CHILD DEVELOPMENT PERSPECTIVES

From Developmental Psychologist to Water Scientist and Back Again: The Role of Interdisciplinary Research in Developmental Science

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ABSTRACT—***The current focus on large-scale problems emphasizes interdisciplinary research. In this essay, I describe interdisciplinary research and the role of developmental scientists in this endeavor. The goal is to encourage greater involvement by developmental scientists in interdisciplinary research on global problems that affect the well-being of children and youth. The involvement of developmental scientists in these efforts will increase the effectiveness of many projects, broaden the scope of research in the discipline, and provide information about the experiences of children and youth around the world. To illustrate, I describe my involvement in interdisciplinary research on water conservation and use. I conclude the essay by describing challenges and benefits of engaging in interdisciplinary research, and offer suggestions for developmental scientists interested in this role.***

KEYWORDS—*interdisciplinary research; developmental science; global problems*

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The lives of children and youth today are threatened on many fronts. Large-scale problems such as disease, economic development, social inequalities, climate change, food insecurity, and environmental concerns are at the center of efforts to provide a safe and secure world for future generations (1). The United Nations Sustainable Development Goals, adopted in 2015, call for a global campaign to combat poverty and create a healthier and more sustainable planet (2). The goals are broad in scope and to be reached, require the knowledge and skills of researchers and practitioners from many disciplines working in interdisciplinary teams (3).

In this essay, I address the role of developmental scientists in interdisciplinary research in the context of global problems that affect children and youth. The article is directed at both beginning and more established scientists, for different reasons. I hope to encourage newly trained developmental scientists to consider interdisciplinary research as part of their career goals. Established scientists may be interested, but they will also need to support new scientists in these pursuits, both because of the value of the work to society and as a way to advance the discipline. These points are not new. Many developmental scientists have advocated for interdisciplinary engagement, and applied developmental science is a problem-oriented approach concerned with the many contexts in which children and youth live and grow (4). Rather, my purpose is to draw attention to the need for developmental scientists to be involved in interdisciplinary research now, when many young people worldwide live in rapidly changing, and often dire, circumstances (2).

INTERDISCIPLINARY RESEARCH AND DEVELOPMENTAL SCIENCE

Over the last decade, researchers have recognized the need to involve a broader array of scientists in interdisciplinary research (5). Developmental scientists are important to this effort because many global problems bear directly on the well-being and

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developmental trajectories of children and youth (6). Also, as described in the UN Sustainable Development Goals (2), interventions and policies addressing these problems aim for sustainable solutions that transcend generations, which means that young people are critical to their success.

Although the number of developmental scientists involved in interdisciplinary research on global problems is small relative to the number of scientists in other disciplines, especially health and engineering, ecological systems theory provides a strong foundation for their involvement (7). However, the fact that developmental training tends to emphasize specialization—an approach common to much of contemporary science—may inadvertently discourage developmental scientists from getting involved in interdisciplinary research. To borrow from Isaiah Berlin's essay (8) regarding the ancient Greek saying, "the fox knows many things, but the hedgehog knows one big thing" (p. 1), many developmental scientists are trained to be hedgehogs. The one big thing the hedgehog knows—to roll into a ball and present its spikes when a predator appears—works well in that situation. In contrast, the fox knows many things and, when threatened, adapts its behaviors to the situation. Research on global problems requires the skills of both the hedgehog and the fox. This is a tall order, and the National Academies of Sciences (3) recommends that scientists work together in interdisciplinary teams that can benefit from the skills and knowledge of many specialists. Developmental scientists have many strengths to offer interdisciplinary research teams working on global problems that affect children and youth, including experience working in different social and cultural settings and across levels of analysis (9, 10). Consider the role developmental scientists might have played in the following example from global health.

