatic nucleus (SCN) of the hypothalamus, the master circadian clock in the brain (Hattar et al 2002). In this way, the SCN is entrained to the daily light-dark cycle; disruption of its oscillation by unnatural light exposure can perturb downstream physiological processes. For example, the SCN regulates hormonal output (e.g. melatonin and cortisol), patterns of gene expression, and behaviour (Mohawk et al 2012). Properly controlled environmental light-dark cycles are critical to maintaining appropriate circadian behaviour and physiology. Even relatively small changes in illumination or spectral quality can profoundly disrupt circadian responses (Brainard et al 1983; Bedrosian et al 2013).

Laboratory animals should be maintained under carefully controlled lighting conditions; however, pollution of the housing environment by light at night (LAN) is a common problem. Laboratory vivarium doors are sometimes designed with windows that allow light to leak into the housing space from the hallways. Personnel entering and exiting housing rooms during the dark phase may also cause LAN pollution. These occurrences may affect experimental outcome by altering animals’ physiology and behaviour. The profound effects of LAN on physiology are well established. LAN suppresses secretion of melatonin (Brainard et al 2001), provokes metabolic dysfunction (Fonken et al 2010), alters clock gene expression (Bedrosian et al 2013), and promotes carcinogenesis (Brainard et al 2001). Thus, contamination of laboratory animal housing spaces with LAN may interfere with experiments across a wide variety of biological sciences.

In this study, we investigated the effects of exposure to dim LAN in the housing environment on laboratory mouse behavioural responses. We used male C57bl/6 mice, which are commonly used in biological studies across many fields. Levels of LAN were maintained at approximately 5 lux throughout the night. We hypothesised specifically that exposure to LAN alters locomotor activity and increases rodent anxiety and depressive responses. Our results suggest that care should be taken to properly control light-dark cycles for laboratory rodents to prevent unintended effects on behavioural responses.