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PERSPECTIVES

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Sensory Disruption in Modern Living and the Emergence of Sensory Inequities

Kara C. Hoover*

Department of Anthropology, University of Alaska, Fairbanks, AK

Modern lifestyles are disrupting the human senses—primarily sight, sound, and smell. Noise-induced hearing loss has been noted for centuries and increasing over time following the industrial era. From the mid-20th century, the numbers of individuals with myopia (the leading visual impairment) have been increasing globally. Historical evidence for olfactory dysfunction is not known but its etiological links to pollution suggest it increased following industrialization. Clinical interventions for sight and sound loss include preventative and corrective measures but none exist for olfactory dysfunction. Further, olfactory loss is linked to multiple negative health outcomes across physical, mental, and social domains. Due to the global rates of exposure to pollution, olfaction is a global health concern. The environmental injustice inherent in human society (locally and globally) results in inequitable risk for sensory loss by the most vulnerable populations and creates an even deeper gradient in health disparity. Situated within the environmental justice and health disparity literature, this paper introduces the term *sensory inequity* to describe variation in sensory environments based on socio-economic status (which is often entwined with race and education). A key challenge to risk management is awareness of sensory inequity experienced by vulnerable populations and incorporating that awareness into basic research and policy.

INTRODUCTION

Senses are our primary source of information about the environment and, within that perceptual landscape, we develop behavioral repertoires to adapt and contribute to fitness [1]. While the human environment is simplistically described as a linear progression out of nature into built spaces, the human ecological niche that shaped our senses is highly complex and the environment to which our senses were tuned is vastly different from the one we inhabit today. As a result, we see an increasing number of cases of sensory loss—chiefly hearing, vision, and olfaction. While some clinical interventions are in place, the environment we have built is placing our senses in jeopardy and this risk is not equitably distributed. The concept of "sensory inequities" is introduced to describe unequal access to healthy sensory environments and the inequitable distribution of resources to create positive and healthy sensory environments.

Human-environment interaction has radically changed throughout human prehistory and history and these changes have impacted our sensory and perceptual landscapes. Perhaps the first radical change occurred with the creation of permanent shelters—built structures that radically altered our primary interactions with the world by making us apart from rather than part of the environ-

*To whom all correspondence should be addressed: Kara C. Hoover, Department of Anthropology, 1790 Tanana Loop, University of Alaska, Fairbanks, Alaska, 99775; Tel: 907-474-6110, Email: kchoover@alaska.edu.

†Abbreviations: WHO, World Health Organization; CDC, Center for Disease Control; LULU, locally unwanted land use.

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ment. The next major changes occurred alongside animal and plant domestication which allowed consistent population density and sedentism and eventually gave rise to urban centers by 3000 BCE—indeed, hunter-gatherers have a better sense of smell than modern populations [2-4]. The earliest urban centers were characterized by inequality in living spaces with the rich having more space and the poor less [5]. These early urban centers probably had sensory inequity due to the conditions created by crowded living space. Reconstructions of Çatalhöyük suggest that the average person would have had a very unpleasant smellscape due to the activities of daily living taking place in a crowded dwelling within a density of close-by crowded dwellings [6]. The industrial revolution is the most recent and perhaps most radical change, constituting a major split between the sensory past and present with the notable increase in medical documentation of sensory disorders associated with modern living—technology overburdened the senses (*e.g.,* the noise of industry, the visual blight of pollution) [7]. Our radical alteration of the "sensescape" by the built environment was so pervasive that even so-called natural spaces were blighted by technology (*e.g.,* engines, trains, factories). While the senses have always been challenged by the environment, the built environment of the modern world may have provided too many challenges too quickly for our biology and genetics to adapt as seen in the following brief sensory histories.

