5.4 Nature, Health, and the Built Environment

Effective public health strategies succeed at the intersection of crisp dose–response relationships and the popular imagination. Nature captures the latter with ease, as E.O. Wilson memorably wrote in his treatise *Biophilia*¹: “to an extent still undervalued in philosophy and religion, our existence depends on this (innate love of nature), our spirit is woven from it, and our hopes rise on its currents.” The ubiquitous presence of nature and natural design cues in the built environment poses a challenge for researchers bent on connecting exposure to changes in physiological and psychological health². Innovative research strategies attempt to clarify dose–response relationships at every scale, from the pixelated maps of vegetation generated by spiraling satellites to the most miniscule microbiota that are increasingly cast as essential protection against and treatment for a wide range of conditions. Nature as mentor, model, muse and medicine: if ever there was an hour when we needed to radically expand our definition of ecosystem services to include support for human health, it is now.

In October 2013, the Center for Health and the Global Environment at the Harvard School of Public Health brought together 20 international experts to consider this question of dose–response from diverse fields of medicine, landscape architecture, public health, and forestry science. Doctors Miyazaki, Tsunetsugu and Li contributed nuanced characterizations of therapeutic environments from their personal research as well as experiential insights from Forest Therapy Bases across the Japan. Colleagues from Finland, Doctors Korpela and Tyrväinen, recalled a three year collaboration with Dr. Tsunetsugu and her colleagues, citing the influence of Japanese Forest Bathing practices on their evolving conceptualization of Finnish Power Forests. Dr. Lee contributed perspectives on Korean forest tourism facilities, including University-level degree granting programs, while Dr. Logan recounted the decade he has spent teaching “Vitamin G” to clinicians in Harvard Medical School’s continuing
medical education program. The contribution of natural environments to improved health outcomes was discussed in the context of global trends including increasing urbanization, disruptions due to climate change, and rising rates of chronic, non-communicable diseases including mental health disorders. Our conversations formed the basis for the Natural Environments Initiative, a working group paper and illustrative review that explores how we can and should integrate nature into urban planning to support public health under the larger framework of “ecosystem services”. The group captured this sentiment with the acronym “AIM”: Advocate (access to nature for health), Invest (in equitable access), and Mediate (engage in translation between disciplines to build support beyond the health sector)³⁰.

Large cohort studies with residential or occupational addresses tethered to normalized difference vegetation index (NDVI) satellite data helps establish associations between exposure to green space and chronic health outcomes in the general population. Wilker et al.³¹ found a striking positive association between residential proximity to green space and post-stroke mortality: survival rates decreased in low socioeconomic status (SES) neighborhoods with little greenspace, highlighting the need for equitable access. Wu et al.³² found a strong positive association between large green space buffers surrounding schools and performance on state-wide standardized tests of Math and English proficiency, even after adjusting for gender and SES. These techniques, while valuable, rely on an urban/nature dichotomy that is coarse and doesn’t reveal the differences in landscape characteristics that may contribute to outcomes in health and well-being. By way of example, a recent study from Wheeler et al.³³ harnessed 2011 health data derived from the national census in Great Britain and used linear regression to analyze the influence of green space grouped by small-area environmental indicators like land cover type, bird species richness, and designated protection status. Positive associations were observed between good health and the density of certain green space types including “broadleaf woodland”, “arable and horticulture”, “improved grassland”, “saltwater” and “coastal” landscape types. Bird species richness was used as an indicator of biodiversity and was also associated with good health. A recent study by Mitchell et al.³⁴ underscores the importance of equity in access to healthful landscapes. In a large cohort of 21,294 urban residents from 34 European nations, socioeconomic inequality in mental well-being was 40% narrower among respondents reporting good access to green/recreational areas as compared with those who had less access. It is critical that we understand more about the landscape types that are “equigenic (through) disruption of the usual conversion of socioeconomic inequality to health inequality”.

Structural features in landscape present an important (if poorly understood) contribution to the dose–response relationship. The ordered complexity found in natural environments is key to their neurological intelligibility and, indeed, enduring allure. The eddies and swirls of seasonal winds, the fractal branching of trees, the low murmur of streams and Fibonacci structure of flower petals all provide unconscious and conscious cues that settle the addled mind and
soothe the troubled body. Biodiversity—and, by default, structural diversity—is broadly associated with landscape preference. Increasingly, these preferences are recognized in our built environment under the term “Biophilic Design”, defined as the use of natural settings and design features to improve occupant health and well-being. Whether through direct introduction of phytoncides from unvarnished hinoki and sugi to more structural references found in spiraling staircases that mimic a nautilus, the divisions between our built and natural environments continue to become ever more porous. Do gross structural features (i.e. a lush atrium) or references (i.e. an archway that looks like a canopy) act as neurobiological confounders, changing our ability to effectively test when a subject is ‘exposed’ to nature? This question, among others, has not been well addressed.

The contribution of sound—and, in particular, birdsong—to the perception of restorative environments also deserves special attention. Exposure to birds is both visual and aural; generally speaking, they are a widely accepted category of urban wildlife, with a high potential for adaption to the built environment and strong cross-cultural penetration into various art forms (painting, fashion, music, etc.). Birdsong is famously variable, responding both to geophony (landscape features that determine how sound travels) as well as biophony (sounds generated by surrounding biota with which the song must compete for its sonic niche in order to be heard). Each species has its own rhythm, tempo and pattern, some so flamboyant that one might be convinced that they sing for the sheer joy of it. However, just as is the case with human speech, exposure to contaminants such as heavy metal changes their vocalizations. Songbirds contaminated with methylmercury have been shown to sing shorter, simpler, lower pitched songs, and birds near a smelter in northern Europe with “a lot of heavy metal contamination knew fewer songs and sang less at sunrise than birds at two less polluted sites”. The story doesn’t end with metals, of course; chickadees exposed to polychlorinated biphenyls “sing strange songs” Whistle, trill, chirp and caw: the increasingly garbled sounds of our disordered environment are often invisible but perceptible if we listen.

Do changes in these songs affect the perception of biodiversity or observed rates of human ‘restoration’ in response to natural settings? There’s no doubt that sound matters; we continue to study what qualities of sound are most important. Natural sounds, when compared to urban noise, allow for physiological and psychological restoration to occur up to 37% faster after exposure to a psychological stressor. Participants in a UK study comparing tranquility ratings of scenes with and without coupled audio tracks noted that participants tolerated higher noise levels when they were associated with biodiversity. Studies suggest that we prefer moderate sound levels (65-70 decibels) of ambient noise with the kind of layered, fractal complexity found in streams flowing over rocks or wind in the trees. The psychological benefits of nature increase with higher levels of biodiversity; these benefits increase with biodiversity and not with an increase in natural vegetative area, reminding us that complexity and integration rather than quantity is critical.
Ecological perturbation—whether through global shifts wrought by climate change or more site-specific contamination—is to ecologists what allostatic load is to public health clinicians. Both terms capture individual and communal responses to environmental stressors and the degree of adaption or accommodation that is possible in a given system at a given time. Disease and death can follow from a system that is stressed beyond its adaptive capacity. Can cities be our allies in restoring and sustaining adaptive capacities? As we continue to explore and validate the contribution of natural environments to the health and well-being of urban residents, we get closer to understanding the types and qualities of natural features that influence health. We may never arrive at a dose–response relationship in the conventional sense, but I am confident that our international partnerships will eventually lead to recommendations for population health that apply across cultures, building practices and biomes.

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