Manifesto for New Directions in Developmental Science

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Abstract

Although developmental science has always been evolving, these times of fast-paced and profound social and scientific changes easily lead to disorienting fragmentation rather than coherent scientific advances. What directions should developmental science pursue to meaningfully address real-world problems that impact human development throughout the lifespan? What conceptual or policy shifts are needed to steer the field in these directions? The present manifesto is proposed by a group of scholars from various disciplines and perspectives within developmental science to spark conversations and action plans in response to these questions. After highlighting four critical content domains that merit concentrated and often urgent research efforts, two issues regarding "how" we do developmental science and "what for" are outlined. This manifesto concludes with five proposals, calling for *integrative*, *inclusive*, *transdisciplinary*, *transparent*, and *actionable* developmental science. Specific recommendations, prospects, pitfalls, and challenges to reach this goal are discussed.

Keywords: Developmental science, Diversity, Globalization, Reproducibility, Applicability

Manifesto for New Directions in Developmental Science

Developmental science is a multidisciplinary field concerned with understanding the "what?" (contents), "how?" (processes), "where?" (contexts), and "why?" (intent or goal) of human development (e.g., Bornstein, 2017). The core characteristics of contemporary developmental science are its scientific foundations and principles, multidisciplinary scope, lifespan perspective, and implications for the interplay among research, practice, and policy. Because real-life problems rarely call for simple answers, developmental science integrates insights from multiple disciplines (e.g., Lerner, 2018). Like any field of inquiry, developmental science is undergoing continuing development. The breadth and speed of recent progress across subdisciplines of developmental science—some of which arose only in the last decade (Johnson & de Haan, 2015)—are reshaping the nature of insights on human development (e.g., Hendry & Kloep, 2018). These rapid changes coincide with a broad scientific reform agenda, which together set the general context for the present manifesto.

This paper is the product of collective reflections by a group of scholars and practitioners from a diverse range of backgrounds and thematic interests in developmental science, convened as part of the incoming editorial board of *New Directions for Child and Adolescent Development* (NDCAD). Although this paper is not meant to represent the journal's new scope or vision[1], it purposely builds upon NDCAD's founding editor's intent to offer an outlet for work "that addresses recognized problems in the field" (Damon, 2005, p. 18). To update these "recognized problems in the field" and stimulate discussions about promising directions to address them, the contributors to this paper were initially tasked with answering a seemingly simple question: *Where should developmental science be headed?* This question prompted a range of individual stances and discussions among the authors, with six issues emerging as points of convergence. Four concern the "what" of developmental science - that is, topics identified as critical content domains that need concentrated research efforts: (1) the interaction between biological bases and environmental influences; (2) environmental changes, migration issues, and their impact on development; (3) the need for global and diversity-inclusive perspectives on development; and (4) the role of technology in development. Two additional issues addressed the "how?" and "what for?" of developmental science significance and practice. The former focuses o the

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[1] For this, please refer to the editorial note, this issue.

replicability crisis and the need for integration of findings; The latter attends to the challenges of translation and implementation of developmental science research into policy and practice. Accordingly, this manifesto first discusses the key content domains identified (the "what"), then outlines the "how" and "what for" issues. We conclude with five broad and interrelated proposals for the field of developmental science.

Some issues and proposals may not fundamentally constitute new standpoints: many variations have been stated for decades in disparate corners of the developmental science landscape. Beyond the reminders these recommendations deserve, the value of the present work is to integrate them in a common place, outlining not just new, but—in our opinion—meaningful directions that we hope will challenge the *status quo* on these issues. It is in this regard that the present paper takes the form of a manifesto—that is, a statement of opinions, ideas, and guidelines—regarding possible paths for developmental science. Although this manifesto largely reflects the authors' shared views, it does not necessarily reflect full endorsement of every statement by all contributors. Likewise, it is not meant to be prescriptive, but rather generative of new scientific directions, debates, and actions that build on the synergy among the ideas outlined here.