Noise-induced hearing loss is part of the deep historical record. Common occupations like metal smithing created noise pollution and damaged hearing, but social interventions (*e.g.,* moving smithies to outlying areas, limiting working hours) protected the general public, even if they did not protect the metalsmiths themselves [8]. The use of gun powder constituted the first uptick in hearing loss frequency but this tended to be occupation specific (*e.g.,* soldiers) [8]; indeed, the noise of guns are still a hazard in modern society, particularly in the US where they are prolific [9] and in the military [10] and those in war-torn areas. The primary risk factor for hearing loss in the industrial revolution was also occupational—working with machines—and by the late 19th century and establishment of major industrial factories and railways, occupational hearing-loss was a rising concern that affected a large portion of the populace [8]; occupational hearing loss continues to be an issue (*e.g.,* forestry, construction, mining) [11-13]. Today, the World Health Organization (WHO†) reports that 360 million people worldwide suffer from hearing loss and the Center for Disease Control (CDC) reports that 20 percent of individuals with hearing loss share an etiology in the loud noises of everyday living (*e.g.,* sirens, washing machines, lawn mowers, leaf blowers). The health impacts caused by hearing loss are mainly social—decreased verbal communication and connectivity [9]. The earliest noted preventative measures were cotton ear plugs for factory workers in the 1830s, but this was not a widespread practice because workers themselves argued that not hearing co-workers (and other workplace noises) might increase risk of injury—these arguments persist today [8]. Treatments for hearing loss date to the 17th century (ear horns) with in-ear hearing aids most commonly used today. Restoration of hearing can be accomplished for some via cochlear implants. Preventative drug therapies are also in development to minimize the impact of noise-induced hearing loss on age-induced hearing loss [14].

Loss of visual acuity has also been noted for a long time with the earliest accounts of reading stones in Pliny the Elder in the first century CE. Indeed, refractive errors are the most common visual impairment today—particularly myopia or near-sightedness [15]. Once thought to be attributable entirely to genetics, a case study on intergenerational increases in myopia frequency in Eskimos promoted an environmental origin linked to modern lifestyles [16]. The growth in myopia cases was attributed to close work and education, an association which was strongly supported by a growing number of myopia cases in children from disadvantaged backgrounds due to increased access to education [17]. Today, over 23 percent of the world's population suffers from myopia and 3 percent suffer from high myopia; projections of those rates in 2050 indicate major increases to 50 percent and 10 percent, respectively [17]. The health impacts caused by myopia can be severe enough to prevent independent daily living (in rare cases) and increasing risk of retinal detachment as severity of myopia increases [15]. The earliest preventative measure of reading stones gave way to glasses then contact lenses. Preventative measures for those not genetically prone to myopia—more time outdoors during growth and development—may reduce global myopia incidence and severity [18,19]. Restoration of vision can even be accomplished for most people via laser surgeries.

Unlike vision and hearing, there is little information on smell loss in history. Smells themselves are the focus—whether via histories of the natural environment (usually as marking pollution and environmental damage) or the cultural environment (*e.g.,* socially marking the derogatory smell of the other, place-based smells food or sewage, ritual smells like incense/perfume) [20-23]. The mind-body dichotomy suggests a separation of the human and the environment which is somewhat contradictory to the historically persistent notion that smelling brings the environment into the body and alters the person [23]. Further, smell is not considered as having historical worth and has been reduced to a gimmick—such as reconstructing smellscapes for history museum exhibits [23]. Many historians have argued that the process of deodorization has removed smell from our consciousness and olfaction has become reduced in importance (a related but separate argument)—the physical environment of smelling has changed, but due to human action (the built environment) rather than natural action [23]. So, while these histories may evoke smells of the past and their contextual meaning, they talk more about olfactory stimulation than loss of the sense. Perhaps an echo of the historical view that smells have little historical value due to their ephemeral nature [23], modern instances of olfactory dysfunction often are characterized by victims not being able to pinpoint the moment it happened—smell, and smell loss, is hard to capture. There are many idiosyncratic causes of smell loss (*e.g.,* head injury, inhaling strong chemicals, sinus infection, chronic allergies) but the primary risk factor is pollution, particularly in urban areas with higher amounts of traffic pollution [24-26]. Rates of olfactory dysfunction are hard to calculate because it has not been considered part of routine clinical assessment nor is it treated when identified; however, frequency of the condition may be as high as 20 percent globally but there are major data gaps from the developing world [27]. The health impacts of smell loss include multiple negative physical, mental, and social health outcomes, but no systematic study has yet to examine the health impact from having a decreased sense of smell [28]. While sound and sight impairments have been the focus of both medical and basic research, little attention has been paid to olfaction and there are no preventions, treatments, or reversals available for those with dysfunction.

