



## Natural environments and mental health



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### ABSTRACT

Ancestral experiences and evolutionary processes continue to influence the brain in ways that may escape conscious awareness by contemporary adults. It is becoming increasingly evident that the 2.2 million years our genus has spent in natural environments are consequential to modern mental health. This might be especially true in the context of rapid global urbanization, loss of biodiversity and environmental degradation. Here, we examine some of the emerging research related to natural environments (and specific elements within them) and mental health. Our synthesis includes research from various branches of science and medicine, e.g., epidemiology, psychology, physiology, anthropology, evolutionary biology, and microbiology. Significant knowledge gaps remain. However, the accumulating strength of research from multiple disciplines makes it difficult to dismiss the clinical relevancy of natural environments in 21st century mental health care.

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### What is already known about the topic?

- The study of natural environments and mental health is an expansive topic.
- Experience within natural environments (or with components of natural environments) produces a differential effect on human stress physiology vs. similar activity in predominantly built environments.
- Experience within natural environments (or with components of natural environments) supports cognitive restoration.

### What this paper adds?

- Our review attempts to tie evolutionary aspects of the human-natural environment relationship to modern clinical relevancy.
- Our review attempts to break down the silo-contained research related to the topic so that the relevancy of compartmentalized natural environment research areas (e.g. microbiota) can be viewed through a single lens.

### 1. Introduction

In contemporary lexicon, natural environments are defined as those that are *relatively* unchanged or undisturbed by human culture [1]. These environments are often rich in vegetation and/or non-human animal life, with varying degrees of trees, shrubs, rocks, soil, sand and water. Natural environments are inclusive of atmospheric components such as light, radiation, charged ions, aromatic chemicals and microbes. Distinct from the purely human-built environment, natural environments are typically not defined as exclusively wilderness areas; they can include areas that are designed, manipulated and/or sustained by human interventions. In the context of urban settings this may include gardens, parks, forests and waterside areas.

In the context of rapid global urbanization, loss of biodiversity and environmental degradation, natural environments are increasingly being viewed as an 'ecosystem service' for the promotion of psychological well-being [2]. This, of course, is not a new concept. The notion that natural environments can influence human health dates back to Hippocrates' teachings on Airs, Waters and Places [3]. Biologist Sir John Arthur Thompson continued this argument in his 1914 keynote address at the Annual Meeting of the British Medical Association, maintaining that human evolutionary connections to natural environments were being eroded by modernization. In Thompson's view, individuals were contending with stressors of the urban built environment while missing a layer

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of mental health resiliency otherwise provided by mindful awareness of nature [4].

In this illustrative review we will discuss Thompson's contention from the view of multidisciplinary research. Although referencing depression and anxiety, we approach our discussion with mental health being defined as the World Health Organization sees it: the ability of an individual to reach their potential, cope with normal stressors, work productively, and make contributions to the community [5]. The absence of a mental health disorder is not assumed to be synonymous with a state of good mental health.

### Ancestral experience, contemporary implications

For over 2.2 million years, our ancestors in the genus *Homo* etched out an existence within natural environments. These experiences have shaped many aspects of modern brain functioning [5,6]. Human ancestral survival necessities related to sustenance, shelter, and predator avoidance (as well as other threats) continue to influence emotion, motivation, learning, and reasoning in subtle ways. In addition, since the ancestral experience was often an outdoor one, sleep and mood-regulating circadian rhythms became coordinated by the cycles of natural light [7].

Detailed discussions of advances within the fields of evolutionary and environmental psychology are available in recent reviews [8,9]. A sample of recent findings may help to underscore the subtle resonance of ancestral experiences that still influence brain functionalities today. For example, while processing complex photographic scenes inclusive of many different objects, humans display attentional privilege toward animals [10,11]. Children as young as 9-months of age demonstrate perceptual bias for threatening reptiles and even the mere sound of an ancestral threat can elicit a differential physiological response [12,13]. Even in crowded market environments, humans display enhanced spatial memory for locations that are purveyors of calorie-dense foods. Since this finding was independent of taste and personal food choices, it more likely reflects ancestral foraging experiences [14]. Other researchers have linked human preference for the shininess of contemporary glossy (versus matte) objects to the ancestral requirement of sourcing a daily supply of fresh, flowing water [15].