"What?": Critical Topics in Developmental Science

The four topics emerging as important "what?" of developmental science are discussed here in a sequence that conveys a progression across levels of analysis—from biological bases of change to digital environments—within which human development unfolds. Although we will mainly discuss them with illustrations taken from childhood, adolescence, and emerging adulthood, they are relevant to development throughout the lifespan.

In Development by Design: G x E, beyond Nature and Culture

What develops in human development? Various domains of development, such as cognition, emotion, and language, can be partly separable as empirical entities, but developmental science acknowledges that these domains do not develop in a vacuum. Inherent biological bases interact with multiple environmental factors across developmental time. In addition to behavioral genetic approaches that have dominated the Gene-by-Environment (G x E) studies in recent decades, the rise of molecular (epi)genetic studies that address questions regarding social, emotional, and cognitive processes in typical and atypical development offer

exciting new directions (e.g., Halldorsdottir & Binder, 2017). This line of work suggests important interactions among experiences, structural variations in DNA, and epigenetic markers affecting gene expression, which further interact with the larger environments (e.g., Meaney, 2017). These advances in molecular genetics, which have been driven by advances in bioinformatics, providedevelopmental scientists with insights regarding classic questions and new topics to explore.

Looking ahead, we see several outstanding questions, future directions, and potential challenges for this line of inquiry on the biological bases of development. First, research is needed to understand processes that shape our phenotype under varying (epi-)genetic and environmental conditions, as well as timing effects underlying variations in gene expression patterns across the lifespan. To this end, focusing on gene pathways that may be most affected according to the timing of exposure or of the phenotype measurement may be fruitful. Second, although current approaches to examining polygenic risks are improvements over more traditional candidate G x E approaches, it is important to consider more complex G x G interactions than commonly formulated. New avenues offered by recent developments in data sciences are also worth exploring, especially given increasing opportunities to leverage very large-scale genetic research enabled by the spread of consumer DNA testing in the West. These opportunities come with serious bioethical, cultural, and psychological concerns that must also be addressed.

Finally, a recurrent challenge in G x E studies is that "E" is often interpreted solely as "psychosocial determinants". However, the measurement and modeling of the "environome" should include more factors, from physical to ethnic and cultural influences, that are often missing from current developmental models (Super & Harkness, 2002; Trentacosta & Mulligan, 2020) and may challenge Western perspectives (Serpell & Marfo, 2014). For example, it may be fruitful to consider concomitant biological exposures that neatively or positively impact prenatal brain development, as well as their associated timing during pregnancy as they moderate developmental outcomes. Regarding ethnic and cultural factors, nearly all human developmental genetics studies are monocultural and study only the kind and range of environmental variation within a single society—notwithstanding few large, multi-country consortia. To the extent that environments are cultural products, genetic studies will be vastly more informative when carried out in multiple cultural settings; such studies can be ever more possible within an increasingly

global and collaborative academic networks that include institutions in low- and middle-income countries (LMIC). In sum, a better measurement of E —including cultural environments—in G x E and gene-by-intervention (G x I) studies is, despite its complexity, necessary for advancing developmental science (Bakermans-Kranenburg & van IJzendoorn, 2015).

Environmental Changes and Changes of Environment

A further challenge in modeling environmental influences in developmental processes is that what we consider to be the environment is constantly changing. Therefore, we need to consider not only the stable but also changing aspects of context, including: (1) *random changes* (unpredicted events in the lives of individuals and their social partners, such as sudden death of a relative, accidents, job loss, or immediate consequences of major disasters); (2) *predictable shifts in immediate contexts*, such as planned family and community events such as marriages, births, or moves; (3) *predictable and systemic changes* (socially prescribed developmental sequences such as school transitions; Eccles, 2013); and (4) broadly *shared historical events and movements*, such as national or international financial disruptions, social movements, epidemics, or wars (Elder, 2018).