When viewing the risk factors for sensory loss in the modern built environment, a pattern is seen: it can happen to anyone. While hearing loss is tied to occupation (and that remains the primary cause today) [29], the loud noises of everyday living (including personal listening devices) are implicated as well. While visual loss is also tied to occupation (education), the increased accessibility to education has extended the risk to most people. While many cases of olfactory loss are idiopathic, pollution is strongly indicated as causative for dysfunction [24-26,30,31]. Granted, most of these risk factors are linked to urban environments, but according to the UN World Urbanization Prospects, 54 percent of the world's population is urban (Americas, 81 percent; Europe, 73 percent; Africa, 40 percent; Asia 48 percent) and most of the world's population will be urbanized by 2050 [32].

A majority of people live in environments with high sensory loss risk and more are migrating to urban areas. But, is risk of sensory loss shared equally? No, environments vary even in urban areas and that variation is generated by larger socio-political and economic forces. Thus, a study of risk for sensory loss must be housed in theoretical frames of inequity and injustice relative to the environment. After an examination of these theoretical frames (environmental justice and health disparity), olfaction will be examined as a key sensory inequity for three key reasons. First, there is no known treatment for olfactory loss. Second, we have a limited understanding of how health is impacted by olfactory dysfunction despite a growing body of knowledge on the health impacts of olfactory loss. Third, pollution is prevalent in most human communities but there is great demographic disparity in the experience of pollution intensity and toxicity.

THEORETICAL PERSPECTIVE

Environmental Justice

Environmental justice refers to the fair distribution of environmental benefits and burdens [33]. Acts of environmental injustice are often racialized and include disproportionate exposure to toxic waste, flooding, pollution from heavy industrial or natural resource extraction developments, or lack of utilities such as clean water and exclusion from land management and natural resource-related decision-making [34-38]. Race, poverty, and environmental risk are socially and politically entwined.

Nathan Hare's seminal paper on black ecology first noted how the physical and social environments of blacks are strikingly different from that of whites; he argued that ecological problems in the suburbs and the ghettos differ fundamentally in both causes and solutions in that black environments have more industrial pollution, pests (rats and cockroaches), disease, accidents, crime, crowding—a windfall of environmental "handicaps" [39]. As a result, black populations engage in both social and psychological adaptations to a unique race-driven set of circumstances. Terry Jones argued in even stronger terms than Hare that the racialized division of environments is apartheid ecology; he analyzes the ghetto in terms of urban crowding, housing, education, employability, the emotional state of people in the ghetto, and the view of society from the ghetto—in short, the fundamental conditions for well-being are not met [40]. These perspectives reattached the concept of "environment" to everyday living rather than some pristine wilderness that is separate and apart [35].

Perhaps the most abiding example of environmental racism that persists globally today is the LULU, locally unwanted land use. LULUs are characterized as having societal benefits (*e.g.,* power plants, landfills, prisons, roads, factories, hospitals) with expensive local costs (*e.g.,* potential health hazards, poor aesthetics, reduction in home values) that are paid by the marginalized and vulnerable members of society [41]. While government intervention in local planning (*e.g.,* zoning and environmental laws, community participation) is meant to have oversight in equitably distributing and mitigating the harm caused by LULUs, LULUs tend to be located near minority populations. This is part of the larger process that has segregated minorities in places most suited to LULUs—areas in decay with limited resources and lower housing prices; the inverse is true as well—places with LULUs (*e.g.,* landfills, highways) tend to be more affordable for lower income earners. The gravitational pull of impoverished areas on LULUs results in an increased negative environmental burden to lower socio-economic classes, minorities, and areas with low population density (which translates to less political representation). The cycle is complete when those areas with LULU decline further in value and resources after the arrival of the LULU.

