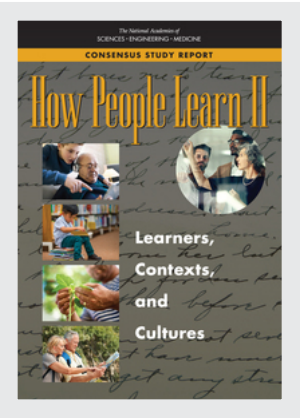

How People Learn II Learners, Contexts, and Cultures

DETAILS

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How People Learn II

Learners, Contexts, and Cultures

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Context and Culture

An individual's development is affected by the environment in which she lives—including not only the family and other close relationships and circumstances but also the larger contexts in which families and communities are situated. This idea is not new, and debates about the relative contributions of "nature" and "nurture" to people's characteristics and abilities date at least to the 19th century. Since the 1970s, many scholars have explored ideas about culture and context and have also asked questions about the act of investigating such things. Understandings of race and ethnicity, cultural values, historical perspectives, modes of communication, and the importance attached to different kinds of knowledge and skill are just a few of the topics that have been examined and reexamined as researchers have sought to understand the complex dynamics between culture, context, and learning.

The authors of *HPL I*[1] acknowledged the importance of culture but confined their attention to specific ideas for educators. For example, that report noted the following:

- Experts have knowledge that is "conditionalized"; that is, they understand the contexts in which their knowledge can be useful and how to apply it.
- School failure may be partly explained by the mismatch between what students have learned in their home cultures and what is required of them in school.

[1] As noted in Chapter 1, this report uses the abbreviation "*HPL I*" for *How People Learn: Brain, Mind, Experience, and School: Expanded Edition* (National Research Council, 2000).

- Because learning is influenced in fundamental ways by the context in which it takes place, schools and classrooms should be learner and community centered.

What has become far clearer since *HPL I* was published is that every individual's learning is profoundly influenced by the particular context in which that person is situated. Researchers have been exploring how all learners grow and learn in culturally defined ways in culturally defined contexts. While humans share basic brain structures and processes, as well as fundamental experiences such as relationships with family, developmental stages, and much more, each of these phenomena is shaped by the individual's precise experiences. Learning does not happen in the same way for all people because cultural influences pervade development from the beginning of life.

We focus on the rich cultural, contextual, historical, and developmental diversity of learning itself and how understanding of this diversity offers ways to improve learning and create optimal learning environments. We recognize that learning is the product of a complex, interactive system of physical processes, which also interact with the complex systems and environments in which individuals live.

This chapter sets the stage by providing a brief overview of developments in thinking about culture and learning since *HPL I*. We examine how the word "culture" is used, explain why the committee has approached its work from a sociocultural perspective, and briefly describe some key ways that culture is an integral part of development and learning.

THE CULTURAL NATURE OF LEARNING

The committee has taken a sociocultural view of learning. Because our concern is with how *people* learn (not, say, with how computers learn), we viewed our charge as including the social, emotional, motivational, cognitive, developmental, biological, and temporal contexts in which learning occurs. This stance derives from our understanding of what culture is, a subject about which much has been written.

Defining Culture

In its broadest sense, culture is the learned behavior of a group of people that generally reflects the tradition of that people and is socially transmitted from generation to generation through social learning; it is also shaped to fit circumstances and goals (Dirette, 2014; Hofstede, 1997; see also Nasir et al., 2006).

Culture is reflected in the behavior and beliefs of a single individual, but it is also fundamentally social. Culture is a product of the way individuals learn

to coordinate desirable and useful activities with others, and it is expressed in many ways, including through the actions, expectations, and beliefs of individual persons; physical elements such as artifacts, tools, and the design of physical spaces; norms for interacting with others, both verbally and nonverbally; and beliefs and ways of looking at the world that are shared with others.

