

Benefits of Nature Contact for Children

Louise Chawla¹

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Abstract

This review examines different ways that contact with nature can contribute to the health and well-being of children. Applying the capabilities approach to human development for a broad definition of well-being, it traces research from the 1970s to the present, following shifting research approaches that investigate different dimensions of health. A compelling body of evidence exists that trees and natural areas are essential elements of healthy communities for children. They need to be integrated at multiple scales, from landscaping around homes, schools, and childcare centers, to linked systems of urban trails, greenways, parks, and “rough ground” for children’s creative play.

Keywords

health, recreation and open space, urban design, neighborhood planning, children, adolescents

Introduction

In the history and practice of urban planning, children’s access to nature lies in the larger context of people’s access to nature. The great park systems of the nineteenth and early twentieth century expressed pragmatic goals for public health—fresh air, light, and space for movement—along with a belief in the healing and morally uplifting power of nature (Spirn 1984). Children were beneficiaries of the park building movement along with other ages. In addition to crown jewels of park planning like Central Park in New York and the Emerald Necklace in Boston, mosaics of mundane nature filled marginal and interstitial spaces in pre–World War II cities: kitchen gardens, pastures for milk cows and work horses, overgrown vacant lots, undeveloped river banks, marshy edges, brambly quarries, steep ravines, and small woodlots. According to oral histories, resourceful children made good use of these spaces that largely existed because they escaped the planner’s compass (Gaster 1991; Chawla 1994).

Children’s need for nature was singled out, however, as one of the justifications for the rapid development of streetcar and commuter rail suburbs. This suburban nature was domesticated and plotted out in private lots; but during the years of rapid post–World War II suburban growth, many children found themselves on the borderlands where suburban streets were penetrating farms, fields, and woods. Richard Louv (2005, 9), author of the bestseller *Last Child in the Woods*, spoke for this generation:

I spent hours exploring the woods and farmland at the suburban edge. There were the Osage orange trees, with thorny, unfriendly limbs that dropped sticky, foul fruit larger than softballs. Those were to be avoided. But within the windbreaks were trees that we could shinny, the small branches like the rungs of a ladder. We climbed fifty, sixty feet off the ground, far above the Osage windbreak, and from that vantage looked out upon the old blue

ridges of Missouri, and the roofs of new houses in the ever-encroaching suburbs.

Louv touched a nerve when he coined the term “nature deficit disorder” to describe the loss of children’s free-ranging exploration of “wild lands” in cities and suburbs, as children withdrew indoors in front of television and computer screens, parents’ fears for children’s safety outdoors grew, and bulldozers relentlessly removed wild edges. A Google search for “nature deficit disorder” in mid-2015, ten years since the publication of Louv’s book, yielded 1,410,000 citations.

In this context, this review examines contributions of access to nature to children’s well-being and implications for the practice of planning. It builds on previous reviews and annotated bibliographies that examine outcomes associated with children’s engagement with nature (Faber Taylor and Kuo 2006; Lester and Maudsley 2007; Muñoz 2009; Pretty et al. 2009; Woolley, Pattacini, and Ward 2009; McCurdy et al. 2010; Gill 2014). This review is distinct because in addition to including more recent studies in its sweep, it places work in the context of changing research approaches, beginning with the 1970s. It asks, how do different research questions and methods shape our understanding of the benefits of access to nature for children? It focuses on elements of nature with which urban planners engage: trees, parks, lawns, water, and undeveloped land in the neighborhoods where children live.

¹Environmental Design Program, University of Colorado Boulder, Boulder, CO, USA

Corresponding Author:

Louise Chawla, Environmental Design Program, University of Colorado Boulder, Campus Box 314, Boulder, CO 80309, USA.
Email: louise.chawla@colorado.edu

The search for relevant referred articles and chapters in academic books began with citations in the preceding reviews. For work from January 2010 to June 2015, a search was made of the databases Web of Science, PubMed, and PsycInfo, using the key words “child*,” “youth,” “young people,” or “adolescents” in combination with “health” or “well-being” and “natural environment,” “green space,” or “parks.” The Research Resources database of the Children and Nature Network was also scanned (<http://www.childrenandnature.org/learn/research-resources>). Ethnographic work on children in nature in the 1970s and later years was gathered through the author’s participation in the development of this field.

This review is also distinguished by placing research on children and nature in a theoretical framework that provides a broad definition of health and well-being. The American Planning Association currently encourages planners to work with public health professionals and other partners to improve health (<https://www.planning.org/nationalcenters/health/priorities>). In 2013, the American Public Health Association issued a policy statement on “Improving Health and Wellness through Access to Nature” that calls for joint action by professionals in public health, parks, recreation, and urban planning and design (Chawla and Litt 2013). Similar initiatives to bring urban planners and health professionals together are underway in other countries (Kent and Thompson 2014). Important groundwork for collaboration is a shared definition of health. In the case of children in particular, what distinguishes optimal development from less healthy development? To answer this question, the following section begins by looking at the World Health Organization (WHO)’s widely cited definition of health and supplements it with the capabilities approach to well-being articulated by Sen (1993) and Nussbaum (2011). As this review shows, the way people define health and well-being affects the type of research they conduct, with implications for the elements of nature and nature-based activities that research makes salient.

A Comprehensive Definition of Health

The Declaration of Alma-Ata

In 1978, the International Conference on Primary Health Care met in Alma-Ata in the Soviet Union and affirmed a view of health that remains a global standard. According to Article I of the Declaration of Alma-Ata, “Health, which is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity, is a fundamental human right” (www.who.int/publications/almaata_declaration_en.pdf). The conference was cosponsored by the WHO and the United Nations Children’s Fund (UNICEF)—organizations that shared a commitment to primary health care in the sense of care that is universally accessible at affordable costs, involving the participation of individuals and communities, and provided near the places where people live and work.

The Declaration expressed a decade of optimism in the 1970s, when there was a widespread feeling that advances in

well-being were possible in a more economically and socially just world (WHO 2011). In the 1980s, the election of conservative governments in the United States and United Kingdom effectively ended this vision of “health for all” in all dimensions of human functioning. UNICEF retreated into more narrow goals, such as immunization and oral rehydration, despite the protests of some of its leaders that it was losing sight of the whole child. As this review shows, this history has its parallel in shifting conceptions of health in research on children and nature.

The Capabilities Approach to Well-being

The “capabilities approach” to well-being was developed by the economist Amartya Sen (1993) in collaboration with the philosopher Martha Nussbaum (2011). It addresses the question implicit in the Declaration of Alma-Ata: What does “complete physical, mental and social well-being” mean? It revives Aristotle’s notion of *eudaimonia* or happiness, often translated as “human flourishing.” Happiness, Aristotle (2014) concluded, is the ultimate goal of human life, achieved through people’s full and balanced realization of their capabilities. In the often repeated phrase of Sen (1993) and Nussbaum (2011), these are our human capacities “to do and to be.”

Sen and Nussbaum acknowledge that different cultures express human potentials for action and experience differently but contend that basic capabilities are universal, defining what it means to be human. Like health in the Declaration of Alma-Ata, well-being in this multifaceted sense is a human right, and therefore governments and their institutions have an obligation to provide conditions that enable citizens to realize their full range of capabilities. This approach is well suited to thinking about well-being in childhood; but it needs to be adapted to the special characteristics of this life stage, when arguably the foundational capability is the “capability to develop,” to become able “to do and to be” in rapidly expanding new ways (Sadlowski 2011). As a consequence, investments in children’s well-being are particularly fertile, as a foundation for the expression of further capabilities later in life, whereas disadvantages in childhood can be particularly corrosive (Dixon and Nussbaum 2012).

Table 1 lists Nussbaum’s proposed ten “Central Capabilities” of a flourishing life worthy of human dignity (Nussbaum 2011, 33–34) along with ways that access to nature enables children to realize each capability, based on the research that this review presents. The list is consistent with the quality-of-life framework in Ward Thompson and Aspinall’s (2011) review of benefits of access to nature for adults, but it provides a more articulated description of domains of well-being. Nussbaum (2011) and Sen (1993) note that every society should debate what belongs in this list: the human capability for practical reason, for forming a conception of the good and engaging in critical reflection about how to achieve it, requires no less. Nussbaum claims, however, that this list of ten represents a basic minimum. It identifies different facets of physical, mental, and social well-being, and it includes the ability to live in

Table 1. The Role of Nearby Nature in Children's Realization of Their Capabilities.

