Project Details	
Project Code	NMH27Br Siviter
Title	Quantifying the impact of heatwaves on cognition, neuroanatomy, and mitochondrial function
Research Theme	Neuroscience & Mental Health
Project Type	Wet lab
Summary	Climate change is increasing the frequency and severity of heatwaves. In the UK, homes and essential infrastructure are not adequately prepared for these extreme weather conditions. Consequently, people are increasingly exposed to severe temperatures. This poses a severe risk to vulnerable individuals and means that people will have to work, learn, and function at uncomfortable temperatures. Heatwaves have been shown to influence cognitive functioning, performance, attention, and motivation, and yet the cellular and neurological underpinning of reduced cognition are poorly understood. Here, the candidate will explore the impact of extreme heat on cognition, neurology and neuroanatomy using bumblebees and Drosophila.
Description	Climate change is increasing the frequency, duration, and severity of heatwaves worldwide. In the UK, extreme heat events are becoming increasingly common and are projected to intensify over coming decades. Unlike many countries that routinely experience prolonged periods of high temperatures, the UK is poorly prepared for extreme heat. Homes, workplaces, public transport systems, and schools were designed for a temperate climate and frequently lack cooling infrastructure. Consequently, large numbers of people are increasingly exposed to temperatures that can impair health, wellbeing, and performance. Of particular concern is the impact of heat on education. During heatwaves, students are often required to learn in overheated classrooms, potentially during critical developmental periods. Understanding how heat affects learning and memory is therefore becoming an important public health and societal challenge. Heatwaves have been linked to reduced educational attainment and poorer workplace performance. However, the biological mechanisms through which heat impairs cognition remain poorly understood. Human studies are often complicated by variation in environmental conditions, socioeconomic factors and health status. Consequently, identifying the cellular and physiological pathways through which heat impairs cognitive function remains challenging. Understanding these mechanisms is essential for predicting vulnerability and developing interventions that improve resilience to future climate change. Here, we will investigate how extreme heat influences learning, memory, and neurological health using two complementary model organisms: the buff-tailed bumblebee (Bombus terrestris) and the fruit fly (Drosophila melanogaster). Bumblebees possess sophisticated learning abilities and perform complex cognitive tasks. Drosophila offers unparalleled opportunities for molecular and cellular investigation. Together, these species provide a powerful framework for identifying both the behavioural consequences and mechanistic basis of heat-induced cognitive decline. While the candidate will ultimately shape and develop their own research programme, we anticipate they will address four key research questions.

	1. How do extreme heat events influence learning and memory in bumblebees and Drosophila? Here, the candidate will establish the extent to which short- and long-term heat exposure affects cognitive performance. The candidate will expose bumblebees and Drosophila to experimentally simulated heatwave conditions that reflect current and projected UK climate scenarios. In both bumblebees and Drosophila, learning performance will be assessed using colour and odour association tasks based on established conditioning paradigms. The candidate will determine whether cognitive impairments are driven by heat intensity, exposure duration, developmental timing, or cumulative exposure history. These experiments will establish the degree to which extreme heat compromises learning and memory and identify potentially vulnerable life stages. 2. What cellular mechanisms link heat exposure, cognition, and mitochondrial function? Mitochondria play a central role in energy production and are essential for maintaining neuronal function. Here, the candidate will investigate how heat exposure alters mitochondrial performance and determine whether these changes predict cognitive impairment. Using physiological, molecular, and biochemical approaches, they will quantify mitochondrial respiration, oxidative stress, ATP production, and cellular damage following heat exposure. These measurements will be integrated with behavioural data generated in Question 1 to establish mechanistic links between thermal stress and cognitive decline. The candidate will identify molecular pathways associated with heat-induced mitochondrial dysfunction and determine whether variation in mitochondrial performance explains differences in learning and memory under heat stress conditions. 3. How does extreme heat alter neuroanatomy associated with learning? Having identified behavioural and physiological consequences of heat exposure, the candidate will investigate how thermal stress influences brain structure and neurological function. Using confocal microscopy, the candidate will examine whether heat exposure alters the development, architecture, and integrity of key brain regions associated with cognition. Particular focus will be placed on insect brain structures involved in cognition, including the mushroom bodies. Neuroanatomical measurements will be integrated with behavioural and physiological datasets to identify structural changes associated with impaired learning performance. This work will provide important mechanistic insight into how environmental heat stress alters the nervous system and ultimately influences cognition. 4. How do heatwaves influence cognition across the animal kingdom? A systematic review and meta-analysis Finally, the candidate will conduct a systematic review and meta-analysis to quantify the global evidence linking heat exposure and cognition. Studies across humans and non-human animals have reported effects of heat on learning and memory, but these findings have not been synthesised. The candidate will collate experimental and observational studies across all animal taxa, including humans, to determine the overall impact of heatwaves on cognition. They will identify factors that

	influence vulnerability, including exposure duration, developmental stage, thermal intensity, and species characteristics. Furthermore, they will identify major knowledge gaps and priorities for future research. Outcome: The aim of this project is to determine how extreme heat events influence cognition and neurological health and identify the cellular mechanisms responsible. By using an interdisciplinary approach, this work will generate fundamental insights into the biological consequences of heatwaves. These findings will improve our understanding of how climate change may affect human cognition, educational attainment, and public health in an increasingly warming world.
Can be completed part time?	Yes
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