Migration encompasses multiple dimensions of the changing environmental contexts worldwide and is therefore a particularly relevant issue for developmental science. In 2019, one of every 30 people (i.e., 272 million people) was considered an international migrant (International Organization for Migration, 2019). Moreover, by the end of 2019, 79.5 million individuals had been forcibly displaced as a result of persecution, conflict, or conditions of violence; and 40% of forcibly displaced persons were children and adolescents below 18 years of age (United Nations High Commissioner for Refugees, 2020). Internal migration from rural to urban areas, particularly in highly populated Asian countries, is driving rapid urbanization, with profound implications for parenting and for educational and health systems (e.g., Ge et al., 2019; Zhong et al., 2017). Adding to these stark figures is a foreseeable increase in migration as a result of climate change. Child and adolescent refugees who are displaced due to conflict, disasters, and other crises are particularly vulnerable to trauma exposure and stressors, hazardous living conditions, unsafe environments, challenges in meeting basic survival needs, and social isolation (e.g., Alipui & Gerke, 2018; Richter et al., 2018). Further, these youth may experience difficulties in developing their own identities in the context of their new host societies, and they can be victims of discrimination and prejudice (e.g., Crocetti et al., 2011).

On a different line, but with similar ramifications, nationwide closures of educational institutions as a result of disease outbreaks may dramatically change the daily lives and developmental outcomes of young people across the world. For instance, responses to the spread of the COVID-19 pandemic in 2020 led to school closures for up to 91% (1.5 billion) of the children and adolescent student population worldwide (UNESCO, 2020). These events have contributed to compromised mental health (e.g., increased depressive and PTSD symptoms; Xie et al., 2020) and increased risks to safety and well-being (The Alliance for Child Protection in Humanitarian Action, 2020), while exacerbating educational inequities (Wang et al., 2020). Moreover, even temporary closures of universities and training programs worldwide can delay emerging adults' preparation for adult work.

Together, these global events are fundamentally changing the picture of typical living conditions of people across the world. There is an urgent need to scrutinize programmatic approaches and practices to promote opportunities for young people facing these global challenges, as they may become more the norm than the exception.

In this changing world, how can developmental science, as a field, contribute work that will best support families, caregivers, educators, practitioners, and policymakers in providing safe and nurturing environments (UNICEF, 2018), in which children and adolescents can grow into healthy, functioning, and well-adjusted adults? Our answer is that we need, more than ever, to address the lack of knowledge about the multiple and interdependent individual, social, and cultural factors that can enhance the well-being of children growing up in highly vulnerable and rapidly changing contexts and situations. A good place to start may be by broadening the scope of research with migrant and refugee communities in order to explore how multiple personal and social assets influence developmental outcomes (e.g., Trentacosta et al., 2016). Another critical direction is to study the differential impact of contextual shifts in people's lives according to their age, cognitive abilities, health, race/ethnicity, or social class.

Global and Diversity-Inclusive Perspectives in Developmental Science

A consequence of ongoing migration and globalization is that contemporary societies are increasingly diverse (van de Vijver, 2019). Yet, this diversity is still insufficiently accounted for in developmental science theories, methods, and models. For example, although references to "culture" have become increasingly evident, the great preponderance of research in academic

journals continues to focus on people living in Western countries, especially the United States and Western Europe (Arnett, 2008; Nielsen et al., 2017; Thalmayer et al., 2020). There are, of course, exceptions to this observation, with, for example, cognitive development studies that have been conducted *in* LMICs (e.g., Barbot et al., 2016; Lloyd-Fox et al., 2017), but rarely *by* LMIC researchers. As noted by many, the dominance of Western institutions in developmental science has narrowed the research base of theory and practice. Moreover, reliance on "etic" approaches that impose external and supposedly universal meanings may not reflect local "emic" realities of cultural communities; this limits our knowledge and may introduce cultural bias on interventions promoted around the world for the benefit of children and families (Tomlinson et al., 2014).

Our field must move toward a global and inclusive science of human development. As part of this effort, it will be important to shift from identifying "culture-general" versus "culture-specific" aspects of development, to recognizing that many aspects of human development are often both general—i.e., based on of species-specific biological processes—and specific, that is, shaped by local environments. In an increasingly global world, we need such a dual perspective that combines attention to both dimensions of development (Jensen, 2012) to achieve more accurate portrayals of a "universal" science of development while situating it within the multiple contexts in which development takes place.