Ten Central Capabilities Adapted for children's development from Nussbaum (2011)	Children's Capabilities Associated with Access to Nature A summary of research findings in this review
Life: being able to live to the end of a life of normal length; not dying prematurely	<ul style="list-style-type: none"> ○ Increased birth weight and head circumference ○ Lower infant mortality
Bodily health: being able to have good health	<ul style="list-style-type: none"> ○ Lower rates of asthma and allergies in some settings ○ Vitamin D production from sunlight ○ Shade protection from excessive sun exposure ○ Better motor coordination and balance ○ More moderate to vigorous physical activity ○ Healthier weight; more stable body mass index
Bodily integrity: being able to move freely from place to place	<ul style="list-style-type: none"> ○ More walking and cycling on green streets or near parks ○ Free exploration and manipulation of the environment
Senses, imagination, and thought: being able to use the senses and have pleasurable experiences; to imagine, think, and reason	<ul style="list-style-type: none"> ○ Better concentration; less inattention and impulsivity ○ Imaginative play; resourceful use of nature's loose parts ○ Rich multisensory experiences in the natural world
Emotions: being able to have attachment to things and people outside ourselves; to feel a range of emotions; not having one's emotional development blighted by fear, anxiety, or restricted experiences	<ul style="list-style-type: none"> ○ Development of place attachments ○ Experiences of environmental competence ○ Green retreats for emotional restoration ○ Less depression, psychological distress, stress; greater sense of energy
Practical reason: being able to form a conception of the good and engage in critical reflection about the planning of one's life	<ul style="list-style-type: none"> ○ Participation in evaluating and planning healthy environments
Affiliation: being able to live with and toward others, to recognize and show concern for other human beings	<ul style="list-style-type: none"> ○ More cooperative and creative social play
Other species: being able to live with concern for and in relation to animals, plants, and the world of nature	<ul style="list-style-type: none"> ○ Direct exposure to the natural world ○ Learning about nature through exploration and engagement ○ Sense of affiliation and connection with nature ○ Childhood play in nature forms a foundation for lifelong care for nature and adult recreation in green spaces
Play: being able to laugh, to play, to enjoy recreational activities	<ul style="list-style-type: none"> ○ More outdoor play in green neighborhoods ○ More creative play in natural settings
Control over one's environment: being able to hold property and have property rights; having the right of political participation	<ul style="list-style-type: none"> ○ Freedom to appropriate undeveloped land that is not controlled by adults ○ Inclusion in participatory planning and design

relationship with animals, plants, and the world of nature and feel and express concern for other species. Therefore, it is well suited to accommodate children's developing relationships with nature, as well as different dimensions of child development that access to nature and healthy ecosystems can foster. Together, these capabilities represent the functioning of a whole child. The following sections consider how research on children and nature has engaged with these different dimensions of flourishing and health.

The 1970s: A Decade of Enthusiastic Beginnings

The Emergence of Place-based Fieldwork with Children

In 1975, nearly 500 people assembled in Washington, DC, for a five-day symposium fair on Children, Nature, and the Urban Environment, including senior scholars like the human

ecologist Paul Shepard, the anthropologist Margaret Mead, the geographer Yi-Fu Tuan, and the environmental psychologist Irwin Altman. In the foreword to the proceedings, the program committee explained that the gathering was motivated by concern that "Urban children of today have become increasingly divorced from the natural environment of forests and fields that was part of the surroundings in which children developed just a generation ago" and the effects of this separation from nature were not known (U.S. Department of Agriculture [USDA] Forest Service 1977, iii). (In effect, the symposium was motivated by concern about "nature deficit disorder" thirty years before Louv gave the condition a name.) In addition to seeking "to compare notes on what is known, and what needs to be known, of what really happens when children are exposed to nature" (p. iii), the goal of the symposium was to imagine how cities could be designed with a more deliberate interweaving of natural and man-made elements so that children could enjoy more balanced contact with nature.

Two of the leading figures at the symposium were a geographer, Roger Hart, who had just completed a dissertation on *Children's Experience of Place* (Hart 1979), and an architect and urban designer, Robin Moore, who was in the midst of exploring children's use of the urbanizing landscape in the San Francisco Bay area (R. C. Moore 1980). They shared a link to the urban designer Kevin Lynch, who was busy at that time assembling the book *Growing up in Cities* (Lynch 1977). When Moore was a student of Lynch at Massachusetts Institute of Technology, Lynch encouraged him to investigate how children use and experience their environment (R. C. Moore 2015). When Lynch heard that Hart had independently initiated similar research in a rural Vermont town, he invited Hart to present what he was doing to Lynch's seminar class, which led to repeated meetings between them, joined by Lynch's doctoral student Michael Southworth (Hart 2015). Among all of them, there was the excitement of pioneering how to do research in a new field of study.

Lynch, Hart, and Moore were all driven to understand how cities and towns can facilitate children's development. They shared a question that Lynch articulated: "What interchange between people and the environment encourages them to grow into fully realized persons?" (Lynch 1976, v). As they undertook their work, they gave no more focus to nature than streets, squares, shops, playgrounds, or other features of the environment, but by seeking to understand in an open-ended way how children used and experienced local places, they uncovered the value of natural areas.

Lynch had proposed the *Growing up in Cities* project to the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1970 as a contribution to the new Man and His Environment Program (later renamed Man and the Biosphere) that was launched in response to concerns about intensifying urbanization and environmental degradation. He organized nine study sites under the direction of local country directors in Argentina, Mexico, Australia, and Poland, and fieldwork began in the early 1970s. At each site, a small group of about twenty ten- to fifteen-year-old boys and girls were interviewed about their use, perceptions, and feelings about their surroundings. Their outdoor behaviors were observed, and parents and local officials were interviewed about changing local conditions for children and their knowledge about children's place use. During the interviews, children were asked to make drawings of the areas where they lived, and in some cases, they led researchers on tours of their familiar places or took photographs of places important to them.

Lynch and his colleagues found that children used the streets around their homes most heavily when the streets were not taken over by cars, but other important places included parks and overgrown interstitial spaces that Lynch called "wastelands." Lynch noted that wild areas like riverbanks, woods, and hills evoked both attraction and fear, but they gave children freedom to be alone or with friends and act independently—valued opportunities in urban districts where there was little space that children could call their own. These places also appeared when children talked about where they best liked to

be. When children were asked to imagine the best place to live in, they often mentioned trees, and as beautiful places, gardens and parks. Lynch (1977, 57) concluded that "The hunger for trees is outspoken and seemingly universal. Landscaping should be as essential a part of the basic infrastructure of a settlement as electricity, water, sewers, and paving." He also recommended that wastelands should be made accessible and safe for children's recreation as a supplement to traditional parks and playgrounds, as they were often the only spaces available for adventure and creative play.

Children's Experience of Place

In his book *Children's Experience of Place*, Hart's (1979, 4) goal was to understand children's "phenomenal landscape": "both their physical and experiential engagement with the landscape from the door of their home to the fringes of their known world." His study site was a small Vermont town where he worked from 1971 to 1973 with all eighty-six children in the elementary school, aged four to eleven. One of his legacies is the range of methods that he developed to study children in their environment: having each child build a model of the town, asking children if they recognized images of locations around town, child-kept geographic diaries, child-taken photographs, children's drawings and maps of places they used, activity surveys, interviews with children and their parents, and child-led place expeditions. He did extensive observations and systematic drive-around surveys and documented what he saw through field notes, photography, and film. Much of his book is about children's free range of movement, alone and with friends, and their geographic knowledge of their town, but when he turned his attention to place feelings and values, the importance of the natural environment became apparent.

When Hart interviewed children about their favorite places, they most frequently mentioned their homes or friends' homes and the ball field that functioned as a central meeting place. Then a long list of natural features followed: the river, lakes, trees, fields, hills, slopes for sliding, lawns, woods (places of both fear and fascination), and the play forts and houses that they built in overgrown edges. The place expeditions revealed small places for particular uses, such as a brook, a frog pond, a climbing tree, a hiding place under bushes, and a sand bank. The town's play equipment was rarely mentioned. As Hart observed children and moved beside them on their place expeditions, he could see functions that the natural environment served especially well. "Children spend a lot of time alone quietly resting, watching or dabbling in sand or water," he noted. "Such activities have been given little recognition in those reports of children's play prepared for environmental planners" (p. 335). Some children confided that these places were important retreats in times of trouble. Children also spent large amounts of time making constructions with loose parts (Nicholson 1971) like earth, water, stones, grass, and branches. These activities depended on the availability of areas close to home that were not dominated by adults "either by verbal restrictions or by the kind of physical manicuring of the

landscape which announces ownership by adults” (p. 335). Patches of dirt, Hart found, were the most intensively used of all children’s places, often for modeling miniature worlds for toy cars or animals. By the age of twelve, children no longer showed interest in these transformations of the landscape, as they became preoccupied with social worlds.