Malaria kills about half a million Africans annually, most of them children (11). Bed nets treated with insecticide are a cost-efficient and effective way to combat this disease in infested regions. Although use of bed nets varies across contexts in Africa, recent estimates indicate that about half of young people in Nigeria and Uganda do not use nets that are provided (12, 13). Young children are often confused about the purpose of the nets and in warm climates, children find them too hot and uncomfortable to use. Thus, this solution is less effective, especially for the most vulnerable individuals; a deeper understanding of child development could help. Developmental scientists could detect barriers to use among children, determine the age when children can understand the nets' purpose, devise ways to teach children about proper use, and disseminate information to families to persuade children to use the nets. Although this situation differs from ones in which many developmental scientists work, relevant research can be found. True, the participation of developmental scientists would not have alleviated all the problems with this intervention. But their expertise may have reduced some of the problems, and reducing problems has great value when it affects the well-being, perhaps survival, of individuals.

If developmental scientists could have improved the chances of success for bed nets, why were they not involved from the outset? We do not know in this particular case, but more generally, aspects related to human development may be overlooked, discounted, or not based on current thinking. For instance, young people may be seen as lacking knowledge, agency, or authority, which can lead to managing them rather than involving them in meaningful, age-appropriate ways. This view not only belies current understanding of the active role young people play in their own development, it ignores research on the diverse experiences of children and youth worldwide, including studies related to social and civic responsibility (14, 15). Other problems may result from the use of presumed standard assessments that are ill suited to local conditions (16), or lack of knowledge about the child and adolescent behaviors that are valued and promoted in certain cultural settings (17). Sometimes researchers or practitioners unfamiliar with developmental science may make implicit assumptions about learning, such as the belief that when someone is told something, it will be learned straightaway. This assumption not only does not square with research in developmental science (including self-regulated learning; 18, 19), but it also increases the chance that any failure of the project will be blamed on those who failed to learn. In short, developmental science has decades of scientific findings useful for addressing such issues, along with techniques for collecting relevant information when needed (20). In addition, information is available about how to conduct research and implement interventions that affect the lives of children and youth, including those living in low- and middle-income countries (21).

The claim that developmental scientists can be valuable members of interdisciplinary research teams working on global problems is borne out by their contributions in many areas, including health (22), literacy (23), community and capacity building (24), and environmental health and protection (25). Greater involvement of developmental scientists is especially important now, when the scope and intensity of large-scale problems that affect the well-being of children and youth are growing (6, 26). Developmental scientists working in many areas are needed in these efforts. To illustrate one such journey, next I describe how, as a long-time hedgehog, I got involved with interdisciplinary research on the global issue of water use and conservation. I begin by describing the current water crisis, including some of its impact on child and youth development.

THE CURRENT WATER CRISIS AND DEVELOPMENTAL SCIENCE

By 2050, about one in three people will have limited access to potable water (27). Although people living in urban areas in desert ecosystems will face major challenges (28), climate change will also affect water supplies in less arid regions as a result of inconsistent patterns of rainfall (29). Challenges to

water supplies will result from increasing demand due to population growth and urbanization (30). Deteriorating infrastructure will also play a role, as occurred in Flint, Michigan, when lead, a neurotoxin, leached from failing pipes, contaminated public drinking water, and elevated lead in children's blood to dangerously high levels (31).

Water- and food-borne diseases are major threats to human health in most of the world (32). Unsafe water and food are related because unsafe water is often used to clean and process food, resulting in a vicious cycle of disease and malnutrition. Each year worldwide, more than 1.5 million people die from diarrheal diseases, about 500,000 deaths are attributable to unsafe or insufficient drinking water, and more than 600 million illnesses and 200,000 deaths result from food contaminated with microorganisms, parasites, and chemicals (33). Children under age 5 are the most vulnerable and account for most illnesses and deaths from unsafe food and water.

Many of these illnesses can be prevented by greater access to a safe water supply and improved water and food hygiene (34). Communities have tried different ways to introduce youth to practices for safeguarding water and food. Formal education has helped, especially near urban centers (35–37). We know less about the contribution of informal learning. Informal learning may be especially important in rural areas with limited access to schooling and where young people spend much of their time doing domestic chores and subsistence activities that involve water (e.g., keeping the cooking area clean, feeding younger children, fetching and storing water).