To address these concerns, we offer several specific recommendations. First, training programs should be truly transdisciplinary, involving multiple disciplines and sub-disciplines that are not typically included. Further, training should prioritize supporting careers of emerging scholars who represent a diversity of cultures and life experiences, from both within and across geographical and disciplinary boundaries. Developmental scientists from different nations and cultures will need to engage in equitable collaboration in research and authorship, starting with graduate and post-graduate training (Hedt-Gauthier et al., 2018; Tomlinson et al., 2006). This includes fostering open access to current research publications for scholars in all parts of the world, as well as opening data-sharing policies and access to measures. Relatedly, it is especially important for developmental science programs to reach beyond currently dominant approaches, to include greater emphasis on, for example, ethnographic and anthropological perspectives and methods.

Pursuing these goals should also help to address concerns of communities not typically represented in mainstream Western publications, including minorities and minoritized communities (e.g., Santos & Toomey, 2018), as well as generating knowledge about what is normative and desirable across diverse populations, both within and across geopolitical boundaries. Finally, standards for scholarly dissemination of developmental research should emphasize clear and comprehensive reporting of culturally-relevant features (Yousafzai et al., 2018), including sufficient detail on the study sample and the extent to which findings are thought to be generalizable beyond the study context, as well as constraints on such generalization. Commitment to open science that provides these details is needed to promote the reproducibility and replicability of findings documenting increasingly complex and nuanced perspectives on human development.

Developing in a Digital World

Among the drivers of rapid societal changes and globalization are new technologies and digital media. The digital dimensions we live in are globally transforming our daily lives and affecting how youth address developmental tasks. Early studies of the effects of digital media and technology exposure tended to emphasize negative outcomes, such as new forms of addictions and other mental health correlates (McCrae et al., 2017; Misra et al., 2016). More balanced accounts highlight both benefits and risks of digital media to the health and development of young people (Cole et al., 2018). For example, emerging adults are especially high-frequency users of digital media and rely on them for social support during what can otherwise be a lonely time of life (Arnett, 2013). Furthermore, promising evidence-based benefits of experiences with new technologies, such as immersive virtual reality (IVR; Bailey & Bailenson, 2017), have been reported in cognitive (Schmitz et al., 2020) and psychosocial development (Barbot & Kaufman, 2020).

Educational opportunities may also be leveraged by new technologies and digital media. Many youth use new forms of social media to learn and share knowledge with one another, so the contribution of these new modalities for teaching and learning environments must be considered (Bus et al., 2020). Online education may address circumstantial challenges, such as those imposed by the current COVID-19 pandemic, but it may also offer important benefits for

planning more tailored and diversified learning opportunities for children and youth from multiple social groups and cultural backgrounds around the world.

In all, the advent of digital media and technology presents several challenges as well as new directions. First, developmental science needs to continue fostering more balanced perspectives on new technologies and our digital existence. If only "negative" correlates of these dimensions are investigated, then their "positive" side will surely not be understood. Our responsibility is ultimately to embrace these digital realities for current and future generations and use them to shape new intervention modalities that support development. Doing so will require research to clarify conditions that minimize adverse effects such as cyberbullying (Schultze-Krumbholz & Scheithauer, 2015) and optimize positive developmental outcomes. Developmental science may also capitalize on unique opportunities offered by new data collection and measurement approaches offered by media technologies, such as digital experience sampling. Such approaches may be used to monitor development in a dynamic way, providing new insights on developmental processes and prompting new kinds of research questions. These promises will require addressing challenges posed by a global digital divide between high- and low-income communities (Dutton & Reisdorf, 2019; Gómez, 2019). If technology and cutting-edge data collection techniques are leveraged to provide better educational opportunities or access to mental health service, the primary target of those prospects should not be just those with greater "technological capital" (Gómez, 2019).