Hart saw that through their interactions with the environment, children were learning about themselves as much as they were learning about their world. They were developing environmental competence in the sense of knowledge, skill, and confidence in their ability to use the environment to carry out their goals and enrich their experience. They eagerly sought new achievements such as more complicated routes for travel or more ambitious building tasks. The natural world lent itself to this type of self-paced challenge. For example, a boy explained to Hart that one reason why he valued his favorite birch tree was that there were many ways up it, from the way he hoisted himself into it when he was “just a baby” to increasingly difficult routes toward the top by his current age of seven (p. 203). Once he was in the branches, the tree was a lookout tower.

Manipulating the environment at the large scale of forts and play houses or the microscale of dirt play involved dramatic play and negotiation: acting out real-life situations, practicing adult roles, expressing needs, and finding cooperative solutions. By symbolizing phenomena, children could address emotional conflicts. Small-scale modeling also enabled children to assimilate their knowledge of the large-scale environment, such as the layout of streets or how water moves down slopes. Hart noted that according to the child psychologist Erikson (1963), these “microspheres,” or worlds that children create in play, provide a safe base before moving into more complicated social worlds over which children have little control. In this Vermont town, wastelands neglected by adults served these purposes, whether it was dirt at the base of a tree in a yard, an overgrown hill behind houses, or a distant riverbank.

Hart found the ideas of the German educator Friedrich Froebel (1887) most resonant with the many dimensions of children’s experience that he observed. Froebel believed that the natural world exhibits a harmony and unity of life that children seek to grasp in their explorations to nourish a sense of inner unity. Like Froebel, Hart (p. 340) concluded that children need to understand the extent, diversity, and connections among things in the world as an important part of their developing sense of their own existence and place in the universe. He noted conflicts between this spontaneous learning outdoors and school values. “A more realistic measure of ‘intelligence’ for a society concerned with long-term human survival,” he suggested, “would include initiative or resourcefulness as central qualities,” enabling children to learn “the effective construction and modification of environments,” but also “to make trade-offs within the framework of a developing sense of social and environmental responsibility” (p. 347). He also noted the paradox that a new suburban development in town represented official planning rationale: the assumption that its manicured green spaces platted off in private yards formed an excellent environment for rearing children. In fact, such areas systematically

removed the undeveloped spaces that children needed to explore and modify their landscape.

Childhood’s Domain

Whereas Lynch (1977) and Hart (1979) discovered the importance of natural areas for children as an outcome of general investigations of children’s place use, knowledge, and feeling, R. C. Moore (1986, 9) began his equally wide-ranging research with the thesis that playful interactions with natural materials form “the basis upon which the child can acquire creative intelligence by interacting with the inherited world.” His interest in children’s awareness of their relatedness with the natural world, however, was part of his general concern for how urban environments can be managed to support healthy human development. Therefore, he investigated children’s relationships with their local environment as a whole using child-made maps or drawings of favorite places, interviews, and child-led expeditions. Like Hart, he was interested in range extension, as children gain independence to travel further distances with age, but he also introduced the concept of “range development” when places attract children to visit them again and again because there is always something new to discover.

In 1974, R. C. Moore (1980) began studying children’s everyday landscapes in the San Francisco Bay area and then took his methods overseas to three settlements in England: a “big city” neighborhood in London, a “new city” section of Stevenage New Town north of London, and an “old city” neighborhood in Stoke-on-Trent, an industrial city between Birmingham and Manchester (R. C. Moore 1986). In England, he worked with ninety-six nine- to twelve-year-olds, divided almost evenly among the three cities.

In their place expeditions, children led Moore over a “flowing terrain” that included streets and alleys for close-to-home play and cycling, playgrounds, sheds, garages, yards, greens, sports fields, parks, and “rough ground” similar to the wastelands that Lynch (1977) and Hart (1979) described. Despite the urban character of the three sites, natural elements emerged as children’s most frequent favorite places. Rough ground was essential, as almost one-third of children’s activities could be defined as adventure play that involved manipulating the environment in some way. Adults typically dominated the use of private yards and gardens, and housing authorities posted “No Play Allowed” signs around housing sites; but when children had access to unmown grass, weedy waysides, unpruned trees, varied topography, water edges, and patches of woods, they could colonize their own worlds. Moore noted that in addition to stimulating creative interactions, these places could “absorb the sometimes untidy results” without attracting adults’ ire (p. 160).

Parks with a diversity of features afforded a correspondingly diverse range of play activities. Most notable were two Victorian parks in Stoke-on-Trent, expansive enough to satisfy the needs of children and adults alike with landscapes of natural forms, mature trees and bushes, architectural follies, fountains, statues, bandstands, formal gardens, lawns, paddling pools,

bridges, and amenities like drinking fountains and toilets. Both the parks and rough ground functioned as places where children could be alone or with friends and gain environmental knowledge and awareness. As children were engaging with the environment, they were investigating its properties and learning its qualities.

Like Hart, Moore observed that environments that support healthy human development enable children to explore, test their capabilities, acquire new knowledge and skills, and enjoy a sense of competence. From this principle, he derived the rule that “The number and type of skill-related behaviors supported by a given setting would be a reasonable measure of its *childhood environmental quality*” (p. 15). Also like Hart, he found that parents played a critical role by either facilitating or constraining children’s freedom outdoors. A few parents kept their children to a tight range on their home block or confined indoors, where television dominated. Two-thirds of the children that Moore studied said that they watched television “more than two hours a day” and some said they watched it “most all the time.” Noting the advent of personal computers on the horizon, Moore warned that “Children who live exclusively in a secondary media environment inevitably pose a threat to the future of the planet because such images substitute vague dreams for those intuitive values that can only be acquired by life experience of the biosphere” (p. 21).

A Decade of Open Exploration

There are a number of reasons why child and nature research in the 1970s merits a close review. The field of design research had just formed, as evidenced by the 1969 launch of the journal *Environment and Behavior* and the first conference of the Environmental Design Research Association in the same year. In 1970, the first Earth Day signified a search for better human relations with nature. The Children, Nature, and the Urban Environment symposium fair and the research of Lynch, Hart, and Moore expressed the excitement of the period: a determination to take research out of the artificial setting of laboratories and into everyday settings of people’s lives, with practical applications for urban planning and design. Special concern about children’s access to nature in cities reflected more general concern about the suitability of cities as a human habitat in a rapidly urbanizing world.

Earlier, Barker and Wright (1951) made detailed records of children’s activities in the public realm as well as at home, but as Hart noted, they primarily focused on children’s actions in socially defined behavior settings, with limited interest in children’s spatial range or place knowledge and feelings. Lynch, Hart, and Moore applied a new suite of methods, both quantitative and qualitative, to understand and empathically experience what Hart called “the fluid transaction between a child’s plans and the environment’s attractions” (p. 158). All three shared an interest in how the outdoor realm can support healthy child development, as evidenced by opportunities to experience competence in a broad range of developmental tasks.

In the process, the importance of accessible natural areas spontaneously emerged. More than any other setting, places with earth, sand, water, and vegetation offered malleable elements that enabled children to “dialogue” with the environment in engrossing sensory ways. Wastelands allowed children to appropriate spaces for themselves where they could play creatively, find undisturbed time alone or with friends, and encounter other living things. Although Sen (1993) and Nussbaum (2011) had not yet articulated the capabilities approach to well-being, in retrospect, most of Nussbaum’s Central Capabilities are apparent in the interactions with nature that Lynch, Hart, and Moore described (see Table 1). Notably, natural areas are the only place where children can develop the ability to “live with concern for and in relation to animals, plants, and the world of nature” (Nussbaum 2011, 34).

The capability for practical reason that Nussbaum defines as “being able to form a conception of the good and to engage in critical reflection about the planning of one’s life” (p. 34) deserves special mention. Engaging citizens in this type of critical reflection as it relates to the physical environment is a core value of the planning profession (<https://www.planning.org/apaatag/mission.htm>), and it is consistent with the importance given to individual and community participation in the vision of primary health care in the Declaration of Alma-Ata. The 1960s and 1970s saw the rise of advocacy planning that took planners out of their offices to learn from residents of places and give them a voice in decisions; but even in the *zeitgeist* of this period, it was radical to view children as experts about the impact of local conditions on their lives.

