Original Paper

Human Development
DOI: 10.1159/000490160

Published online: July 4, 2018

Metatheory and the Primacy of Conceptual Analysis in Developmental Science

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Keywords

Conceptual analysis · Metatheory · Embodiment · Epigenesis · Baselines

Abstract

The practice of science entails more than just repeated cycles of theory construction, hypothesis generation, and empirical investigation. Broader, metatheoretical levels of conceptualization necessarily condition all aspects of the research process, establishing the very meaning and sensibility of science's empirical and theoretical activities. When debate arises at these metatheoretical levels, it is the subject of conceptual analysis, not empirical investigation. In this article, we examine the overarching metatheoretical divide that lies at the heart of many key theoretical debates in science: the divide between a Cartesian-Split-Mechanistic research paradigm and a Process-Relational research paradigm. We instantiate this divide in terms of three prominent domains of inquiry within developmental science: the study of epigenesis (including epigenetics); the study of embodiment, specifically embodied cognition; and the study of baselines for human nature and development. We reveal how core issues and theoretical debates within these domains derive from metatheoretical, not theoretical, points of contention.

Conceptual analysis is widely regarded as a necessary activity for conducting and advancing science [Kuhn, 1970; Machado & Silva, 2007; Overton, 2012; Wachtel, 1980; Watkins, 1975]. Unlike activities of empirical investigation (e.g., hypothesis generation, research design, implementation, and data analysis), conceptual analysis consists of *philosophical* investigation into "the well-foundedness of the conceptual

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structures (e.g., theories)" that serve to organize, make sense of, and explain our everyday observations and commonsense understandings of the world [Laudan, 1977, p. 48]. It involves examining and evaluating the cogency and coherence of theories, of the concepts that comprise them, of the hypotheses and conclusions drawn from them, and, most broadly, of conceptual argumentation [Laudan, 1977; Machado & Silva, 2007]. The philosophical feature of conceptual analysis entails, among other activities, what Strawson [1959] termed "descriptive metaphysics." This refers to the description of the most general features (ontological and epistemological) of our conceptual schemes concerning the nature of the world and the nature of knowing the world. Descriptive metaphysics is contrasted with "revisionary metaphysics," which attempts to revise our ways of thinking in an effort to establish an intellectually and morally perfect picture of the world.

Few scientists would seriously dismiss the value of conceptual analysis, especially given the postpositivist climate that pervades disciplines today. Yet, relative to empirical activity, the activity of conceptual analysis all too often assumes a marginalized status in science. This certainly holds true for the field of developmental science [Slife & Williams, 1995; Smedslund, 1991]. When push comes to shove, mainstream thought within our discipline still inclines toward Popper's [1959] instrumentalist tradition, wherein "hard data" serve as "the final and absolute privileged arbiter of truth" [Overton, 1998, p. 171]. Under this mindset, the role of conceptual analysis is to ensure that our theories are suitably packaged for rigorous empirical investigation. As such, conceptual analysis enters the realm of scientific activity as a necessary tool for evaluating the logical consistency, clarity, and testability (e.g., potential for falsification) of our theories and models; for identifying their lacunae; and for revealing implicit assumptions in our argumentation and conceptual presentation. But the "real" business of scientific decision-making does not arrive until the empirical testing of our theories commences. By virtue of developmental science's sustained reliance on instrumentalist doctrine, conceptual work in our discipline routinely subordinates to empirical activity and depends on "hard data" for its very utility and scientific legitimacy [Lakatos, 1978; Overton, 2006, 2012].

Developmental science's second-class treatment of conceptual analysis is predicated on a mistaken conflation of concept and theory [Wakefield, 2007]. More to the point, it is predicated on an impoverished view of conceptualization in science, one that fails to discriminate between two distinct levels of conceptual inquiry: the *theoretical* and the *metatheoretical*. At the *theoretical* level, concepts involve a mode of understanding one step removed from science's most basic, observational level of commonsense understanding [Overton, 1998]. As such, *theoretical concepts*, and the theories that arise from them, serve as our scientific means of "organizing and reformulating observational understandings in a broader and more coherent fashion" [Overton, 2015, p. 14]. They are designed to be operationalized, expected to yield testable, observable predictions, and, as such, are subject to adjudication through empirical activity, in keeping with instrumentalist tradition.