Directions in the "How" and "What for" of Developmental Science

Thus far, we have outlined four topics that concern the "what" of developmental science—in need of more concentrated research. These include identifying individual, social, and cultural factors, and their interaction, that promote (or impede) the development of youth facing global challenges; understanding what is normative and desirable across diverse populations in order to offer culturally adapted interventions; clarifying conditions under which digital technologies can optimize developmental outcomes to develop new intervention modalities while also considering the digital divide; and understanding the processes and timing of effects that shape our phenotypes under varying conditions, which will require more comprehensive measurement of the physical and cultural environments of development. These topics are non-exclusive and likely non-exhaustive, but in our opinion, they represent timely and particularly

important directions for the field. We now turn to the processes and purposes of developmental science - that is, the "how" and "what for."

"How?": The Replicability Crisis and the Need for Integration

At present, a recurrent question in the scientific community at large is: *Can we trust these findings?* (e.g., Open Science Collaboration, 2015). The question of "how" we do developmental science is emerging amid widespread concerns regarding scientific malpractice and integrity. An inherent question for multidisciplinary fields such as developmental science is whether insights from previous research hold up when probed from different angles. Different disciplines tend to translate a complex research problem into different questions, methods, and analytic steps. It is therefore neither surprising nor necessarily an indication of failed replicability if such studies yield different results. But does the inherent diversity of our field, and the heterogeneity of development itself (Molenaar, 2004), doom us to failed replicability? If we cannot expect to find identical research answers from different subdisciplines within developmental science, this may reflect the integral richness of our field. Still, developmental science is faced with the challenge to produce replicable findings.

A necessary but not sufficient condition for improving replicability is *transparency* in planning, conducting, and reporting research. Such transparency is essential for advancing meaningful expectations and understanding of potential differences in outcomes from different studies, which may reflect differences in methods or study context and provide valuable insights into phenomena under scrutiny. Efforts toward greater transparency in various fields include "open data" and preregistration guidelines—promoting access to data, analyses scripts, and other methodological features. There is a small but emerging culture of sharing research data within developmental science, despite common confusion as to who "owns" the data and who should control its availability and access to its use (Gilmore, 2016; Jones et al., 2019). It is essential to address issues of identifiability of research participants, adequate and protocolled data curation, and timing of data release. Additional uncertainties in open data practice involve whether data should be made available for verification (i.e., reproducibility) or secondary investigations for which they were not initially intended (Beckmann, 2018).

A related concern is the prevalent idea that the goal of any research *must be* to conduct hypothesis testing. The dominance of this "deductive paradigm" has led to deceptive and often unethical practices such as *post-hoc* theory-grounding or SHARKing or Secretly Hypothesizing

After Results Are Known (Hollenbeck & Wright, 2017). Although pre-registration of hypotheses (if any), design, measures, and analytic strategy in a time-stamped way represents good practice in promoting research transparency, not all research needs to test hypotheses. Developmental science research may well be exploratory: such research uncovers new questions and generates new hypotheses and is compatible with the imperative for transparency. In fact,/span>pre-registration is meant to make space for exploratory research in the same project or program that aims at testing some *a priori* hypotheses. Moreover, *post hoc* data exploration is sometimes the only way to leverage the value of costly data (Rosenthal, 1994); it might even be viewed as unethical not to do so, as long as exploratory *post-hoc* results are presented as such (Hollenbeck & Wright 2017). This is now well acknowledged in the statistical science community (e.g., Wasserstein et al., 2019), encouraging statistical thoughtfulness rather than unrestrained reliance on statistical inference (e.g., Tong, 2019).

Further, data-driven analyses, such as latent transitions and latent class analyses and other forms of "person-centered" data analytic approaches, offer powerful data exploration strategies to developmental scientists. These techniques capture the inherent heterogeneity of development that is critical to re-situate in developmental science. For example, new methods and apparatus for analyses of developmental change, such as experience sampling or other intensive methods of data collection, may allow researchers to describe developmental processes in a more fine-grained way, make better predictions, and ultimately, support more tailored intervention approaches. A final example is the advent of machine learning of "big data" that has yielded valuable insights across a range of domains, such as the Neurosynth platform for fMRI data (Poldrack et al., 2017) or promising initiatives such as the Adolescent Brain Cognitive Development (ABCD) study, a large longitudinal study designed to understand factors that influence variability in adolescent brain and cognitive development (Volkow et al., 2018). Given the increasing availability of large-scale developmental research data, as well as subject-level metadata generated across an individual's life-span, the field could likewise benefit from big data insights that illuminate the etiology, development, and malleability of human behavior (e.g., Gilmore, 2016). The same structural barriers and narrow perspectives outlined above, however, currently challenge the exciting progress that big data have to offer developmental science.