Faith in children’s ability to contribute to urban planning and design was another value that Lynch, Hart, and Moore shared. Lynch (1977) anticipated that *Growing up in Cities* would expose “the misperceptions of planners and educators” (p. 1) and he called for “institutional advocacy and responsive planning” (p. 57) that would show concern for children’s needs and involve children in evaluating existing environments and participating in the design of improvements. Hart (1979, 347–48) concluded *Children’s Experience of Place* by observing that for planners to understand children’s land use and the meaning of places for children’s development, they must begin by asking children themselves. R. C. Moore (1986) ended *Childhood’s Domain* with a chapter on policy directions for creating and conserving children’s special places and involving children in decision making. Hart (1997; Johnson, Hart, and Colwell 2014) and Moore (Cosco and Moore 2002) have remained leaders in the practice of participatory planning and design with children.

Later Ethnographic Work on the Value of Nature for Children

As later sections of this article show, with the 1990s, most research on children and nature shifted to naturalistic experiments and correlational designs. A few people, nevertheless, were inspired by the work of Lynch, Hart, and Moore to take up their ethnographic methods. Notably, the *Growing up in*

Cities project was revived in the 1990s in response to the United Nations' adoption of the Convention on the Rights of the Child (CRC) in 1989. The CRC became the most rapidly and widely ratified international human rights treaty in history, with the primary exception of the United States. Defining children as all people below the age of eighteen, its fifty-four articles include Article 12 that gives children a right to a voice in all decisions that affect their lives (www.unicef.org/crc/). It has been interpreted to extend to a right to a voice in decisions that affect their environments (Hodgkin and Newell 1998). Spurred by the CRC, UNESCO, Childwatch International, and a quilt-work of other international and national organizations sponsored a revival of Growing up in Cities in preparation for the Second United Nations Conference on Human Settlements in 1996 (Chawla 2002; Driskell 2002). This time the program was launched in eight countries, including a return to original sites in Australia and Poland, and new sites in England, Norway, Argentina, South Africa, India, and the United States.

In the 1990s, compared with the 1970s, more children talked about heavy traffic, crime, drug use, pollution, the removal of trees, lack of sanitation and clean water, and ethnic tensions, but features of their localities that they valued remained remarkably consistent (Chawla 2002, chapter 10). When children evaluated their neighborhoods, social qualities were as important as physical qualities and interdependent. When they perceived parks and wastelands to be safe, they valued them highly. Children and young adolescents in the 1990s, like young people in the 1970s, used overgrown vacant land for exploring, creative play, and hideaways, and used parks for meeting friends, hanging out, active play, and appreciating trees and gardens. *Growing up in Cities* continues to serve as a model for local initiatives to engage young people in multi-method evaluations of their environments that continue to show that safe, accessible green spaces are highly prized (Derr et al. 2013; Malone 2013).

Children's Special Places

Inspired by Hart's work in Vermont, in 1987–1988, the New Hampshire educator David Sobel (2002) carried out an investigation of one aspect of children's engagement with their environment: the value of their self-constructed places. As a leading voice for the place-based teaching of geography and other subjects (Sobel 2005), he had been noticing children's fort building on wooded and overgrown land across the United States. With the aim of comparing these observations with what he called the "affective geography" of elementary school children in other countries, he undertook research with 90 five- to eleven-year-olds in a rural school in Devon, England, and 101 five- to fifteen-year-olds in a school on the island of Carriacou in the West Indies. He began by asking children to draw a map or picture of outdoor areas where they played, interviewed them individually about their drawings, and selected a representative subsample of boys and girls to lead him on walks to their special places. In 60 percent of the Devon interviews and nearly 80 percent of the Carriacou interviews,

children spontaneously talked about their dens, forts, and playhouses.

In seeking to understand these places' value, Sobel drew on the theory of Cobb (1959, 540) that during the middle years of childhood, "What a child wanted to do most of all was to make a world in which to find a place to discover a self." (For a deeper examination of Edith Cobb's ideas, see Schauman 2013.) Reflecting on the place making that he witnessed, Sobel concluded that the construction of these private places is one of the ways that children prepare themselves physically and symbolically in middle childhood for the transition to adolescence, when the question "Who am I?" becomes acute.

He also agreed with Cobb regarding another dimension of these places' significance when they were constructed in nature, as they usually were. Cobb (1959, 538) claimed that during these middle years of childhood, "The natural world is experienced in some highly evocative way, producing in the child a sense of some profound continuity with natural processes." After reading childhood autobiographies by some 300 creative individuals, she came to believe that this childhood sense of relationship with the outer world serves as a well-spring of later creativity. Sobel noted that when Chawla (1990) tested Cobb's theory against thirty-eight randomly selected autobiographies from the late twentieth century, evocative memories of the natural world such as Cobb described appeared in fifteen of the texts, not universally, and only a few authors directly attributed their creative work in adulthood to these experiences. Many, however, said that they returned to these memories as a touchstone for strength and stability and a lifelong sense of the integration of nature and human life, as Cobb suggested.

Aboriginal Children in Their Environment

Following the example of Hart, the architect Angela Kreutz (2015) began a multi-method exploration of children's place knowledge, use, and feelings in the Aboriginal settlement of Cherbourg in rural Australia, focusing on a changing culture with a deep historical bond to the land. Working with twenty-four nine- to twelve-year-olds, Kreutz used observations, photography, drawings, aerial maps, interviews, activity diaries, and child-led expeditions, along with the new method of digital storytelling, and also interviewed adults in the community. After generations of forced relocation and assimilation into European culture, adult residents agreed that the connection to the natural and spiritual landscape for which their culture was renowned was diminishing with each generation. Only four out of twenty-four children in the study could recall going on an excursion into the surrounding bush with an adult companion.

One aspect of the old culture that remained was that children were given great license to roam. With the decline in traditional practices to pass down knowledge about plants, animals, and wayfinding, children were left to themselves to discover the values of the land. On its side, the land was also changing, providing fewer resources. An upstream dam had degraded a local

creek, reducing the flow of water and the deposit of sand and causing algae blooms. Prolonged drought had contributed to reduced biodiversity and the loss of a number of farms, orchards, and vegetable gardens.

Nevertheless, when fears of social threats, ghosts, or physical risks like snakes did not prevent children from entering the surrounding bush, they found many advantages there. Like young people at other ethnographic sites, children in Cherbourg slid down hills, climbed and swung from trees, built forts and cubby houses, explored rocks and caves, went swimming and fishing in the creek when the water flow permitted, and watched wildlife and farm animals. In a community plagued by unemployment, violence, alcoholism, and drug use, natural areas offered important retreats for reflection, quiet, privacy, and peace. Children showed Kreutz their special places for restorative experiences like flowing water, wind in the trees, and lookouts for watching community activities from a distance. Like Hart (1979) and R. C. Moore (1986), Kreutz noticed that as children frequented natural areas repeatedly over time and gave these sites names, they were developing place attachments. She concluded that “The multiple meanings, multi-functionality, flexibility, and responsiveness of natural features and properties ensured that children of all ages and abilities experience a degree of environmental congruence”—a good fit between children’s needs and the environment’s provisions (p. 210).

Ethnography as History

Lynch (1977, 1) listed the ability to learn about long-term changes in children’s environments as one of the potential uses of multi-method fieldwork. When Hart (1979) and R. C. Moore (1980, 1986) chronicled children’s outdoor play in the 1970s, however, they did not realize that they were recording a vanishing childhood culture. In 2004, Hart began a series of visits back to the Vermont region where he did his original fieldwork, seeking out the now-grown children with whom he had worked, who now had children of their own. He has not yet published this second stage of his research, but a journalist recently covered some of his key findings in a feature story in *The Atlantic*. Reading *Children’s Experience of Place*, Rosin (2014) found that Hart’s account, which must have seemed mundane in the 1970s, “today feels like coming upon a lost civilization, a child culture with its own ways of playing and thinking and feeling that seems utterly foreign today.” When Hart showed Rosin film footage that he made at that time, her eyes filled with tears. As she watched a six- and seven-year-old brother and sister build a bed of ferns in a patch of woods, completely absorbed in the world they were creating together, she realized that their way of being was qualitatively different than that of her own children and other children she was used to meeting, “who take it for granted that they are always being *watched*.”