FROM DEVELOPMENTAL PSYCHOLOGIST TO WATER SCIENTIST

My involvement in water-related research began in 2008 when I volunteered for the advisory board of a nongovernmental organization (NGO) working in rural East Africa on health issues. Much of the NGO's work focuses on water safety because of the difficulty of tackling health issues in communities without a safe and reliable water supply. In the villages where the NGO worked, water quality was inadequate with poor sanitation. Sources were mostly open ponds and small water holes, many used by animals.

In my advisory role, I wanted to know what young people in the villages understood about the current water situation and how their lives would change after pumps were installed. When I reviewed research on children's biological knowledge of contamination (38), I was surprised to discover that it was based largely on Western samples. The few studies with non-Western samples were conducted in urban areas (39). Although this research was useful, it did not pertain directly to situations where water contamination is a daily, life-threatening condition. As a result, my colleagues and I decided to study this topic in the regions where the NGO worked. In rural Uganda, we used culturally adapted techniques to interview villagers from ages 4 to 60 about water and food contamination, seeking their explanations of water- and food-borne illness, and asking about their knowledge of invisible contaminants (i.e., germs; 40). Among children and adults, we found high levels of awareness of or sensitivity to contamination; 4- to 6-year-olds were less knowledgeable about water contamination than older children and adults. As with Western studies, young children's explanations for rejecting contaminated water rarely included biological content, which is important for understanding connections between contaminated substances and illness. Subsequent research with 4- to 9-year-olds in an area near an urban center in Tanzania replicated the results (41).

In another study, we interviewed secondary school students and unrelated adults who did not attend school living in a rural Maasai community in Tanzania about the causes and spread of illness from contaminated food and water (42). Most knew about germs, but youth had more biological understanding of how germs function and they reported sharing this knowledge with children and adults at home. Although it is uncommon for youth to instruct adults in traditional societies with strict hierarchical family relations, such as the Maasai, our findings concurred with research in Kenya (37). These studies suggest that adults in traditional communities accept health information that young people learn in school if it is transmitted respectfully and the exchange focuses on this information.

These studies are examples of developmental science; they are not examples of interdisciplinary research. I described them because they led me to interdisciplinary research for two reasons. First, even though we believed our research could be useful to global health practitioners, we had no direct contact with them. Second, it was unclear how our research related to water issues more generally.

Regarding the first issue, I contacted people working on water safety and health at the medical school at the University of California, Riverside; the University of California Global Health Institute; and several nonprofit organizations. A few contacts were prior acquaintances; most were not. In the initial e-mail, I requested a telephone conversation or in-person meeting, and these contacts were, by and large, fruitful. They provided access to practitioners, answered many of our questions, suggested ways to disseminate our findings in outlets used by practitioners (43), led to invitations to give talks on our research, and introduced ideas for later collaborations.

Regarding the second issue, I contacted water scientists on my campus, some of whom I knew through participating in faculty governance. They included chemical and environmental engineers working on water quality and management, microbiologists expert in intestinal diseases, entomologists studying vector-borne pathogens, and international water economists and policy experts. Following these contacts, a small group of us began to meet regularly to discuss water issues and health. Over time, our shared interests led to various interdisciplinary research projects. On some projects, I am the principal

researcher, while in others, I have a secondary role or am a consultant. Following are three examples.

A recent project in collaboration with the municipal water district involves evaluating the effectiveness of a middle-school program on water conservation. Two developmental science questions are central to the project: Do children tell their parents what they learn in the program and does it affect the use of water at home? Children's classroom learning in many science, technology, engineering, and math (STEM) fields, including environmental science, often includes information that is more up to date than what their parents learned in school. In this project, we are studying intergenerational learning, not in the usual way with elders teaching the young, but with youth teaching elders. In this regard, the research is similar to that described earlier on transmitting health knowledge from youth to elders in East Africa. Understanding more about this type of transmission may shed light on the reach beyond school of classroom-based STEM learning and may have important implications for households and the community.