Environmental injustice exists on the global scale [42,43]—corporate exportation of dirty technologies from non-vulnerable nations to vulnerable nations (*e.g.,* pollution havens with laxer environmental policies and safety practices) and the imbalanced ecological relationship between industrialized nations and the Global South due to colonialism, neoliberalism, and globalization [42-44]. Perhaps the strongest example of global injustice is climate change where the ones that contribute the most (white rich) suffer the least and those that contribute the least (minorities and poor) bearing the most harm [45].

Health Disparity

Health disparity (measured comparatively via a common metric like mortality) exists at all political scales of human society as a gradient ranging from rich and healthy to poor and unhealthy with the highest socio-economic gradient (rich and healthy) as the "norm" for comparison [46]. But, disparity suggests a lack of equality and parity in negative health outcomes rather than the actual inherent lack of fairness—equity—in risk for negative outcomes. The WHO defines health inequities as "avoidable inequalities in health between groups of people within countries and between countries […] and arise from inequalities within and between societies". Individual socio-economic conditions and social policies and politics confer risk relative to the circumstances of the lived experience throughout the life span and access to and quality of the local health infrastructure [46,47]. As seen with environmental injustice, a racialized component is obvious at the infrastructural level [48]. The analogy of a river encapsulates the complexity and simplicity of the problem: downstream lies the individual and their peculiar clinical and lifestyle health factors and upstream lies the larger political and economic factors—if upstream actions pollute the water, the rest of the stream bears the consequences [47, p. 28].

The UK Black Report was the first empirically documented link between socio-economic status and health outcomes [49]. The report revealed that health is tied to social position and local hierarchy based on factors such as income, education, occupation, gender, race, ethnicity. The link to environmental justice is clear because socio-economic (and often racial) status determines the environment of daily life [50]—where an individual lives, works, and plays—and that environment is what shapes vulnerability [51]. Responses to the environmental explanation for health outcomes first blamed the behavior of the victims as the result of individual choice that resulted in poor health outcomes (*e.g.,* smoking and lung cancer). Now, behavior is placed within a local continuum as embedded cultural practice rather than individual choice practice—a negative health outcome linked to smoking is not seen as individual choice in a culture where smoking is a common behavior [46]. Structural conditions also generate health-related behaviors—the material reality of the environment limits health-related behavior and outcomes (*e.g.,* limited or no access to quality food) [52-54]. Further, poor psychological and social conditions reduce individual capacity to manage stress and increase vulnerability to negative emotions which increase likelihood of negative physical health outcomes—psycho-social factors can be used to understand the health gradient from rich to poor rather than dichotomizing the health of the rich and poor [46,55-57]. A related way of understanding the health gradient is life history; the developmental origins of health and disease model indicates that early life environments shape long-term risk for negative health outcomes. Disparities start at birth and arise from differential developmental trajectories within the environmental context as set forth by early life experiences and cumulative allostatic load over the life course [58,59].

At the global level, societies flourish based on population health where disparity is measured by infant mortality (the risk of a baby dying between birth and one year of age is higher in developing nations) and maternal death during or shortly after pregnancy (lifetime risk is higher in developing nations) [60]. The inequitable distribution of health outcomes is international—the divide between the rich and poor increases as international aid decreases; whether the association between income disparity among larger political units and health outcomes is causal or an artifact of the larger complex health disparity and inequity cycle is not clear but prevalent [46,47]. For example, the Gini coefficient of inequity (scaled from 0, equity, to 1, one person having all the wealth) places the United States as the least equitable of the industrialized nations due to higher morbidity and mortality rates in minority populations, particularly black and indigenous [61].