When he returned to Vermont in 2004, Hart immediately realized that he could no longer study children’s autonomous world making in outdoor spaces as he had once done. He found a level of fear among parents that didn’t correspond to actual

threats. Most parents no longer allowed their children out of their sight, and children were used to having their lives organized by their parents. Although Hart observed that increased time with parents can be a benefit, he was concerned about the loss of a child culture where children were inventing their own activities and building their own communities. Although Rosin (2014) was cautious not to attribute complex social problems to a single source, she noted that this loss of a creative play culture outdoors coincides with objectively measured increases in psychiatric disorders and declines in creativity in contemporary children.

A New Emphasis on Naturalistic Experiments and Correlational Research

When innovators in the new field of environmental psychology in the 1960s and 1970s determined to take research out of the artificial setting of laboratories, some pioneered naturalistic experiments, manipulating conditions in public spaces or finding settings that offered naturally occurring experimental conditions (Proshansky, Iltus, and Rivlin 1976). In 1981, the architect Ernest Moore published a study that applied this approach to a new topic: the benefits of contact with nature for health and well-being (E. O. Moore 1981). By 2015, hundreds of experimental, quasi-experimental, and correlational studies have investigated the benefits of access to nature for human health and happiness, with new findings regularly appearing (see recent reviews by Matsuoka and Sullivan 2011; Bratman, Hamilton, and Daily 2012; Wells and Rollings 2012; Hartig et al. 2014; James et al. 2015).

In the 1990s, Frances Kuo, William Sullivan, and colleagues at the University of Illinois in Urbana–Champaign took advantage of Chicago public housing settings where architecturally identical buildings were inhabited by demographically similar populations, and applicants on a waiting list took units as they became available—effectively random assignment. One condition varied: whether there were trees, bushes, and grass around individual buildings or barren dirt and asphalt. In a series of natural experiments, the researchers demonstrated that residents, including children, who happened to have a view of trees and other vegetation outside their windows did better on many measures, and nearly twice as many adults and youth used open spaces with trees and other vegetation versus barren spaces. (For a list of the studies, see Kuo 2002 and <http://lhlh.illinois.edu/all.scientific.articles.htm>.) Seeing the impact that this research had on greening policies in Chicago, Kuo (2002) argued that research is more likely to be applied by planners and policy makers if it involves realistic and well-controlled experiments with dependent variables that matter to decision makers (such as family violence) and independent variables that decision makers can feasibly control (such as the number of trees in a setting).

Since this research in Chicago public housing, many studies have compared children in more or less vegetated settings on different measures of well-being or related the distance that children live from green spaces to health measures. These

studies are covered briefly here because many of them have already been included in previous reviews and annotated bibliographies on children's nature contact (Faber Taylor and Kuo 2006; Ward Thompson, Travlou, and Roe 2006; Lester and Maudsley 2007; Muñoz 2009; Pretty et al. 2009; Woolley, Pattacini, and Ward 2009; McCurdy et al. 2010; Gill 2014). Most of the studies that follow are quantitative, involving experimental, quasi-experimental, and correlational methods. A few involve qualitative surveys of young people's favorite places, observations, and interviews.

Physical Health

General measures of health and well-being. Many studies with adults measure biomarkers of stress, such as blood pressure and cortisol levels, and ask people to rate their subjective sense of health and well-being (Hartig et al. 2014), but these measures have only recently been applied with children and adolescents. When Soderstrom et al. (2013) compared the health of Swedish preschoolers with high-quality schoolyards that integrated trees, shrubbery, and hilly terrain with open areas and play structures, versus preschoolers with yards with less play quality, those with high-quality outdoor spaces had better outcomes that included longer sleep at night and higher health ratings by their parents. They also had higher mid-morning cortisol levels, but this was related to greater physical activity and appeared to be a reasonable physiological response. In a German study, urban ten-year-olds who lived in areas of high greenness had lower levels of blood pressure, after controlling for temperature, air pollution, noise, and other potential confounding factors (Markevych et al. 2014a). No similar difference was found between areas with different levels of greenness in rural locations. After schoolyard greening at an Austrian middle school, students showed significantly reduced blood pressure compared to students at two control schools (Kelz, Evans and Röderer 2015).

When Scottish families with young children lived less than twenty minutes walking distance from a green space, mothers rated the general health of their children as higher (Aggio et al. 2015). Canadian teenagers defined environments that support health as being outside, in safe, clean, and *green* spaces where they could walk and participate in community activities (Woodgate and Skarlato 2015). Finnish ten- to fifteen-year-olds were more likely to report that they had very good health when there was a large amount of green structure around their home, after controlling for neighborhood socioeconomic status (Kyttä, Broberg, and Kahila 2012).

Neonatal weight and survival. Protective effects of nature begin at birth. Dzhambov, Dimitrova, and Dimitrakova (2014) conducted a systematic review of eight studies that measured birth weight and levels of greenery around pregnant mothers' homes, as low birth weight is a major cause of neonatal and infant mortality and a predictor of later health risks. Study samples resided in the United States, Canada, England, Spain, Germany, and Israel, comprising 214,940 cases in total. Seven

studies found positive associations between residential greenness and birth weight after appropriate controls. An eighth study found a significant effect only for mothers with the lowest level of education. Although effects were significant within 100 meters of the home, they were stronger for wider green buffers up to 500 meters.

Kihal-Talantike et al. (2013) looked at cases of infant mortality in metropolitan Lyon, France. Neighborhood levels of economic deprivation and greenness had independent effects on infant mortality, with greater deprivation and less greenness each increasing mortality risks. Although the causes of these beneficial effects of greenery on neonatal survival and weight are not known, Richardson (2014) noted that there may be direct effects through passive exposure, as green buffers are associated with less air pollution, noise and lower temperatures, and indirect effects through healthy behaviors in the form of more physical activity outdoors and more social contacts. All of these factors would predict reduced maternal stress during pregnancy.

Respiratory diseases and allergies. The effect of nearby nature on asthma and allergies is mixed. Dutch children and adolescents who lived near green spaces had lower rates of respiratory diseases (Maas et al. 2009), and four- and five-year-olds in the United States who lived in neighborhoods with more street trees were less likely to have asthma (Lovasi et al. 2008). On the other hand, levels of tree cover near the prenatal addresses of Dominican and African American children had no effect on outcomes at age five but predicted more asthma and allergic sensitization at age seven (Lovasi et al. 2013a). Spanish children who lived near a park had higher rates of asthma, but proximity to an urban forest and levels of greenness around their homes had no effect (Dadvand et al. 2014). More residential greenery was associated with higher rates of allergies among children up to age ten in metropolitan Munich, but lower rates among children in rural Germany (Fuertes et al. 2014). In Texas, Pilat et al. (2012) found no associations between levels of vegetation or tree canopy coverage and childhood asthma.

How are these conflicting results to be explained? Studies controlled for air pollution and other potential confounding factors. Trees and vegetation filter particulates from the air but release pollen; but these contrasting functions do not offer an adequate explanation. According to Rook (2013), children develop a well-regulated immune system that effectively distinguishes dangerous molecules from harmless allergens through exposure to a great variety and number of microbiota that coexist with diverse vegetation, animal species, and fertile soils. Therefore, it is not enough to measure levels of vegetation cover from aerial imagery, as most studies of nearby nature and respiratory diseases have done. It is also necessary to know the biodiversity of trees, other plants, and animals in children's surroundings. Consistent with Rook's suggestion, Hanski et al. (2012) and Ruokolainen et al. (2015) found that Finnish adolescents who lived near greater biodiversity had a higher diversity of skin bacteria as well as less allergic sensitization.

Given the role of a healthy immune system in protecting against diseases of all kinds, Rook (2013) argued that microbial diversity needs to be recognized as an essential ecosystem service. This “biodiversity hypothesis” supplements the psychoevolutionary theory of Ulrich (1983), which proposes that humans are biologically hardwired through evolution for immediate positive responses to safe natural settings associated with survival, such as trees, other vegetation, and water. Ulrich’s theory addresses rapid short-term recovery from stress in nature. The biodiversity hypothesis may help explain long-term health benefits of living near more biodiverse natural areas.

Physical activity. The relationship between proximity to green spaces and levels of physical activity is the most frequently explored benefit of nearby nature for children (Gill 2014). Driven by concerns about high rates of obesity in the United States, the United Kingdom, and other high-income nations and costs to individuals and health care systems due to associated diseases, this research is motivated by the principle that children who are more physically active burn more calories, build muscle, and are more likely to have a healthy weight and body mass index (McCurdy et al. 2010). The question, then, is what environmental conditions encourage greater physical activity? In this research, nature is typically factored into correlational designs under the designation of “parks,” “green spaces,” or “urban forests,” and physical activity measured through accelerometers or self-reports.