Integrating different cultural practices is a key learning challenge, and culture is a matter not only of *what* people learn but also *how* they learn. Culture is also reflected in the historical time period and society in which someone lives. The dynamic nature of culture is evident in the fact that people who make up a cultural community maintain cultural practices acquired from previous generations, while also adapting practices over time to fit changing circumstances or even transforming them altogether (Cole and Packer, 2005; Lave and Wenger, 1991; Super and Harkness, 1986; Tomasello, 2016). In this way, a culture is a living system. People living now are the bearers of the culture they received from the prior generation, but they also become the generators and carriers of culture, as they have adapted it, into the future. Culture refers not only to the manifestations of membership in a group; it also refers to something much less static: a way of living that sustains a particular community (Nasir et al., 2006; Rogoff, 2016). People live in, reflect, and transform their culture (Gauvain, 2009). Yet within each cultural community, there is great diversity, as people take on different roles, employ different tools, and engage in varied practices.

All settings for learning, including schools, are socially constructed contexts shaped by culture. School is designed to provide young people with the experiences necessary to adapt to the demands of modern society by providing a broad array of cultural knowledge of specific topics (e.g., reading, mathematics, and science) but also knowledge of how people interact with one another. The social practices of school, such as coordinated activities and routines, reflect the culture of that school and the goals and values of the larger society in which the school is embedded. Individuals learn to navigate that culture and may do so in different ways that reflect their own unique experiences within their homes and communities. Within classrooms and in all learning contexts, the learner may embody and express the culture of his own family and group in many ways, for example by using particular speech patterns or gestures, or averting his gaze from the teacher out of respect.

An important point is that although questions of race and ethnicity frequently arise in the context of examinations of culture, these are distinct constructs. The terms "race" and "ethnicity" do not have generally agreed upon definitions. "Ethnicity" is often used to refer to a person's group and cultural identification, including nationality and ancestry (Sue and Dhinsda, 2006). While the concept of race has often been used in Western societies to create taxonomic categories based on common hereditary traits related to an individual's physical appearance (such as skin and eye color and hair tex-

ture), both concepts—ethnicity and race—carry complex implications that reflect culture, history, socioeconomics, political status, and connections to geographic origins of ancestors (Collins, 2004). Research on genetic differences among population groups has established that there are not scientifically meaningful genetic differences among groups commonly identified as belonging to different races (Smedley and Smedley, 2005). It has long been recognized by social scientists that race is a social construction and that criteria for inclusion in a racial category or definition of particular groups as racial ones have varied over time (see, e.g., Figueroa, 1991; Kemmelmeier and Chavez, 2014; López, 2006).

The Role of Culture in Learning and Development

Perspectives on what constitutes culture and how it relates to learning have changed over time. There are also differences in how the dynamic relation between culture and learning is conceptualized across fields of study. At least four disciplines—anthropology, education, linguistics, and psychology—have contributed to the evidence the committee discusses regarding the role of culture in learning, particularly learning that occurs during childhood and adolescence. We do not discuss the full range of culturally shaped differences in children's developmental environments in depth, as these have been well documented (see, e.g., Bornstein, 2010; Rogoff, 2003; Super and Harkness, 2010). Rather, we focus on examples that illustrate the ways early experiences in childhood can influence learning.

Perhaps two of the most important and longstanding insights gained from early work in these disciplines are that caregiver practices vary across cultures and that these variations influence learners. A large body of work published before *HPL I* (but not addressed there) established that socialization practices—caretakers' ways of interacting with children—shape how children learn, what they learn, how quickly they learn, and even what the developmental end point of that learning is (for everything from walking to how they interact socially). More recent work has explored how ideas of what is desirable to learn may vary across cultures. For example, a study that compared parental expectations in the United States and Vanuatu suggested that whereas U.S. parents tend to consider deviation from a model as showing creativity, parents in Vanuatu tend to equate precise imitation with intelligence (Clegg et al., 2017).

Another major contribution to understanding of the interplay between culture and learning arose out of efforts to establish developmental norms: benchmarks against which children could be compared to assess whether they were developing normally. Arnold Gesell—considered a pioneer for systematically mapping motor development using large samples of children—inspired many researchers to explore what children were able to physically do, in what order, and at what age, across a wide variety of cultural contexts (Gesell, 1934).