SENSORY INEQUITIES

As defined at the start of this paper, the term *sensory inequity* refers to unequal access to healthy sensory environments and the inequitable distribution of resources to create positive and healthy sensory environments; a key part of what constitutes a healthy environment is lack of pollutants (light, sound, smell, air) that jeopardize the senses. The modern world is characterized by inequality and inequity. Not everyone has access to a healthy environment (physical, biological, psychological) and inequity is often unjustly racialized; the restriction of vulnerable populations by social, political, and economic practices creates increased disproportionate risk and vulnerability to negative health outcomes [62]; this can be seen in the relationship between physical activity, obesity, and recreation facilities [63] or the relationship between income, polluted environments (heavier traffic, poorly constructed homes), and health [64]. While the focus of this piece is mainly on dysfunction, access to positive sensory environments is critical, as seen in the health equities and environmental justice research—not simply mitigating the ill effects but providing the resources to restore equity. Typically, however, only some members of society gain access to resources that allow an improvement in conditions. At the very origins of urbanization, only some members of a community had access to better quality living space [5]. As previously observed by Hare [39] and related to LULUs [41], vulnerable populations often live in environments of urban decay and blight (*e.g.,* disrepair, decrepitude, empty structures, high local unemployment, fragmented families, political disenfranchisement, crime)—the New York Bronx in the 1970s, for example. The impact of desolate environments has been witnessed in history [23] as the start of sensory disorders and human unhappiness with where they live, work, and play. In other words, place matters—the environment is not separate from the body but part of it.

The senses incorporate the environment into the body—literally and figuratively taking in the environment (absorbing light, inhaling odors, receiving external sound vibrations) and creating a perceptual landscape that shapes behavior. The sending and receiving of signals is vital to a successful environmental adaptation and environment changes that disrupt this balance are buffered until they are no longer tolerated; the massive changes to the human environment would, in another species, have caused a critical juncture to continued health. Not only is modern living diametrically opposed to the sensory ecology of our evolutionary origins, but the rapid change from the natural to the built environment has occurred far too rapidly for our genes and biology to adapt. The inequities inherent in sensory environments is inferentially noted in environmental justice research which suggests the greater stress placed on vulnerable populations increases their vulnerability to environmental hazards [62]. The coupled system of sensing, signals, and ecology [65] has shown resilience to the external assault from rapid changes associated with modern living but sensory loss related health declines have only been buffered by cultural interventions—in the case of olfaction, there is no buffer.

Continued resilience to sensory loss may be difficult to achieve given the central role of the senses in interfacing with the environment and the central role of the modern built environment in diminished sensory functioning. The core of the problem is that a negative environment (social, natural, built, political, economic, cultural) diminishes well-being, the ephemeral concept of overall life quality across multiple domains of health [66]. According to the Constitution of the World Health Organization, well-being is a fundamental human right—the "highest attainable standard of health" wherein health is defined as a state of complete physical, mental, and social well-being (not simply the absence of disease or infirmity). Many strategies have been advanced to measure well-being, but all come with critiques that either argue individual gaps in well-being are overlooked, inurement to a reduced set of circumstances generates a false positive, or metrics generate contradictory findings [67]. But, well-being is difficult to define, which has led to serious deficits in measures of well-being [66 p. 222]. Well-being is increasingly seen as dynamic—a state of equilibrium between static and dynamic domains that comprise life satisfaction and happiness and include some consideration of resilience to challenges which is determined to an extent by available resources [66]. The environment and well-being have become tightly bound together in policy packages that seek to environmental justice for all members of human society. But, the environment is seen as static and cast in the role of external driver to well-being rather than seen as subjectively experienced and a human product that can be altered by humans. Thus, generating equity in access to environments that foster well-being is the larger task at hand if we aim to achieve sensory resilience.