Together, these challenges converge towards a common need for *integration* at multiple levels. Developmental science should shift towards integrating discipline-specific methodologies

and insights (e.g., neuroscience, developmental psychology, and behavioral genetics) and those of neighboring disciplines (e.g., anthropology, biomedical sciences). Mapping both commonalities and differences among findings across developmental science disciplines will require integration across a range of methodological approaches to study a given developmental phenomenon. Beyond addressing the imperative of replicability, developmental science also needs integration of extant bodies of research for a given topic, so that more robust inferences (e.g., meta-analysis), as well as new insights (e.g., deep learning), may be uncovered. While doing so, developmental science should better acknowledge the value of hypotheses-free, data-driven, and exploratory approaches, provided they are transparently reported as such, and encourage inter-agency data sharing and open science infrastructure capable of supporting data sharing at the lowest unit of measurement (e.g., Verhage et al., 2020).

The latter is a prerequisite for meaningful integration of nomothetic and idiographic approaches (Molenaar, 2004) in developmental science, which would advance more differentiated understanding of developmental phenomena and, ultimately, differentiated intervention plans. Cronbach (1957) called for such integration of the experimental approach—concerned with replicable interventionist control over situational variations—and the correlational approach—focused on variation between individuals in settings where such control is impossible but knowledge of individual variation would be indispensable for application. Now more than ever, this call should be taken seriously.

"What for?": From Developmental Science to Practice

Developmental science today faces another urgent question: *How do we make our research meaningful in the real world outside the ivory towers of academe?* Although developmental science has grown exponentially over the past decades in numbers of people, projects, and publications, in some ways it has narrowed its focus. Over-specialization and discipline-based compartmentalization call for greater integration, as outlined above. Illustrations of this trend include the weakening or dissolution of interdisciplinary departments and dominance of academic "silos" in some universities. A similar drift is seen in intervention program research and evaluations, where the "gold standard" has become narrowly defined "rigorous" designs (usually randomized controlled trials or RCTs), often omitting information on samples, contexts, and processes that would allow evaluators to gauge the effectiveness of a program in terms of why, how, and for whom the intervention works (Britto et al., 2017; Harkness & Super, in press;

Hein & Weeland, 2019). As a result, large interventions may fail to provide satisfactory return on investment, as discussed in this issue (van IJzendoorn & Bakermans-Kranenburg, 2020).

To address these challenges, we need culturally adapted preventive and ameliorative interventions to support the health and development of children and families. When possible, these should be based on a unifying conceptual model to align concepts from various fields such as prevention science, health psychology, anthropology, and education. To scale up evidence-based prevention and intervention programs, we must communicate the value and broader impacts of our work to decision-makers who often strive to get more value for less money spent for an existing or competing program – a growing challenge in the post-COVID-19 era of scarcer resources.

We need to stimulate discussions about which aspects of early child or adolescent development are desirable and should be promoted, and which are considered undesirable and should be prevented. This debate should engage not only bioethicists but also professionals, practitioners, and policy-makers, as well as individuals at all stages of development across the lifespan. We must also strengthen outreach and engagement with the public, including teachers or staff in education, on the rle and significance of developmental science (e.g., Shonkoff, 2020). This includes providing training to pertinent stakeholders and policy-makers to help them gauge preventive interventions and their utility across domains and developmental time. The publication process can be a way for developmental scientists to communicate their research, both within their research communities and to the public. In this regard, applying suggestions of the American Psychological Association's task force on translational communication to the public (Kaslow, 2015) may be an important first step. Finally, essential to transforming developmental science is fostering local, regional, national, and international partnerships that bring together researchers, practitioners, and policy investors in the multicultural societies of which we are all a part (Cooper & Seginer, 2018). Ongoing engagement of members of the communities affected, educators, practitioners, and policymakers in research, from design to implementation, and interpretation of results, will increase the applicability of our findings (e.g., Piquero, 2019). This endeavor is possible, as elegantly illustrated by Mulvey and colleagues (2020) in this issue.