Subsequent work revealed surprising differences in rates of motor development across cultures in different countries, regardless of poverty status (Karasik et al., 2010). For example, studies with children from African countries showed infants holding their necks up and walking earlier than average European American children. Most important, this work showed that precocity was most likely to be noted in cultural groups in which parents expected their children to acquire the milestones at earlier ages or adopted child-rearing practices that facilitated accelerated growth, such as formalized massage and stretching of children's limbs during daily baths (for a summary of this work, see Karasik et al., 2010).

Similarly, work on social and moral development reveals that cultural groups differ in their conceptualization of the relationship between "self" and "others." Even early in life, community expectations regarding this relationship strongly influence how children go about learning, how they think about themselves, and the ways in which they socially engage (Keller et al., 2009).

There is a large body of work on culture and cognition that has examined how children and adults across different cultural groups and societal contexts (remote, urban, rural) perform on cognitive tasks (see Cole and Scribner, 1974, for an influential early example). This work was designed to assess whether developmental milestones on problem-solving tasks were universal or varied across cultures and to try to uncover processes that could account for any observed differences in the rate of development or in the highest level of development obtained (Cole, 1995; Rogoff and Chavajay, 1995). These and other studies strongly suggest that culture plays a role in basic cognitive processes that help learners understand and organize the world, such as memory and perception.

A classic example that illustrates culture's influence on basic developmental processes is the illusion susceptibility study by Segall and colleagues (1966). This work challenged the assumption that people everywhere, regardless of their backgrounds, see the world in the same way because they share the same perceptual system. It showed that people living in urban, industrialized environments are more susceptible to the Muller-Lyer illusion (the perception that a set of lines of the same length, but flanked by angles pointing inward (<) or outward (>) are actually different lengths) than people who live in physical environments in which straight lines and right angles are not often seen. Work on these kinds of cross-cultural differences demonstrates that the environment in which a person lives matters and that people construct their perceptions by drawing on their prior learning experiences, including cultural ones. More recent work has explored cultural differences in attention and other cognitive processes (e.g., Chua et al., 2005).

Culture also affects the cognitive processes that shape learning (Markus and Kitayama, 1991; Nisbett et al., 2001; see also Gelfand et al., 2011; Kitayama and Cohen, 2007; Kronenfeld et al., 2011; Medin and Bang, 2014).

Researchers have identified many examples of cultural differences in what are considered "basic" cognitive processes once assumed to be universal (Henrich et al., 2010a; see also Ojalehto and Medin, 2015b). This work illustrates the important point that by taking cultural processes into account, researchers can develop a more complete understanding of processes that underlie developmental change and of the course and end points of development (Henrich et al., 2010b).

Learning as Social Activity

Another body of work in psychology that explores the role of culture in shaping psychological processes has focused on learning as a dynamic system of social activity. Many of these researchers draw from a set of ideas about development advanced by Lev Vygotsky, Alexander Luria, and Aleksei Leontiev: the "troika" of pioneers in what is variously known as the sociocultural, social historical, or cultural-historical theory of development (Cole, 1998; Wertsch, 1991): the idea that social, cultural, and historical contexts define and shape a particular child and his experience (John-Steiner and Mann, 1996).

The underlying principle in this body of work is that cognitive growth happens because of social interactions in which children and their more advanced peers or adults work jointly to solve problems. Adults help children learn how to use their culture's psychological and technical tools (e.g., number and writing systems, calculators, computers). These types of tools have skills and ideas built into them, and learning how to use them is a critical aspect of cognitive development. Each child does not reinvent these tools; they are passed on across generations and adapted (Wertsch, 1991).

The use of this theory to understand the cultural nature of learning emerged among cross-cultural psychologists who began their work testing Piagetian cognitive tasks in different societies. Researchers who adopt the sociocultural-historical perspective in examining learning do so within the cultural context of *everyday life.* This body of research illustrates through rich and detailed examples how everyday cultural practices structure and shape the way children think, remember, and solve problems (see Gauvain and Monroe, 2012; Greenfield, 2004; Rogoff, 2003; Saxe, 2012a, 2012b). For example, Saxe's work among the Oksapmin people in Papua New Guinea documented a body-counting practice that shapes mathematical thinking and problem solving in that community. Rogoff's work demonstrates how, among the Mayan people, aspects of family life and community practice promote learning by keen observation.