OLFACTION AS AN EXAMPLE OF SENSORY INEQUITY

Olfactory dysfunction manifests as qualitative impairments to odor perception (*e.g.,* changes in odor quality, parosmia) and quantitative impairments to odor detection (*e.g.,* changes in odor strength, hyposmia; no functional sense of smell, anosmia), affecting roughly 16 percent of the population [27]. Estimates for various types of dysfunction are culled from modern clinical studies using psychophysical tests (identification, discrimination, threshold) in Europe (Germany, Spain, pan-Scandinavian, Sweden) and the United States. The data gap in Africa, South America, and Asia prevents a calculation of actual global prevalence of dysfunction and also points to a hint at global inequity in observation and concern for a sensory disorder. While typically not considered an important sense by clinicians or public health agencies

[68], there is an increasing awareness of the vital functions of olfactory in everyday living [69]; despite this, there are no clinical interventions (even if smell training offers some individuals minimal benefit [70]) or coping mechanisms (*e.g.,* electronic nose to detect danger like rotten food, gas leak, or body odor)—those with smell loss typically rely on others to perform those functions for them [71,72].

Excepting age, idiosyncratic causes are at the root of olfactory dysfunction and include trauma, infection, and the use of specific medications [27]. In keeping with the historical roots for sensory disorders at the start of the paper, the major cause of olfactory dysfunction is one we have generated ourselves—environmental pollution. Olfactory dysfunction increases to 10 percent in polluted areas from 2 percent in rural, non-polluted areas—even young individuals with no olfactory dysfunction in polluted areas perform worse than peers in non-polluted areas [24,73]. A comprehensive study across the United States identified the same relationship between decreased olfactory functioning and pollution using longitudinal pollution data for participant residence, olfactory function, and demographic variables [26]. A comprehensive review that explored the relationship between olfactory impairment and pollution in humans and animals found robust evidence to support wide-scape ecological disruption to olfaction from ambient air pollution [25].

While empirically documented across a series of studies in North America and Europe, the effect of pollution on olfaction is universal. Clinical studies have found deposition of particulate matter along the olfactory tract from the nasal epithelium to the olfactory regions of the brain [25,26]. The olfactory system is the brain's environmental probe—receptors are expressed on the tips of olfactory sensory neurons in order to bind odorant compounds inhaled from the external sensescape and transmit their information to the perceptual and behavioral centers of the brain where they are interpreted and translated into action. Thus, the olfactory nerve is unique in the nervous system for its close proximity to the external environment, which also makes it vulnerable. Indeed, the effect of accumulating pollution along the olfactory tract may well be a factor in neurodegeneration after long-term exposure to pollution [74]; this supposition is supported by several studies showing a relationship between impaired cognition, pollution, and olfactory ability [31,75-86]—children may be particularly vulnerable [77,87], which places the youth of the most vulnerable populations in a very high-risk environment.

Impaired cognition is one mental health outcome of pollution-induced olfactory dysfunction caused by physical damage to olfactory tissues (epithelium) and brain areas (bulb and nerves) as observed in functionally disruptive changes to morphology, increased and prolonged local inflammation, and induced cellular stress responses [25]. The impact on mental health is even broader than the cases suggesting cognitive impairment; individuals who have lost their sense of smell during life report depression over not smelling food and drink, increased anxiety over not smelling signal odors (*e.g.,* gas leaks, rotten food, body odor), and the resulting reduced quality of life [88]. The link between physical damage and mental health is further evidenced in diet. The relationship between perception of odors and satiation is complex but centers on the inverse relationship between appetite stimulation via olfaction and diminishment of olfactory perception as satiation is reached [89]. In individuals with a reduced sense of smell, the signaling system between olfaction and satiation is not functional. As a result, the tendency is to find satiation in taste which often results in malnutrition from unbalanced meals and changes in weight via increased consumption of fats, salts, and sweets [90] or loss of interest in eating and drinking [27,68]. An intriguing final area of impacts to health are seen in sociability—as noted above, hearing results in obvious social impedances but olfaction appears to play a strong role in sociability too. Olfactory ability has been linked to larger social network size [91], perception of socially meaningful olfactory signals [92,93], and perception of emotions [94]. The intertwined nature of physical, mental, and social health impacts of olfactory dysfunction result in reduced well-being [72]—discussed previously as an integral part of positive health outcomes.