Green environments support children’s moderate and vigorous activity (Wheeler et al. 2010; Coombes, van Sluijs, and Jones 2013). In a review of the influence of the neighborhood environment on the health and development of children from birth through age seven, Christian et al. (2015) found twenty-two studies that examined associations with neighborhood green space. Most of these studies found positive associations between access to green spaces and more outdoor play and physical activity. In an additional study, Lovasi et al. (2011) found that low-income preschoolers in New York were more physically active when they lived in neighborhoods with more street trees. Gardsjord, Tveit, and Nordh (2014) reviewed thirty-two studies that examined characteristics of parks and other green spaces that contribute to physical activity in eight-through twenty-one-year-olds. The most frequently reported factor was ease of access, measured either as distance from home to green areas or the percentage of green cover in the neighborhood. According to a number of studies, it was also important that green spaces included amenities like sports facilities, trees, open areas, playgrounds, or paths and be perceived as safe and well maintained. Additional studies by de Vries et al. (2007) in the Netherlands, Janssen and Rosu (2015) in Canada, and Young et al. (2014) in the United States are consistent with these findings. Children are also more likely to walk and cycle when they have street trees and nearby parks (Timperio et al. 2004; Larsen et al. 2009).

Positive associations between green spaces and physical activity are not invariable, as outcomes often vary by sex, race, ethnicity, family income, perceptions of neighborhood safety,

and other factors (Pont et al. 2009). Noting inconsistent outcomes, Ding et al. (2011) recommended that in order to support physical activity in children and adolescents, it is necessary to address a cluster of factors in addition to proximity to spaces for active recreation. These include walkability, traffic speed, traffic volume, land use mix, and residential density.

Many studies link proximity to parks and other green spaces to healthier weight or lower body mass index in children (Liu et al. 2007; Bell, Wilson, and Liu 2008; Potwarka, Kaczynski, and Flack 2008; Veugelaers et al. 2008; Wolch et al. 2011; Wall et al. 2012; Alexander et al. 2013; Lovasi et al. 2013b; Ohri-Vachaspati et al. 2013; Dadvand et al. 2014; Fan and Jin 2014; Kim et al. 2014). Children under medical treatment for obesity show greater reductions in their body mass index when they have more parkland nearby (Epstein et al. 2012). “Proximity” in these studies generally means distances within 800 to 500 meters. As with levels of physical activity, associations between green space, weight, and body mass index are not always consistent (Casey et al. 2014).

Studies that explore landscape features that encourage physical activity have been primarily conducted on school grounds where children of similar ages and backgrounds can be observed in different settings. Although built play equipment affords vigorous activity, more children maintain at least moderate levels of activity on school grounds with natural elements like trees, shrubbery, rocks, earth, sand, water, or combinations of built equipment and vegetation (Boldemann et al. 2006; Cosco 2007; Dymont and Bell 2008; Dymont, Bell, and Lucas 2009; Boldemann et al. 2011; Coe et al. 2014; Pagels et al. 2014). Play areas with more diverse features support more diverse interests and activities (Martensson et al. 2014). When children’s health at preschools with different quality yards was compared, children with play yards with more trees, shrubbery, and hilly terrain among open spaces and play structures took more steps per minute and had slimmer waists and more normal scores for body mass index (Soderstrom et al. 2013).

Studies in the United States and Europe show that low-income and ethnic minority families have less access to urban green spaces in general or large well-maintained parks with amenities in particular (National Recreation and Park Association 2011; Evans et al. 2012; Wen et al. 2013). At the same time, children from low-income and ethnic minority families are most likely to be overweight or obese and have high body mass index scores (Evans et al. 2012), indicating a heightened need for high-quality spaces for physical activity. Therefore, equitable access to attractive parks and other green spaces, as well as grounds around schools and childcare centers that integrate natural elements with play equipment, is an environmental justice issue.

Physical fitness. In a natural experiment, Fjørtoft (2001) compared forty-six Norwegian children who played freely in the forest next to their kindergarten with twenty-nine children who used traditional playgrounds. At the beginning of the school year in September, the experimental group scored below the reference group on the EUROFIT test of physical fitness, but

over the course of nine months, Fjørtoft observed them become “strikingly better at mastering a rugged ground and unstructured landscape,” and by June, they significantly surpassed the reference group on tests of balance and motor coordination. Fjørtoft noted that this result was similar to a Swedish study in which kindergarteners with access to a natural environment for play showed significantly greater gains in the EUROFIT test than kindergarteners with a traditional urban playground (Grahn et al. 1997).

Pesticide risks. In the literature on children and nature, the risks of pesticides are rarely mentioned. Mounting research indicates that this silence needs to be broken. Recent reviews and policy statements from the American Academy of Pediatrics (Roberts, Karr, and Council on Environmental Health 2012) and American College of Obstetricians and Gynecologists (2013) in the United States and the Ontario College of Family Physicians (Sanborn et al. 2012) in Canada present strong evidence that herbicides, insecticides, and other pesticides need to be avoided in any places that children use. Widely applied on public as well as private lawns and gardens and around schools and childcare centers, and widely present in the bodies of pregnant women and children, these chemicals are associated with a long list of adverse effects, including miscarriages, low birth weight, birth defects, childhood cancers, respiratory and lung diseases, reduced IQs, attention deficit disorder (ADD) and other learning disabilities, and autism spectrum disorder.

Cognitive Functioning and Self-control

When Faber Taylor, Kuo, and Sullivan (2002) investigated the effects of vegetation around Chicago public housing, they found that the greener the view from apartment windows, the better teen girls performed on tests of concentration, control of impulsivity, and delay of gratification. With other populations, the same research team found that contact with nature can reduce symptoms of ADD and attention deficit and hyperactivity disorder (ADHD). According to parents’ ratings of their children’s behavior, activities that reduced ADD symptoms were disproportionately likely to take place in green settings, and the greener the setting in terms of tree cover and grass, the milder the symptoms (Faber Taylor, Kuo, and Sullivan 2001). A nationwide questionnaire confirmed these results (Kuo and Faber Taylor 2004; Faber Taylor and Kuo 2011); but whereas children diagnosed only with attention deficits improved after play in both grassy areas with big trees and grass and large open lawns, children with hyperactivity showed improvement only after play on open grass (Faber Taylor and Kuo 2011). When children with ADHD diagnoses were led on twenty-minute walks through a city park, a downtown district, and a residential neighborhood, their performance on tests of concentration improved only after the walk in the park, to a degree comparable to the effects of a widely used medication for ADHD (Faber Taylor and Kuo 2009).

Other researchers have found similar effects. Wells (2000) used the ADD Evaluation Scale to track the effect of a

move from substandard housing to better-quality single-family homes on low-income children in the United States. The strongest predictor of post-move improvements in concentration was the amount of increase in the naturalness of home surroundings, measured in terms of green views and grass yards. Martensson et al. (2009) used the early childhood version of the same scale to compare measures of attention and impulsivity in children in eleven Swedish preschools where the playgrounds varied in amounts of trees, shrubbery, hilly terrain, and vegetation around play structures. Children playing in large and integrated natural areas showed significantly less inattention, with lower measures of impulsivity that bordered on significance. In Barcelona, Amoly et al. (2014) found that higher levels of residential greenness around the homes of seven- to ten-year-old students (but not the distance to a major green space) were associated with less inattention and hyperactivity, using both parents’ and teachers’ assessments of symptoms. Greenery around the home was independent of family income. In metropolitan Munich, Markevych et al. (2014b) showed that as the distance from a child’s home to urban green spaces decreased, so did the odds of hyperactivity/inattention symptoms. In English cities, Flouri, Midouhas, and Joshi (2014) found that children who had access to a garden or visited parks and playgrounds had fewer conduct, peer, and hyperactivity problems, according to their mothers.

In the Netherlands, van den Berg and van den Berg (2011) gathered observations, interviews, and test–retest scores of twelve children diagnosed with ADHD. More than half of the children had additional diagnoses such as autism or oppositional defiant disorder. Observed in two groups, each group visited a woods and engaged in building a cabin on one day and made an expedition to a small town on a second day. In the woods, each group showed enthusiasm, cooperative social behavior, and concentration, versus little social behavior and much inattention and impulsivity in the town, and each group performed significantly better on a test of concentration only after the field trip to the woods.