These in-depth studies demonstrate that approaches to learning are embedded in the practices of communities and that as these communities change over time, cultural adaptation happens (Greenfield, 2009). This adaptation, in turn, transforms how people within these communities learn and solve problems

(Gauvain and Munroe, 2009; Greenfield, 2009). Many of these ethnographic research studies address learning in countries and cultural settings that may seem very distant from a U.S. context. However, the same principles can be applied in examining cultural practices and tools everywhere, including urban metropolitan areas. Consider, for example, how the emergence of cultural tools, such as calculators, the Internet, and Twitter, has transformed not only expectations about what people learn but also how they learn (these issues are discussed further in Chapter 6).

Not surprisingly, embrace of sociocultural theory led to one of the most important recent theoretical shifts in education research: the proposition that all learning is a social process shaped by and infused with a system of cultural meaning (Nasir and Hand, 2006; National Research Council, 2009; Tomasello, 2016). This work bridges the worlds of home and school. It examines how culturally defined expectations and the ways caregivers in a community engage with their children interact with *school learning*: the context and the content of what one learns in the structured setting of a school. Some of this work was described in *HPL I*; it addresses issues of congruence or match between expectations and practices children learn at home or in their cultural communities and the expectations embedded in the culture of school. Examples include variations between how language is used at home and how it is used in the classroom (Cazden, 1988), including expectations about whether a child should learn by observing or through directed individualized verbal instruction (Cajete, 1999; Correa-Chávez and Rogoff, 2009); how conceptions of time influence how children differentially adapt to expectations and the pace set in the classroom (Levine, 1997); whether instructional practices promote individual or collaborative learning (Swisher, 1990; Tyler et al., 2006); or even what skills—for example, "book" knowledge or socially responsible behavior—children need to demonstrate to be considered intelligent (Serpell and Boykin, 1994).

These studies documenting the cultural nature of learning have largely been *ethnographic*: systematic descriptions of the culture of a particular set of people at a particular point in time. And they often were conducted with small study samples. However, as with the early cross-cultural work on cognitive development, these studies yielded significant insights about learning that are relevant for understanding all people, from infancy to old age: Namely, that *everyone* brings to their opportunities to learn the experiences they have acquired through participation in cultural practices in their communities.

THE DYNAMIC INTERACTION OF CULTURE, BIOLOGY, AND CONTEXT

Learning is a dynamic process that requires coordination of multiple systems within the individual and occurs within a dynamic system encompassing

the changing contexts and people that surround an individual throughout life. Recognizing this principle is essential to understanding the forces that help shape learning over the life span. Human development, from birth throughout life, takes place through processes of progressively more complex reciprocal interactions between the human individual (an active, biopsychological organism) and that individual's immediate physical and social environments. Through these dynamic interactions, culture influences even the biological aspects of learning.

In the 1970s, Urie Bronfenbrenner offered a formal model to illustrate the complex and diverse influences of context on the development of individuals (Bronfenbrenner, 1977, 1994; Bubolz and Sontag, 2009). His model is a set of concentric rings representing the different systems in which the individual develops, moving from family, school, peer groups, and workplaces outward to broader social and institutional settings, ideologies, value systems, laws, and customs. The model also depicts change and consistency in all of these elements over time, representing the cumulative experiences in an individual's lifetime.

Similarly, learning at the individual level involves lasting adaptations of multiple systems to the changing external and internal environment, including changes in the biology of the brain. The biology of the brain provides the physiological platform for learning and is shaped by the social and cultural influences outside of the individual. For example, there is evidence that individuals' brains are critically shaped by social relationships and that the information people learn through these relationships supports not only their knowledge about facts and procedures but also their emotions, motivations, and interests (Immordino-Yang et al., 2014; Nelson et al., 2007).