However, a broader level of conceptualization necessarily frames both observational and theoretical levels of scientific discourse. It is the level of *metatheory*: a level of *pre-empirical* and *pre-theoretical* conceptual grounding within which both the empirical and theoretical activities of science operate. Metatheories involve a set of *background concepts* – various philosophical beliefs and assumptions that we, as humans and as scientists, hold concerning the nature of reality (ontology) and how we come to know that reality (epistemology) [Overton, 2015]. They establish what does and does not make sense to even consider or investigate in the observations that we make and the theories that we construct. All of our scientific work, therefore, necessarily presupposes, and is preconditioned by, the background concepts of metatheory [Overton, 2015]. Critically, this means that, unlike their theoretical counterparts, background concepts are *not* amenable to empirical investigation and adjudication; instead, they are, in Hacker's [2009] words, "grist for *philosophical* mills – not philosophical problems for experimental investigation" (p. 132).

In its conventional wisdom, mainstream developmental science still largely disregards the need to demarcate metatheoretical from theoretical levels of conceptualization. This disregard has obscured one of the most critical functions of conceptual analysis, namely the identification and explication of background concepts in science. And, as a result, one of conceptual analysis' most valuable lessons frequently goes unnoticed in our discipline. That lesson is simple but its implications profound: *many key theoretical debates within the sciences are actually metatheoretical debates and, as such, can only be resolved through conceptual analysis* [Hacker, 2009; Laudan, 1977; Wakefield, 2007].

Our purpose in writing this article is to instantiate this critical lesson. In the process, we hope to disabuse readers of the belief – deeply entrenched in our discipline – that all competing scientific theories can ultimately be adjudicated, completely and solely, through *empirical* activity. We begin by providing an overview of the metatheoretical divide that extensively, but all too often implicitly, frames theoretical discourse and debate within developmental science today. This is the divide between a Cartesian-Split-Mechanistic research paradigm [Lakatos, 1978], and a Process-Relational research paradigm – two fundamentally different ontological-epistemological frameworks of meaning through which we can view the theoretical concepts of our discipline [Overton, 2015; Overton & Lerner, 2014]. We then critically examine three influential theoretical concepts in developmental science – epigenesis, embodiment, and the notion of baselines for human nature and development – to reveal how seminal issues and debates within these domains of inquiry are driven by metatheoretical, not theoretical considerations, and therefore require conceptual, not empirical analysis, for resolution.

The Metatheoretical Divide in Developmental Science

An overview of the metatheoretical divide within developmental science today begins with the recognition that the metatheoretical level, in fact, consists of two levels of metatheory, arranged as a nested hierarchy (Fig. 1). The Cartesian-Split-Mechanistic and Process-Relational research paradigms represent the top level of the hierarchy and, as suggested, these paradigms are composed of ontological and epistemological concepts. Such concepts form the framing context for the next level of metatheory, as well as the framing context for the construction of theories and empirical methods. The second metatheoretical level, termed Mid-Range Metatheories or Metamodels, derives its concepts from the paradigm level. However, these mid-range conceptual systems are less general than the paradigms and entail principles that are identifiably more specific to the observational domains of interest. For example, nested within the Process-Relational research paradigm, the Relational Devel-