Three studies with large samples and controls for many potential confounding factors show beneficial effects of vegetation around schools. Third-grade students in Massachusetts made higher scores on standardized tests of English and mathematics when there were more trees and other plants around their schools (Wu et al. 2014). In Michigan, students in high schools with views of trees and shrubbery versus large empty lawns, athletic fields, and built features had significantly higher graduation rates, merit awards, and student plans to attend college (Matsuoka 2010). In Barcelona, Dadvand et al. (2015) periodically assessed the cognitive development of seven- to ten-year-olds over the span of a year, and compared their progress to levels of vegetation around their homes, along their route to school, and within and around school boundaries. Children showed significantly greater improvement in their working memory and reduced inattentiveness when they had more vegetation in and around their school and higher overall scores for greenness. The study showed that one potential explanation is that vegetation mitigated air pollution from traffic, a factor that negatively impacts cognitive development.

Psychological Well-being

As the ethnographic work of Hart (1979), R. C. Moore (1986), and Kreutz (2015) showed, natural areas provide children with places for creative play, self-tests of their developing strength and skill, and quiet retreat—all important resources for psychological well-being. Other ethnographic studies of children in conditions of poverty, war, and displacement show the high value of green refuges (Chawla 2014). Because psychological well-being is a subjective experience as well as an expert diagnosis, levels of greenery have been related to children's self-assessments, parent's perceptions of their children's condition, and professional diagnoses. All of these measures indicate that access to nature is a protective factor.

Four studies that have used large health databases showed that green space proximity predicts better mental health and emotional adjustment among children, though the effect sometimes varies with family income and education. When Maas et al. (2009) examined the medical records of Dutch citizens in relation to the percentage of green space near their homes, they found that more green space was associated with significantly lower rates of fifteen- out of twenty-four major diseases, with the strongest relation for adults aged forty-six to sixty-five and children under twelve. For children, the strongest effect was lower rates of depression. The study controlled for socioeconomic and demographic variables. In Scotland, children living less than twenty minutes from a green space had better mental health, regardless of family income, but children of low socioeconomic levels were more likely to live at a greater distance (Aggio et al. 2015). In English cities, more neighborhood green space was associated with fewer emotional problems only for three- to five-year-olds in families in poverty (Flouri, Midouhas, and Joshi 2014); and in Lithuania, closer distances to city parks and greenery were only associated with better mental health for four- to six-year-olds of mothers with a low level of education (Balsevicene et al. 2014). Working with 337 children in rural New York, Wells and Evans (2003) found that children with more nature in and around their homes exhibited less psychological distress and a greater sense of self-worth, after controlling for family income; but importantly, the more stressful events that children experienced, the more strongly nature acted as a buffer.

Korpela (2002) reviewed research that shows that when children and adolescents describe favorite places, they commonly associate them with feeling relaxed, calm, and comfortable, and frequently identify natural settings. When Korpela, Kyttä, and Hartig (2002) examined fifty-five eight- to thirteen-year-old Finnish children's favorite places through structured interviews, they found that three-quarters of the children who named a favorite place in nature stated that forgetting troubles, being free and relaxed, or reflecting on personal matters and clearing their mind were reasons for going there. However, children associated these needs for restoration and relaxation with favorite places in general, including sports fields and homes, and also valued favorite places for play, fun, and meeting friends. Studies in Tasmania (Abbott-Chapman 2006), England

(Milligan and Bingley 2007), Scotland (Ward Thompson, Travalou, and Roe 2006), and the United States (Owens and McKinnon 2009) confirm these results. In the case of woodlands, Milligan and Bingley (2007) observed that adolescents were most likely to find therapeutic qualities in woods when they played in woods as children. They avoided woods as scary places when they associated them with parents' anxieties or horror films.

A few studies set in schools have compared mental health effects of indoor classrooms to outdoor classrooms, naturalized playgrounds, and gardens. Roe and Aspinall (2011) assessed eighteen young adolescents in Scotland who differed across a spectrum from good to poor behavior, before and after they spent a day in a forest school versus a typical day in classrooms. The forest school had significant positive effects on both the good behavior and poor behavior groups in terms of a greater sense of energy and happiness and less anger at the end of the day and an effect of borderline significance in terms of less self-perceived stress. Young people classified with poor behavior experienced the greatest benefits in terms of greater energy, happiness, and less stress. Chawla et al. (2014) documented young people's behavior on an elementary school playground where children could choose woods play during recess, in a natural habitat that older students (aged nine to thirteen) used as an outdoor classroom, and in school and community gardening programs for teenagers. Compared to classrooms indoors, the natural areas promoted concentration and relief from stress. Students frequently described the natural habitat and gardens as peaceful, calm, and relaxing. When 550 eight- to eleven-year-olds in fourteen Australian schools rated the restorativeness of their school grounds, they rated grounds with more vegetation and grass cover as more restorative but also highly valued positive play experiences and diverse affordances (Bagot, Allen, and Toukhsati 2015). Thirteen- to fifteen-year-old students in Austria showed significant increases in self-reported psychological well-being after schoolyard greening, compared to students at control schools (Kelz, Evans, and Röderer 2015). In a Canadian study, however, green land uses within five kilometers of schools had weak and inconsistent effects on eleven- to sixteen-year-old students' assessments of their positive emotional well-being (Huynh et al. 2013). Students appear to benefit more from green school grounds than distant surrounding green cover.

Affiliation and Imaginative Play

Nussbaum (2011) includes *affiliation* as one of the Central Capabilities that contribute to human well-being: being able to live with and toward other people, engage in various forms of social interaction, imagine the situation of another, and show concern for others. As separate capabilities, she lists *play* and the *use of the senses, imagination, and thought*. When children engage in creative play together, they are exercising all of these capabilities. Faber Taylor et al. (1998) observed that when outdoor spaces in Chicago public housing had more trees and grass, children played more often, more creatively, and had more access to adults.

A number of studies on school grounds and childcare centers, where researchers observe children's behavior in different settings, or before and after a site is naturalized, indicate that natural areas provide for more imaginative, constructive, sensory, and socially cooperative play than asphalt, flat expanses of lawn, or built play equipment (Kirkby 1989; Grahn et al. 1997; R. C. Moore and Wong 1997; Herrington and Studtmann 1998; Fjørtoft and Sagaie 2000; Blizard and Schuster 2004; Cosco 2007; Samborski 2010; Stanley 2011; Kuh, Ponte, and Chau 2013; Cloward Drown and Christensen 2014). In the words of Herrington and Studtmann (1998), on built play structures, children use physical prowess to establish social hierarchies. In the "vegetative rooms" created by school ground greening, there is more fantasy play, where the social hierarchy is based on "a child's command of language and their creativity and inventiveness in imagining what the space might be" (p. 203). When Malone and Tranter (2003) compared the play of eight- to ten-year-olds on five Australian schoolyards, they cautioned that such findings need to be placed in the larger school context. They found that children exhibited more imaginative role playing, fantasy, exploration of the environment, and construction of huts and objects from loose parts only when the schoolyard had natural areas and the school philosophy encouraged creative use of the grounds. In playground observations, Luchs and Fikus (2013) documented that children engaged in longer play episodes and a greater variety of different types of play in a natural versus traditional play area.

Affiliation with Other Species and the Natural World

By including affiliation with other species as a Central Capability, Nussbaum (2011, 34) introduced a rarely heard note to discussions of human well-being: that caring relations with nature are necessary not only because of the services that ecosystems provide but also because experiences of nature connection and concern for nature are part of a well-lived human life. A recent study of children in Swedish preschools found that schools with similar demographics and teaching philosophies, but closer to urban green spaces, had children who were more empathetic and concerned for other life forms and more aware of human-nature interdependence (Giusti, Barthel, and Marcus 2014).

Most research on childhood sources of concern for nature takes a retrospective approach. "Significant life experience" research seeks to identify childhood experiences that influence adult values and behaviors toward nature, using interviews, open-ended questionnaires, and surveys. It begins with samples as young as adolescents, asking about formative experiences in their young lives or relating survey responses about childhood to current environmental behaviors. In a review of more than thirty studies of this kind, the most common experiences associated with adult care for nature are childhood play in nature and adult figures who communicate nature's value (Chawla and Derr 2012). Research also shows that people who played in nature as children are more likely to choose natural areas for recreation (Ward Thompson, Aspinall, and Montarzino 2008)

and express more motivation to overcome barriers to recreation in nature (Asah, Bengston, and Westphal 2012).