A project in which I play a secondary role involves designing one aspect of an education plan about new water treatment technology in a rural farming community in the United States. The plan focuses on various stakeholders, including educators and children in a water-conservation program in middle-school science classes. The goal is to improve understanding of new wastewater technology, including its operation, its role in securing water resources, and its safety. Many children and adults do not understand new technologies for treating and reusing wastewater, which can raise health concerns that inhibit use. Understanding the technology more thoroughly will enhance its effectiveness with users, and increase a sense of public ownership and commitment to the technology and its sustainability communitywide.

A final example is an interdisciplinary graduate training program my colleagues and I developed for Ph.D. students in engineering and the natural and social sciences (including developmental science). The program is supported by a National Science Foundation Integrative Graduate Education and Research Training award. The goal is to train water scientists who are interested in and can work in interdisciplinary research. My role is to teach students about the social and behavioral aspects of water science, as well as to work on projects that bring our disciplinary strengths to interdisciplinary collaborations. Our projects have focused on the detection and effects of water-borne contaminants, the understanding and use of innovative technologies, and attitudes and behaviors about water conservation.

Overall, my experience with interdisciplinary research in water science has been interesting and rewarding. It has not been without challenges and setbacks, but on balance, the positives have outweighed the negatives. The main challenge has been time: Identifying and contacting people is time consuming, especially when the contacts are busy; some contacts did not pan out. But often, when someone could not help us, he or she suggested others who could. Other challenges came from delving into areas of developmental science outside my expertise. A typical interdisciplinary research team usually includes just one developmental scientist, which makes it necessary to read the developmental literature broadly. This, too, takes time, but it has a rewarding upside: greater appreciation of the breadth and potential of research in developmental science.

CONCLUSIONS

Developmental scientists can contribute considerably to interdisciplinary research that affects the well-being of children and youth. Their involvement will not only increase the effectiveness of many projects, but also advance developmental science by stretching it into settings where young people experience major changes or stresses in their lives or are involved in community activities relevant to sustaining natural and social resources. This research can provide insight into the diverse experiences and resilience of young people, information that will move developmental theory and its evidential base forward (44). It will also involve developmental scientists in conversations reshaping science and policy, and affect child and youth development in the years ahead.

To be clear, involvement in interdisciplinary research is not without costs. It takes time for people with different backgrounds and skills to work together (3). It helps to remember that the focus is on the problem and not the disciplines, that each participant has a role to play, and that team members need to share knowledge and build on each other's strengths. A common language and set of social behaviors that facilitate teamwork need to be created, and communication must be regular and respect others' ideas. Trust is important and building trust takes time. Team members often discover they share concerns about trust—after all, science is a competitive, sometimes secretive, work environment. This realization can help the team work together to build trust. Institutional barriers may also arise: Administrators may be enthusiastic about interdisciplinary research but not understand or be able to support research that cuts across divisions at their institution.

Given these qualifications, is interdisciplinary research worth a try if your research expertise is relevant to global problems and you are interested in this work? Absolutely. It is certainly worth sending an e-mail or making a telephone introduction and having a conversation or two (45). These steps can help determine whether your expertise can contribute in ways that will enhance a project. It is also important to understand that working on an interdisciplinary research team does not go on forever. Interdisciplinary research is focused on a problem and lasts as long as the team is working on the problem. Most scientists involved in this type of research continue their own disciplinary-based projects and, when the interdisciplinary research project ends, resume that research full time. Benefits beyond

the interdisciplinary research project include increased skill in working with a diverse group of scientists, more confidence in one's knowledge and abilities (including the ability to explain what one knows to those working outside the discipline), and an expanded network of scientists and range of ideas to engage.

Although I have called in this essay for developmental scientists to engage in interdisciplinary research, not all developmental scientists will be interested or able to do so. Another useful contribution is for developmental scientists to consider the implications of their research findings for global problems and, when appropriate, include this information in reports. This information will expand the contribution of developmental science to interdisciplinary research by establishing closer links between basic developmental science and the many pressing social, health, and environmental problems confronting children and youth today.

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