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Grand challenges in developmental psychology

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Introduction

Frontiers pioneered an alternative model of publishing: Rather than libraries paying subscription fees to publishers to give library communities access to journals full of articles written, reviewed and edited (at no or modest cost to the publishers) by their own faculty, they instead charge the authors to publish articles that are then made freely available to the world. Some libraries responded by supporting faculty authors directly or negotiating fee reductions with Frontiers, and Frontiers also provides breaks to authors who do not have access to publishing funds. The enterprise has grown to over 170 journals across all fields of science, and the articles are highly cited. The Frontiers acceptance criteria is that the research be scientifically sound and cogently presented. The editor's view of potential impact or importance is disregarded. The public gets to decide on that.

Frontiers in Developmental Psychology is a new Frontiers journal aimed at publishing novel research and theory at the forefront of developmental science, from conception to old age, at all levels of analysis, and including articles on methods geared to the study of change. The sections of the new journal are aligned with what I see as the grand challenges for our field, and here I detail those challenges, starting with the grandest of all, and then proceeding in an order that corresponds roughly to the human journey from conception to senescence.

A paradigm shift, new methods, and expanding attention

The greatest challenge developmentalists face is the challenge of all psychology, and indeed of the Western worldview in general: how to accomplish a paradigm shift (Kuhn, 1962). For centuries we have mainly drawn on a Cartesian (and we could say Aristotelian) worldview; it is a bedrock of Western thought. In this paradigm, dichotomies reign; one such dichotomy is the mind-body split. Systems take input and furnish output; they begin with nothing and build up information in response to the input. Change is typically linear. This Cartesian paradigm has led to many important discoveries. The scientific method of setting up a situation and changing out variables systematically to see the effect of each has revealed a lot about how many systems work. But we know something is missing; we know it is not that simple. The nature-nurture dichotomy still traps us, when we know better. Among developmental psychologists, Elman et al. (1996) contributed a landmark volume just before the turn of the century showing an alternative approach, one that acknowledges how deeply intertwined developmental systems are, but we have very far to go in really adopting such an approach, despite other important and supportive volumes that have followed (e.g., Jablonka and Lamb, 2005).

Psychology is not alone in noting the Cartesian paradigm's failings; across many fields scientists have been seeking to shift toward a dynamical systems view which better corresponds to what we know about the universe, earth, the body, and the brain (Smith and Thelen, 2003). If we take a dynamical systems perspective, development is not seen as static and linear; rather it is seen as a dynamical interchange between organism and environment, proceeding in spiraling hierarchies as variables intersect and influence one another

(Thelen and Smith, 1998); Gilbert Gottlieb's theoretical work demonstrates this well (Gottlieb, 2007). As we become capable of measuring more and more, with technological advances giving us new measurement devices and computing resources, we need new statistical methods to integrate the resulting large swathes of data. New methods will allow us to make better sense of the complexity of developing organisms. Thus, one important section in our new journal is devoted to quantitative methods aimed at the study of change. It is not easy to exchange simplicity for complexity, when simplicity—parsimony—is a scientific ideal, but this grand challenge is before us.

Inherent in the embracing of complexity is attending more closely to the body, thus to the wealth of psychobiological information at our disposal, and attending more carefully to how neuroscience and other biological sciences are conceiving the systems at hand. Neuroimaging studies in animals and humans started with the Cartesian approach; an example is Hubel and Wiesel (1962) showing cortical dominance columns by blocking vision systematically then investigating changes to neural structure. Today, formidable theorists in neuroscience are exploring other conceptualizations, and developmentalists can gain a great deal by attending to these explorations. For example, Buzsáki (2019) eloquently presents the view that rather than the brain being merely a Cartesian representational machine, passively cataloging the real world so we can carry an accurate representation of it (see also Merzenich, 2001; Seth, 2021), it is an action-generator, trying different actions and determining which is most adaptive; the ultimate adaptation serves evolution's ultimate goal of having more grandchildren. As Proffit's (2006) and others' research suggests, the point of a brain is to guide us through space, to coordinate our body's interaction with the external world so we can respond adaptively. A wealth of information and ensuing models from neuroscience, genetics, epigenetics, endocrinology, and related fields needs to be more closely and fully examined and integrated into our way of knowing and studying the developing human.