Discussion

Directions for Future Research

As this review shows, the 1970s was a period of pioneering ethnographic research on the value of nearby nature for children. The work of Lynch (1977), Hart (1979), and R. C. Moore (1980, 1986) revealed the value of nature from children's perspectives and showed contributions of natural areas to the development of the whole child. Natural areas provided opportunities to engage in creative play alone and with friends, set self-paced challenges, find quiet retreats, learn about the environment from direct experience, and form emotional bonds with places and the natural world. Descriptions of children in nature in this work, as well as the later work of Sobel (2002), members of the Growing up in Cities revival (Chawla 2002), and Kreutz (2015), show most of Nussbaum's (2011) Central Capabilities in action: *bodily health* through physical activity; *bodily integrity* in terms of freedom of movement; the *senses, imagination, and thought*; the *emotions; play; control over one's environment*; and *affiliation* with friends and *other species and the world of nature*. If children are involved in the evaluation and design of their localities, as this tradition of research and participatory planning and design with children encourages, then their capability for *practical reason* is fostered too. In this tradition, children are resourceful agents in exploring and shaping their environment to meet their needs for healthy development.

With the shift to experimental, quasi-experimental, and correlational methods, adults define how nature matters to children as they select the dependent variables that they deem important, such as levels of physical activity, motor coordination, and concentration. Rather than a rich sensory field that affords the functioning of multiple capabilities, nature becomes an abstraction that can be quantified, such as levels of vegetation or distance from green spaces. These choices are necessary to investigate the benefits of access to nature with the tools of clinical epidemiology (Frumkin 2012); and as this review has shown, this approach has yielded striking and important results. In the process, however, unquantifiable dimensions of health elude view—including capabilities that give deep meaning to life such as the emotions and senses (Frumkin 2012; O'Brien and Varley 2012). Children become passive recipients of treatments that adults provide.

Moving forward, future research on children, nature, and health will do well to find a balance between ethnographic and experimental/correlational designs, and develop complementary mixed methods. Ethnographic fieldwork with children suggests how nature can contribute to children's "complete physical, mental, and social well-being" and to the development of all capabilities. It also reveals what children are doing in nature that can help explain statistical relationships and the affordances of the landscape that make health-promoting

activities possible. Experimental, quasi-experimental, and correlational studies have investigated how access to nature can contribute to “the absence of disease or infirmity.” They follow a medical model that compares nature contact to a medication that can be used to treat conditions like obesity, depression, or inattention—leading to questions such as the minimum dose necessary for effect (Sullivan et al. 2014). From Nussbaum’s ten Central Capabilities, they primarily investigate two: *life* and *bodily health*. For the full story of health, both quantitative and qualitative research are needed.

Impressive as they are, the number of studies of nature and children’s well-being is small compared to the much larger literature on adult benefits. Up to this point, research is largely silent regarding the influence of nature contact on family systems, although it is reasonable to expect that children may be indirectly benefited when the adults around them enjoy some of the outcomes documented, such as reduced stress, better management of life challenges, and more interaction with friends and neighbors (Wells and Rollings 2012). Future research should address how nature affects children and their caretakers together, and how each side may mediate the nature experience of the other. How are children’s experiences of nature influenced by their caretakers? Can children’s playfulness and curiosity influence what their caretakers notice and feel? It is also important to understand how experiences of nature vary by culture, economic opportunity, and class. Hart (1979) and R. C. Moore (1986) did important early work on some of these topics, but thirty years later, these questions need to be revisited under new social and environmental conditions.

Implications for Planning and Design

The evidence reviewed in this article makes a compelling case for the importance of providing access to nature in the places where children live, play, and learn. It gives a new green dimension to the vision of the Declaration of Alma-Ata that primary health care should be provided near the places that people inhabit. It supports the claim of Lynch (1977) that, “Landscaping should be as essential a part of the basic infrastructure of a settlement as electricity, water, sewers, and paving” (p. 57). As the public health physician Frumkin (2012) concluded after his own review of the evidence, we have enough knowledge now about the benefits of access to nature to warrant action—and the risks of prescribing contact with nature are minimal. Meanwhile, investments in community greening yield additional benefits, as natural areas perform multiple services such as purifying the air, filtering water, retaining stormwater, and providing habitat for wildlife (Spirn 1984).

It is possible to simultaneously plan for ecosystem services, adults’ enjoyment of nature, and children’s nature contact, but planning for children presents some special issues. The tension between planning orthodoxy and children’s place use that Hart (1979) identified in the 1970s remains, as adults’ territorial control and preference for manicured green landscapes conflict with children’s need to engage with nature through creative play and exploration. Given the erosion of wastelands, rough

ground, and edges where suburbs meet farms and forests as urbanization intensifies, these spaces should be evaluated for protection and designation for children’s adventure play where they exist. More often, they need to be deliberately incorporated into community plans, in ways that children find liberating and adults find acceptable. Doing this can provide simultaneous ecosystem benefits (Jorgensen and Keenan 2012).

A number of publications address this design and planning challenge. In his recent *National Guidelines: Nature Play and Learning Places*, R. C. Moore (2014) covers siting, design, site management, risk management, and community-based approaches to creating and maintaining natural areas for children at parks, childcare centers, schools, and other community locations. Other good resources are *Nature Playscapes* by Keeler (2008) and *Designing the Sustainable Site* by Venhaus (2012). Creating access to nature for children requires a mosaic of green spaces at multiple scales, beginning with nature at the front steps and back door, and extending to systems of connected parks and greenways. R. C. Moore and Marcus (2008) review design strategies to accomplish this, including residential site design, urban trails, linked cul-de-sacs, green alleys, and greenways. For children, pathways for independent mobility to reach natural areas can be as important as nearby nature itself. Given studies that document the benefits of green views and local tree cover for children’s well-being, maintaining and planting trees needs to be an important component of greening strategies.

In the United States and Europe, inequities in park access have been documented, with low-income and minority populations less likely to have safe parks nearby with large acreage and well-maintained amenities than high-income white residents (Evans et al. 2012; Wen et al. 2013). In reviewing the siting of parks, planning departments need to consider not only size and quality but also safe access for all ages. In addition, the evidence in this article supports the argument of Strife and Downey (2009) that conceptions of environmental justice and nature access need to be expanded to include more than parks, as many positive outcomes for health and well-being depend on the finer scale of trees and other natural features around homes, schools, and childcare centers where children spend long hours.

This multi-scaled approach to greening requires collaboration between planning agencies and other community partners. To enlist clinics and health departments, the National Environmental Education Foundation in the United States gives doctors training in writing prescriptions for time in nature and sharing information on local green spaces (www.neefusa.org/health/children_nature.htm). Childcare centers and schools are often barren sites, although research shows that trees, naturalized habitats, and gardens offer benefits for many dimensions of children’s well-being. Joint-use agreements between schools and parks can open natural landscapes on schools for community use after hours and on weekends and make parks available to schools for outdoor classrooms and play (Rigolon, Derr, and Chawla in press). Through partnerships with school districts, other community organizations, and people skilled at involving

children and adolescents in participatory planning and design, planners can work with young people directly to create communities where young people themselves perceive that they can flourish and their views matter (Derr et al. 2013).

A concluding observation related to this review is that sites for ethnographic studies of children in their environments included self-built settlements and working-class communities in low- and middle-income nations, but quantitative studies of children's access to nature and health have been restricted to high-income nations. Most children, however, are growing up in the developing world, and this is where the most rapid urbanization is occurring (UNICEF 2012, Table 6). Both quantitative and qualitative research on nature contact and health need to be extended to these settings. The world's urban population is projected to increase by more than two-thirds by 2050, with nearly 90 percent of this growth occurring in Asia and Africa (United Nations 2014a). According to 2012 estimates, a third of the urban residents in the developing world live in slums, with this number continuing to grow (United Nations 2014b). Given the high densities and limited resources in these areas, how can access to nature be provided? In their book *Greening in the Red Zone*, Krasny and Tidball (2014) have gathered global examples of how nature can be integrated into "red zones" of extreme poverty, war, displacement, and natural disasters. Chatterjee (2007) has shown that children can take the lead in greening such settings, if adults support their initiatives. More practical investigations of ways to introduce nature to soften harsh environments are urgently needed.

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Author Biography

Louise Chawla is Professor Emerita in the Environmental Design Program at the University of Colorado Boulder and coeditor of the journal *Children, Youth and Environments*. She helped establish and remains actively involved with Growing up Boulder, a partnership between the university, city of Boulder, and Boulder Valley School District to engage children and youth in city planning, urban design, and park management. She has published widely on the subjects of children and nature, children in cities, and the development of committed action for the environment.