Conclusions

Bringing together our proposed "what", "how" and "what for" of developmental science, this manifesto concludes with some thoughts on "where" we hope to see the field heading. Specifically, we advocate for an *integrative* developmental science committed to *inclusive*, *transdisciplinary,* and *transparent* research leading to *actionable* outcomes. Strategies for achieving this goal were outlined across this paper and may be summarized in the following five proposals.

<u>*Integrating* discipline-specific methodologies and findings (including nomothetic and idiographic approaches), and strengthening collaborations across disciplinary or cultural boundaries</u>. The concept of integration is pivotal: developmental science should not consist of superposition of knowledge and approaches from distinct subdisciplines, but rather a synthesis that acknowledges the dynamic interplay among biological, cultural, psychological, and sociological dimensions in individual and group development.

<u>Making our research *inclusive* of human diversity, including populations underrepresented in scientific publications, particularly minority and minoritized communities such as migrants, refugees, and children and families of color</u>. Because development and the world we live in are not monolithic, we must make every effort to represent human diversity in our study samples and collaborative teams. Only then will we be working towards the global generalizability of findings, while mapping individual and contextual variations and their intersections in the course of human development.

<u>Promoting truly *transdisciplinary* developmental science training programs, by representing a diversity of methods, disciplinary perspectives, and engaging students, scholars, practitioners, and policy investors representing diverse cultures and experiences</u>. Likewise, mirroring the *integration* and *inclusion* we call for, training developmental scientists must also be transdisciplinary and equitable, to encourage our common understanding and spirit of openness and collaboration throughout the research process.

<u>Promoting *transparency* in research by harmonizing key concepts across applied developmental science disciplines (e.g., prevention science and education); clearly reporting comprehensive and culturally-relevant features of research; and encouraging data sharing at the smallest unit of measurement to support (transparent) exploratory approaches and integration</u>. Transparency is not just a response to the replicability crisis; it is also a warranty that our

research contributes to understanding the phenomena at hand (e.g., why two studies show inconsistent findings) and to progress in the integration and synthesis of findings.

<u>Increasing the *actionability* and outreach of developmental science, by communicating the real-world value and broader impacts of our work to policymakers while strengthening outreach and engagement with the public</u>. If we want developmental science to have relevance and benefit for human development, it is essential that we communicate our achievements, challenges, and prospects to all actors, including policymakers, practitioners, and the public affected by our work. Further, we must do this in ways that are accessible and relevant for different audiences who need data for different purposes.

In sum, the purpose of this manifesto is to stimulate discussion and action plans about the future "what?", "how?", and "what for?" of developmental science. We see this conversation as essential, not only because our world is rapidly changing in many regards, but also as a reflection of the growing needs for meaningful directions in developmental science and in broader scientific community. Mirroring the multidisciplinarity of developmental science, this manifesto reflects discussions among a diverse group of scholars whose thinking is reflected here. Despite our individual interests and pursuits, this initiative revealed common ground with respect to the "where?" we hope to see the field going.

Many of the arguments we have advanced have been previously set forth in different forms (e.g., Kaslow, 2015; Mascolo & Bidell, 2020; Nielsen et al., 2017; Santos & Toomey, 2018; Shonkoff, 2020), but they have not been considered synergistically. The road to achieving the transformation of developmental science is paved with considerable challenges. For example, to fully leverage the potential of technology-aided research, open science, and the "big data" revolution, we need to work collectively to address the ethical challenges they pose and build the infrastructures they require. Despite these challenges, our optimism draws from our hope that genuine commitment to the directions outlined here will serve as a catalyst for our collective contribution to the benefit of human development. To address this ultimate goal, we welcome reflections, criticisms, and alternative proposals in response to this manifesto.

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