Culture coordinates the biological systems involved in learning and is the broader social context in which people engage in the experiences that enable them to adapt to the world and learn. Study of the role of cultural adaptation in learning, pioneered by Giyoo Hatano, has shown how cultural influences may both promote and hamper learning. For example, a cultural context may promote particular types of learning such as observation versus explanation (Gutiérrez and Rogoff, 2003). It might convey expectations about exploration and experimentation that foster or hinder adaptation and experimentation and influence the ways learners apply what has been learned in novel situations (see, e.g., Hatano and Inagaki, 1986; Hatano and Oura, 2003).

In the next two sections, we discuss two aspects of an individual's environment that have an impact on individual's learning and are shaped by culture. The first aspect is the social and emotional interactions an individual experiences. The second aspect comprises the factors related to an individual's physical well-being.

Social and Emotional Influences

Brain development and functioning, like the learning it supports, is socially contextualized. It happens in the context of experiences, social relationships, and cognitive opportunities as subjectively perceived and emotionally experienced by the learner. Cultural norms and goals shape how and what people think. This is true even when a person is working alone or independently.

The brain's processing of emotional and social stimuli and experiences has considerable influence on the development of brain networks (Goldin-Meadow, 2000; Hackman and Farah, 2009; Leppänen and Nelson, 2009; Nobel et al., 2015). Humans have evolved to be highly socially interdependent: From birth through old age, no one can manage life without relying on many other people (Rogoff, 2015; Tomasello, 2001). Individuals' brains are critically shaped by social relationships, and the information they learn through these relationships supports both their emotions and their knowledge about facts, procedures, motivation, and interests (Immordino-Yang et al., 2014; Nelson et al., 2007).

Studies of institutionally raised Romanian children provide a tragic demonstration of the effects of social deprivation on brain and cognitive function (e.g., Nelson et al., 2014). Though children reared in Romanian government institutions during the period studied had enough food, clothing, bedding, and other material supplies, they had a rotating staff of caregivers and little opportunity to develop a meaningful, stable relationship with a loving, committed adult. The result was that these children did not simply fail to adequately develop socially, emotionally, and cognitively; they also failed to develop biologically. These children were stunted in physical growth and in brain development: Both their brains and bodies were abnormally small.

Emotion plays a role in developing the neural substrate for learning by helping people attend to, evaluate, and react to stimuli, situations, and happenings. In the past, it was generally assumed that emotion interferes with critical thinking and that knowledge and emotion are separate (Gardner, 1985). However, extensive research now makes clear that the brain networks supporting emotion, learning, and memory are intricately and fundamentally intertwined (Panksepp and Biven, 2012), even for experts in technical domains such as mathematics (Zeki et al., 2014). Emotions are an essential and ubiquitous dimension of thought, and emotional processing steers behavior, thought, and learning (Damasio, 1994; Immordino-Yang and Damasio, 2007).

Quite literally, it is neurobiologically impossible to think deeply about or remember information about which one has had no emotion because the healthy brain does not waste energy processing information that does not matter to the individual (Immordino-Yang, 2015). Emotions help learners set goals during learning. They tell the individual experiencing them when to keep working and when to stop, when she is on the right path to solve a problem

and when she needs to change course, and what she should remember and what is not important.

People are willing to work harder to learn the content and skills they are emotional about, and they are emotionally interested when the content and skills they are learning seem useful and connected to their motivations and future goals. Conversely, emotions like anxiety can undermine learning by causing worry, which depletes cognitive resources and activates brain regions associated with fear and escape rather than with academic thinking (Beilock, 2010; Schmader and Johns, 2003).

Physical Influences

The developing brain is sensitive to physical influences that also affect other aspects of health and development, including nutrition, exposure to environmental toxins, sleep, and exercise. These physical influences can vary dramatically across context and are often shaped by cultural practices.