As a specific example, many studies use recognizing oneself in a mirror using a "rouge test" paradigm to determine when an infant (or another species) has a sense of self (Lewis and Brooks-Gunn, 1985). A bit of rouge is surreptitiously swiped onto a young child's face, and when they next look in the mirror, one looks for signs that they are aware it is their own face rather than another child's. However, other studies using a different, "action" paradigm showed an earlier kind of self-recognition: 5-month-old infants look preferentially at a video of their own kicking legs vs. another child's legs, or their own legs temporally offset (Bahrick and Watson, 1985). Despite continued consideration of these paradigms and their meaning (Suddendorf and Butler, 2013), there has been little discussion of how the neural mechanism of corollary discharge (Crapse and Sommer, 2008), whereby the motor system communicates to the sensory system that it has just made a movement, might contribute to infant self-recognition in action paradigms. The one exception I found to this used a connectionist model (Homma, 2018) and connectionism itself rests on Cartesian models: connectionist models usually begin with a blank slate or *tabula rasa*, and can self-destruct losing all information. Genetically-specified adaptations and levels of operation can theoretically be built in to connectionist models, but they rarely are. The overall point is that in developing more sound developmental models, more attention must be paid to what we know about the brain and the body, to the development of human sensorimotor systems and what they mean for human psychology. Karen Adolph has provided a wealth of new data on how infants' bodies and minds develop together (Adolph and Robinson, 2015), and much more information on intra-system complexity is needed. *Frontiers in Developmental Psychology* will address such issues.

Infant looking time

More attention to neuroscience might shed light on a particularly puzzling corner of developmental psychology: findings from infant violation of expectation/looking time experimental paradigms indicating that infants know much more than verbal experimental paradigms indicate they know. How do we make sense of the fact that 6-month-olds often seem surprised when someone who should not know an object is in a given location looks in that very location for it, whereas 3-year-olds will often tell you the person will look in that location—suggesting the 3-year-old would not be surprised by the person acting on a false belief. There is a good deal of controversy about what is indexed in looking time paradigms (Schöner and Thelen, 2006; Dunn and Bremner, 2017; Poulin-Dubois et al., 2018). Kahneman's (2011) *Thinking, Fast and Slow* dovetails with neuroscientists who consider fast and slow arcs; the latter come on line with advances in cognition, allowing thought to intervene between perception and action in ways that can be useful. This dual process, dissociating thought from perception and action, might undergird pretend play, as Piaget (1962) suggested. We need to resolve the seemingly discrepant findings obtained across different paradigms to discover whether what infants know and what 3-year-olds know is importantly connected, or stems from different systems, and we need to resolve just what infant looking means in these paradigms. This is a grant challenge for the field, and the journal's sections on Infancy or Cognitive Development are well-positioned to take up this challenge.

New models for schooling

Another place where we need to escape poor old models is in the learning environments we set up for children, aka schools. The methods used in most schools are also derived from Cartesian models, with Behaviorism and the Industrial Age suggesting internal structures like grades and bells and strict separation of the disciplines (Callahan, 1962). We need a system of education that treats children as whole human beings, not divided into separate parts of mind and body that operate independently, without room for feeling and activity. We need schools that value the many different gifts any individual child might bring to a situation, schools that nurture the full spectrum of the good that humanity has to offer rather than privilege just a narrow subset relating to multiple choice test performance. We need schools that help all children by providing an array of teaching materials that catch different children's attention at different times. The method of making small adjustments—adding blackboards, then replacing them with whiteboards and now smartboards,

for example—what has been referred to as *Tinkering Toward Utopia* (Tyack and Cuban, 1995)—has not gotten us far enough; discontent over the way we school is ever present, but it need not be. Basic research in cognitive and social development, and applied research in educational settings, can all help toward improving this model.