Billions of people in the world are regularly exposed to pollution levels above the WHO air quality guidelines (annual $PM_{2.5}$ mean values of above 10 µg/m3) [95]. The evidence shows that pollution causes olfactory dysfunction and that results in negative physical, mental, and social health outcomes. Further, the effect of pollution on reduced olfactory functioning is stronger in urban areas, possibly due to traffic pollution [26]. Given the UN's World Urbanization Prospects for current and projected global urbanization trends, olfactory dysfunction is a global health concern that will only become increasingly problematic.

Pollution-caused olfactory dysfunction is a clear case of a sensory inequity and must be placed in the context of environmental injustice and health disparity research. The increased burden of pollution is carried by vulnerable populations (*e.g.,* racial minorities, socio-economically disadvantaged) locally [25,26,38,64,96,97] and globally (WHO reports 87 percent of pollution-related deaths occur in low to middle income countries) [95]. A simple but poignant example is the eight-fold increase in pollution exposure when taking public transport rather than private car [98]—the use of public transport is often the sole means of getting to and from work and performing activities of daily living for vulnerable populations [99,100].

National studies in the US and Korea that collated demographic data with health history data that included olfactory function identified vulnerable demographics as having higher risk factors for olfactory dysfunction [101,102]. As previously discussed, the stressors of social segregation coupled with increased exposure to pollutants, and access to health resources lead to further increases in vulnerability to environmental hazards [62], which creates a double health burden from pollution—and exponentially increases the risk for olfactory loss. Thus, risk of sensory loss—here, olfaction—has elements of both environmental injustice and health disparity: individuals with reduced means (due to socio-political factors) are regularly exposed to unhealthy levels of pollution which causes olfactory dysfunction and ensuing inequitable negative outcomes across multiple domains of health.

CONCLUSION

Physical environments containing more light, noise, and air pollution have been shown to cause sensory disruption [103]. For humans, the environment includes the physical environment and the socio-political circumstances surrounding it. As the environmental justice movement has indicated, vulnerable populations tend to occupy relatively worse environments characterized by LULUs, urban decay, and pollution; the developmental and cumulative effect of the lived experience in these negative environments is negative health outcomes. Thus, environmental injustice breeds health inequity. The senses lie at the heart of this dynamic and critically engage with the evolutionary mismatch between our natural sensory ecology and the modern built environment: everyone is at risk of sensory loss in the modern world, but socio-economically vulnerable populations are at greater risk. Olfactory dysfunction was presented as a case study wherein environmental injustice increases pollution exposure and risk for olfactory dysfunction which then results in increased negative health outcomes locally and globally for vulnerable populations. Olfaction is a particularly compelling example because there is no clinical intervention for smell loss, let alone coping strategies.

What then constitutes a positive and healthy human environment in the absence of a return to “nature”? The simple answer is one with no light, noise, smell, or environmental pollution; a slightly more nuanced answer might be one that is rich and stimulating. But, a first step is to acknowledge the key challenge to global risk management is awareness of the sensory inequity experienced by different populations and how this impacts health. This piece was aimed at olfaction as a critical area for scientific dialogue with policy experts to mitigate the risks and differentially intervene to reduce pollution in urban areas and aid vulnerable populations. Likewise, policies on pollution reduction, green energy, and public health should include planning for healthy sensory environments—building healthier cities, investing more in urban restoration, planting more trees, and encouraging education about the senses, rather than putting a band-aid on impairments.

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