Human preferences for images of nature scenes over those of the built environment are apparent even when they are presented for a mere 1/100th of a second [16,17]. Recent functional magnetic resonance imaging (fMRI) studies have shown that scenes of natural environments (versus urban built environment) increase activity in brain regions associated with positive mental outlook, emotional stability, altruism, empathy and depth of love. On the other hand, urban built scenes consistently increase activity in the amygdala, an area well known for processing threat, arousal and risk assessment [18–21]. Moreover, a greater degree of realism in the display of nature images presented to subjects – e.g. 3- vs. 2-dimensional – alters cerebral oxygen use in ways that support subjective reports of improved mental functioning [22,23].

### Theoretical constructs, primary mechanisms

In order to contextualize the specific value of natural environments to mental health, it may be helpful to briefly underscore known links between psychological distress and cognitive load in relation to depression and anxiety. The accumulation of stressful life events, ranging from daily hassles to more significant negative events, have been associated with a trajectory toward compromised mental health [24–26]. Over time, this may take its toll in the form of damaging physiological consequences, most notably captured by markers of low-grade

inflammation [27,28]. In addition, fatigue [29] and cognitive deficits in attention and executive functioning are common findings in adults with depression, including individuals who are subthreshold to major criteria [30,31].

In a vicious cycle, cognitive demands can promote mental fatigue and hyperactivity of the sympathetic nervous system [32]. Mental fatigue impairs emotion regulation [33], increases the perception of physical effort, and may diminish the motivation to engage in physical activity and/or negatively influence energy expended during activity [34,35]. Once induced, mental fatigue further limits the ability to discount distracting information in the environment [36].

There are many theoretical propositions concerning the mechanisms that might explain the mental health value of natural environments. Two complementary and oft-cited theories include the psycho-evolutionary stress recovery theory (SRT) [37] and the attention restoration theory (ART) [38]. The former focuses on the contention that ancestral experiences within natural environments have resulted in better physiological and perhaps psychological adaptation to natural vs. built or “artificial” urban environments. The central discussion of SRT is emotion. Positive emotion as a result of experience in natural settings can in turn limit the burden of stress physiology. Positive moods offered advantages to our ancestors [39], and there is every reason to suspect that (alongside the dangers which may have helped shape our effective physiological stress response) uplifting experiences, amusement and awe in natural environments were commonplace.

The ART focuses on directed attention, the effortful cognitive work that requires non-salient distracters to be largely ignored. Blocking out distracters during directed attention exacts a cognitive toll; it ratchets up the requirement for inhibitory energy. The modern urban environment, and much of the work we do within it, requires a good degree of directed attention. Mental fatigue is a primary consequence of sustained directed attention. In turn, mental fatigue itself, and states associated with mental fatigue such as sleep deprivation and low-grade inflammation [40,41], impair the ability to direct attention. ART proposes that natural environments are “restorative” settings because they do not require taxing mental effort. The distinction is that such areas are inherently *fascinating*; that is, they provide a more automatic engagement of attention (involuntary attention) and this facilitates a rest and rejuvenation period for the taxed executive system.

These theories are complementary in that mental fatigue can promote stress and vice versa. They are by no means the last word on the mechanistic pathways of natural environments. The development of social capital, opportunity for physical activity, and immune function via exposure to beneficial microbiota (described later) are examples of other pathways. However, since psychological distress and fatigue are interrelated with detrimental lifestyle habits such as unhealthy dietary patterns [42,43] and sedentary behavior [44], any potential mitigation by way of natural environments could have a ripple effect in the promotion of mental health.

### Psychological connection to nature

Several validated instruments are now used to assess the extent to which an individual is connected to the natural world. A recent meta-analysis found that a higher level of nature connectedness (also called nature connectivity, nature relatedness) is positively associated with vitality, positive affect and life satisfaction [45]. Other studies published post-analysis have shown that higher scores are negatively correlated with lower anxiety and anger [46,47].

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