Nutrition

Sufficient, high-quality nutrition is necessary for health, development, and learning for infants (who are affected by prenatal nutrition), children, and adults. In particular, adequate protein, calories, and other nutrients are needed for brain development and function. Because of the protracted course of brain development, nutrition is especially important through the years of adolescence. Deficiencies in protein, calories, and other essential nutrients have been linked to negative effects on cognitive functioning (e.g., inhibitory control and executive function) and emotional functioning (Bryan et al., 2004).

Iron deficiency, for example, is relatively common in the United States; 9 percent of U.S. children ages 1–3 during the period 1999–2002 were iron deficient (Baker and Greer, 2010), as were 2–3 percent of adult males and 9–22 percent of adult females (Gupta et al., 2016). Iron deficiency, which can lead to iron-deficiency anemia, impairs learning, memory, and cognition. Lower test scores in early education have been correlated with infantile iron-deficiency anemia. Further, severe iron-deficiency anemia in infancy has effects that last through adolescence, resulting in lower test scores in motor function, written expression, arithmetic achievement, spatial memory, and selective recall (National Research Council and Institute of Medicine, 2000). It is unclear whether iron deficiency without anemia leads to similar outcomes (Taras, 2005). Iron supplementation has been shown to reverse some of the effects of anemia, but the degree of improvement may vary with socioeconomic status (Lozoff, 2007, 2011; Lozoff et al., 2014).

Sleep

The cumulative long-term effects of sleep loss and sleep disorders have been associated not only with health problems (e.g., increased risk of diabetes, obesity, depression, heart attack, and stroke) but also with performance deficits in occupational, educational, and other settings (Institute of Medicine, 2006). As sleep deficiency accumulates, the cognitive functions associated with learning (e.g., attention, vigilance, memory, and complex decision making) deteriorate proportionately and substantially (Jackson et al., 2013). For instance, one study reported that 36 hours of sleep deprivation (one "all-nighter") resulted in a 40 percent loss in the ability to form new memories (Walker, 2006).

For adults, work schedules that impede sleep, such as shift work, will exacerbate the effect of sleep deprivation on memory formation (Mawdsley et al., 2014). For young children, sleep plays an important role in the consolidation of memories in infancy and early childhood (Henderson et al., 2012; Seehagen et al., 2015), and insufficient sleep dramatically decreases memory for previously acquired knowledge (Darby and Sloutsky, 2015). In adolescents, insufficient sleep can be related to attention problems both in and out of school, general cognitive functioning, emotional regulation, mood disorders, engaging in risky behaviors, and academic outcomes (Wahlstrom et al., 2014).

The amount of sleep considered biologically normal or optimal varies across the life span: the National Sleep Foundation recommends 14 to 17 hours for newborns and 7 to 8 hours for older adults (Blunden and Galland, 2014; Hirshkowitz et al., 2015). However, adults are averaging 1 to 2 hours less daily sleep than they did in the mid-20th century, and 39 percent currently get less than 7 hours of sleep, as compared with 15 percent in the mid-20th century (Institute of Medicine, 2011; National Sleep Foundation, 2008). Average sleep duration for infants, children, and adolescents has decreased by 30 to 60 minutes over the past 20 years, largely because of late bedtimes (Dollman et al., 2007; Iglowstein et al., 2003). Many young children also experience compromised sleep quality, and few outgrow the problem as adults (Centers for Disease Control and Prevention, 2009; Kataria et al., 1987; Lauderdale et al., 2006; National Sleep Foundation, 2006; Nevarez et al., 2010; Pollock, 1994; Spilsbury et al., 2004).

Exercise

The strong association between physical exercise and positive outcomes in physical health and disease prevention is well established (U.S. Department of Health and Human Services and Administration for Children and Families, 2010), but exercise can also be beneficial for learning and cognition.

Because exercise varies considerably in form, duration, and frequency, researchers focus separately on its acute and enduring effects on cognition,

emotion, and behavior. Acute effects of exercise on learning are evident in tests given immediately following the physical activity, while enduring effects are cognitive changes that are evident over a period of numerous exercise sessions. These studies help to clarify when and how exercise is most beneficial to people's mental development and emotional well-being at different ages.

