



Chronic heat stress and cognitive development: An example of thermal conditions influencing human development

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Received 1 November 2004; revised 22 December 2004
Available online 2 March 2006

Abstract

Although thermal conditions influence the development of living organisms in a wide variety of ways, this topic has been recently ignored in humans. This paper reintroduces thermal conditions as a topic of importance for developmentalists by presenting an example of how thermal conditions are hypothesized to influence a particular developmental system. Specifically, several literatures support the theory that chronic exposure to heat stress adversely influences individual cognitive development in children. We theorize that chronic heat stress reduces active interaction with environmental stimuli. Reduced environmental experience results in fewer experience-produced brain changes than would have occurred in a neutral thermal environment. Because many children worldwide develop in thermally stressful environments for at least several months of the year, this topic has real-world implications for human development. Finally, the broader intention of this paper is to encourage developmentalists to consider the influence of a wide variety of thermal conditions on human development.

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Keywords: Cognitive development; Heat stress; Human development; Thermal conditions; Thermoregulation

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The selection of clothing, the quality of sleep, the types of food available, and the decision to spend an afternoon indoors or outside are just a few ways in which thermal conditions can influence human lives. Of course, humans are not unique in being influenced by thermal conditions; as all living organisms (e.g., plants, fish, reptiles, birds, and other mammals) are affected. For example, thermal conditions influence the growth and development of plants (Arms & Camp, 1995), the development of neural pathways (Horwitz, Heller, & Hoffmann, 1982) and hippocampal activity (Karlsson & Blumberg, 2004) in rats, the behavioral repertoires of lizards (Pough, Heiser, & McFarland, 1996), differences in fur color of Himalayan rabbits and Siamese cats (Arms & Camp, 1995), the sex of many species of reptiles (Janzen & Paukstis, 1991; Linzey, 2001), and the swimming speed in salmon (Brett, 1971), to name a few (see Blumberg, 2002, for additional examples).

Despite the variety of climates that humans inhabit and the abundance of evidence that thermal conditions influence living organisms in a variety of ways, the impact of thermal conditions on human development (e.g., cognitive, social, language, and emotional development) has been ignored by developmental researchers and theorists, except as it relates to short-term physical risk (e.g., heat-illness) or as a variable that has short-term impact (e.g., test performance in the classroom). Developmental textbooks, journals across a wide-range of developmental specialties, and scholarly books addressing risk factors for human development have all overlooked or avoided any mention of thermal conditions and development. Especially for those individuals developing in thermal conditions with limited ability to control their environment (such as children in poverty), this topic is particularly important for identifying thermal conditions that can adversely influence development. Because people live in a wide variety of thermal environments (e.g., arctic, tropical, desert, and temperate), thermal conditions can potentially impact a wide variety of developmental systems (e.g., cognitive development).

Although the influence of thermal conditions on development was of interest in the first half of the 20th century (e.g., Keller, 1901; Markham, 1947; Price, 1939; Wilson, 1938), it is unclear why thermal conditions have been overlooked recently, since researchers interested in human development are identifying and investigating potential environmental risk factors for development (e.g., malnutrition). We believe the historical lineage associated with the study of thermal conditions and human development has contributed to an avoidance of this topic. Specifically, the belief that thermal conditions influence human development dates at least as far back as Aristotle, Hippocrates, and the ancient Greeks (Lamb, 1982; also see Toynbee, 1947, for an alternative viewpoint). Unfortunately, this topic also has a long history of being linked with racial inferiority/superiority theories (Gould, 1996; Lamb, 1982; Markham, 1947). This historical lineage has likely influenced developmentalists to shy away from any discussion about the relation between thermal conditions and human development, especially following World War II when legitimate topics of inquiry (e.g., biological contributions to individual behavior) were off limits as a response to social Darwinism, eugenics, and Nazism (see Ekman, 1998, for further elaboration). Also, the current trend away from comparative courses in the psychology curriculum, which requires knowledge of the influence of thermal conditions to understand the behavior and development of a wide range of species, has also likely contributed. However, regardless of the reasons why thermal conditions have been ignored recently, it is time for developmentalists to consider the potential impact of various thermal conditions on individual development, since adverse environments are widely believed to cause developmental difficulties (Carnegie Task Force, 1994).

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