One might argue that we know enough already; that schools of education and educational psychology classes teach upcoming teachers what to do; the problem is they arrive in classrooms and they find they cannot do it. A few do manage, but the vast majority do not, as studies of what is actually happening in schools today make clear (Hojnoski et al., 2008; Bassok et al., 2016; Dintersmith, 2018). Most teachers today still use a teacher-centered model (sometimes referred to as the "sage on the stage") most of the time; today's teachers still use grades and rely heavily on textbooks; children in their classrooms are largely passive, aiming to memorize information with a goal not of learning but of doing well on a test and getting a good grade. I know professors of education will object to this characterization because it is not what they teach, but I frequently ask college students today what they experienced in school, and most of them experienced this old style model most of the time. The fact is, without something more radical to break the system, conventional teaching is like an attractor state to which teachers always return. I know of an alternative model which is going strong over a century after its beginning, which is unlike most alternative models that had their heyday then ceased. Properly implemented Montessori education incorporates a plethora of characteristics that correspond to what research today suggests is optimal for development and learning—in fact most "educational innovations" coming out of schools of education and departments of psychology include aspects of the Montessori system; and yet the whole may be even greater than the sum of its parts. Montessori is a whole school model serving children from birth to 18, and it has excellent outcomes, as revealed by two new meta-analyses (Demangeon et al., 2023; Randolph et al., 2023). Unfortunately its name is not trademarked, and it is often poorly implemented and poorly understood (Lillard, 2019), but as research on its efficacy accumulates perhaps this will change. Regardless of what educational model we use, we clearly need to do better by children than the Cartesian-based system we typically employ. For more discussion of this, see Lillard (2023) in this issue. A planned future Educational Psychology section of the journal will take up such issues, and its Cognitive and Social Development sections could also be good outlets for research on better school models.

Aiding development for meaningful lives

Reforming schools will help with another grand challenge: Raising healthy youth to develop meaningful lives. Even prior to the pandemic we were seeing a tremendous increase in teen suicide (Knopf, 2019); intense despair has worsened since. How do we help young people to find their place in the world, find connections and a way to give back, to contribute to the tremendous human project of making life better for all? To recognize the deep interconnectedness of all humanity, of all life, and even of all elements—that every atom in every body was here when the Big Bang occurred and has cycled through one form after another—so we are all everything. Too few people see this; instead people build lives around causes that mean little to their hearts and spirits, or they see no way to build their lives at all. For developmental psychologists, a grand challenge is to help all humans develop healthy, productive lives. As with education (which is closely related to this meaningful lives challenge), we know more than we implement. How to communicate findings to the public and help see those findings through to continued application is another grand challenge to be taken up in this journal.

Adolesence

Related to this also is development through adolescence, as this is a period when despair often sets in. And it has become an extended period: the age of marriage and beginning a family moves ever later, while puberty comes earlier (Arnett, 2014). We have learned that basic prefrontal circuitry undergoes major developmental transformations into one's early 20s (Blakemore, 2012; Luna et al., 2013). We understand more now than we understood previously about the reward circuits underlying risky behavior in youth and how the late-maturing prefrontal circuitry exacerbates risk-taking. But how to give adolescents a sense of purpose during these important self-building years is another grand challenge, taken up in the section on Adolesence.

Senesence

Someday, the years spanning from adolescence to old age may get more notice, but for now, what is clearly crucial is managing senescence. Thanks to advances in healthcare, nutrition, and technology, more and more of the population is living past the age of 80, adding new life phases that were unknown when the average lifespan was 50 years (Carstensen, 2011). This means more people get diseases of aging, like dementias and cancers. How can we mitigate or even prevent the attendant suffering, and help make these bonus years happy and productive ones? A section of the journal focuses on lifespan development and is aimed at such questions.

Summary

In sum, Developmental Psychology has many grand challenges, from reworking its basic theoretical framework, aided by new statistical methods and measurements, to making sense of infant looking time results, to reforming schooling, to managing the challenges of adolescence and old age. *Frontiers in Developmental Psychology* will be a forum for learning about and tackling such problems, and I look forward to seeing authors take up the challenges in its pages in the years to come.

Author contributions

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