There are many neurochemical changes that follow intense exercise and may cause the brain to be primed for better skill attainment and greater learning immediately following a workout (Meeusen et al., 2001). Older studies of children who have just exercised have identified improvements in mathematical computation (Gabbard and Barton, 1979; McNaughten and Gabbard, 1993), psychomotor performance (Raviv and Low, 1990), and stimulus-matching performance (Caterino and Polak, 1999). More recent studies have found improvements in children's abilities to concentrate and complete complex tasks including reading comprehension, inhibition (impulse control), and attention (Hillman et al., 2009).

Improvements in cognition and academic performance, particularly integrative tasks that involve self-monitoring and executive function, as well as higher-order cognition, have also been associated with consistent exercise training in children (Keeley and Fox, 2009; Tomporowski and Ellis, 1984, 1985; Tomporowski et al., 2011). Beneficial relationships between physical exercise and cognition have been shown in the domains of perceptual skills, verbal tests, math tests, academic readiness and achievement (among children ages 4-18, Sibley and Etinier, 2003), and executive functioning tasks (Davis et al., 2011).

Some research has suggested that the degree to which exercise affects higher-level thinking skills may differ depending on the nature of the exercise and on developmental age (Best, 2010). Exercise that is more challenging—for example, involving attention and learning of new motor skills and patterns, more coordinated activity, and social interaction—may lead to stronger immediate cognitive benefits among adolescents (Budde et al., 2008; Pesce et al., 2009; Stroth et al., 2009).

There is also evidence of a relationship between exercise and cognitive performance in older adults. The positive effects of physical activity on cognitive ability are seen in both cognitively normal adults and those with beginning signs of cognitive impairment (Colcombe and Kramer, 2003; Etnier et al., 2006; Heyn et al., 2004). Although these effects have been seen across all domains, Hillman and colleagues (2008) found that particularly marked benefits are evident in executive control, defined as the cognitive ability for planning, organizing, and thinking flexibly.

Environmental Toxins

Exposure to environmental neurotoxins also can have significant impacts, particularly for developing fetuses and young children. For example, mothers exposed to higher levels of environmental neurotoxins (such as pesticides

and lead) tend to bear children who have poorer developmental outcomes compared with the children of equally disadvantaged mothers who have lower degrees of exposure (Institute of Medicine and National Research Council, 2015). Young children are especially vulnerable for two reasons: They tend to absorb more of a toxin relative to their body weight because their metabolisms are faster than those of older people, and their rapidly developing brains are more sensitive to toxins (National Scientific Council on the Developing Child, 2006; Rauh and Margolis, 2016).

Although lead toxicity levels in American children have declined markedly since legislation prohibiting the use of leaded paint (1971) and leaded gasoline (1984), lead poisoning has returned to public attention through news reports of contaminated drinking water in Flint, Michigan, and elsewhere. Even very low blood-lead levels have been shown to reduce children's scores on reading, writing, and IQ tests. Indeed, according to current guidance from the Centers for Disease Control and Prevention, no blood-lead level is safe and the consequences of lead exposure are irreversible.[2] However, cognitive decline associated with lead exposure is estimated to account for a far smaller degree of variance in IQ levels (1–4%) than social and parenting factors and institutional resource quality, such as early child care and preschools (40% or more) (Koller et al., 2004, p. 987).

CONCLUSION

We have emphasized that each individual learner occupies a unique place in time and space and responds throughout life to a set of circumstances, influences, and experiences that shape both what and how he learns. We examine specific implications of this principle in the chapters that follow, and we return to its implications for education in Chapter 7. But an implication necessary to note from the start is that what were once called "cultural differences" may be better characterized as variation in learners' involvement in common practices of particular cultural communities (Gutiérrez and Rogoff, 2003).

CONCLUSION 2-1: Each learner develops a unique array of knowledge and cognitive resources in the course of life that are molded by the interplay of that learner's cultural, social, cognitive, and biological contexts. Understanding the developmental, cultural, contextual, and historical diversity of learners is central to understanding how people learn.

[2] See http://www.cdc.gov/nceh/lead/acclpp/blood_lead_levels.htm [November 2017].