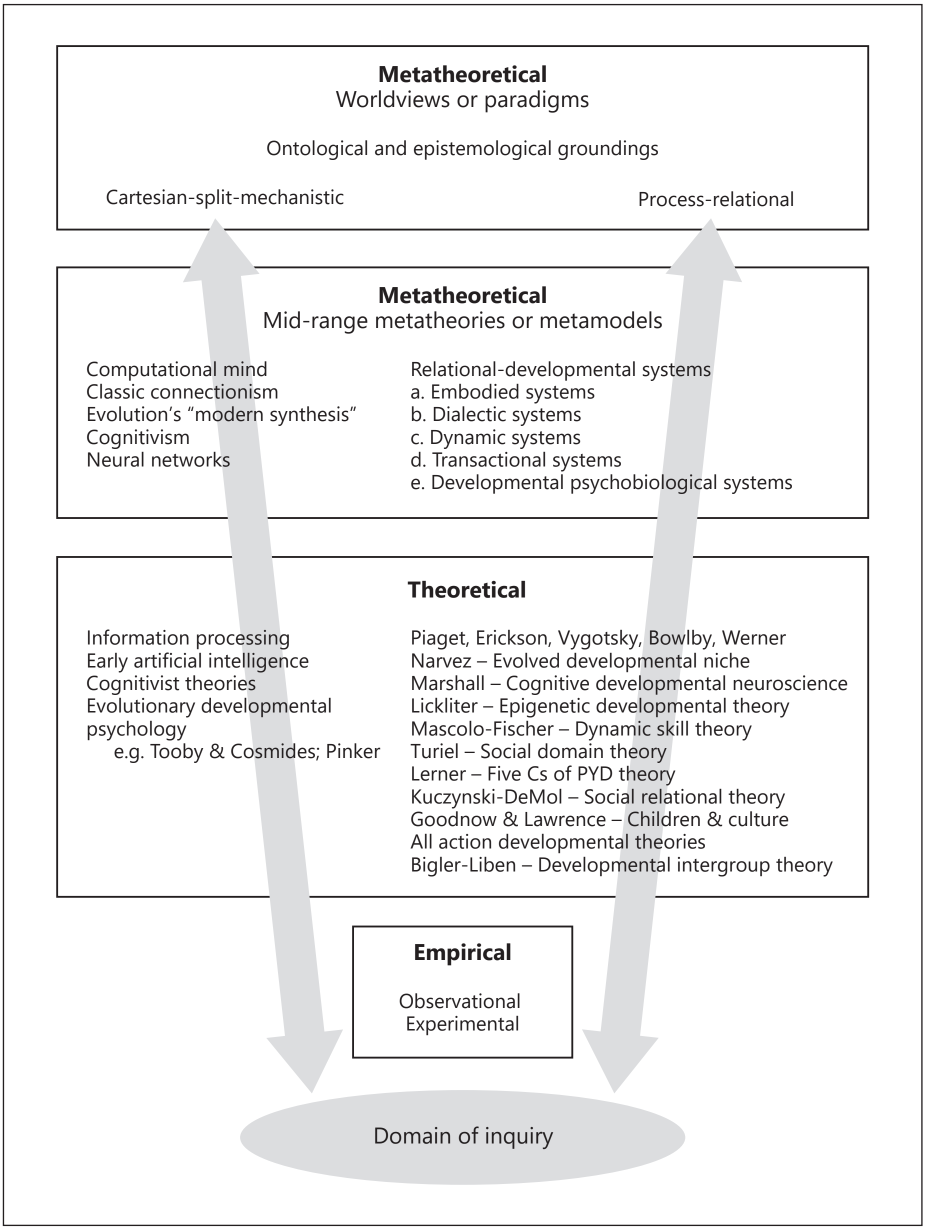

Fig. 1. Levels of empirical, theoretical, and metatheoretical scientific discourse.

Table 1. A comparison of the ontological and epistemological categories of the Process-Relational and Cartesian-Split-Mechanistic metatheories

Paradigms	
Process-Relational	Cartesian-Split-Mechanistic
Ontological categories	
Holism[a]	Atomism
Activity	Fixity
Nature as process	Nature as substance (matter)
Change-becoming	Stasis-being
Dialectic	
Necessary organization	Uniformity/contingent organization
Structure-function relations	
Pluralistic universe	Monistic universe
Epistemological categories	
Holism[a]	Reductionism
Relational understanding	Split understanding
Multiple standpoints of analysis	Objectivism vs. subjectivism
Multiple forms of explanation	Efficient/material causal
Formal explanation	
Structure-function	
Final explanation	

[a] Holism has both an ontological and an epistemological meaning.

opmental Systems metamodel represents the human organism as a *dynamic holistic system*, while nested within the Cartesian-Split-Mechanistic research paradigm, the Computational Mind and Cognitivism metamodels represent the organism as an *input-output computational recording device*. Taken as a whole, paradigm and nested metamodels constitute the conceptual framework of any scientific research program, providing guiding principles for the construction of a variety of specific models and theories, as well as specific methods.

Until recently, the Cartesian-Split-Mechanistic research paradigm has been dominant in guiding theory construction and observational methods in developmental science. As the philosopher of science Imre Lakatos [1978] pointed out, this paradigm entails "Cartesian metaphysics, that is, the mechanistic theory of the universe – according to which the universe is a huge clockwork (and system of vortices) with push as the only cause of motion" (p. 47) and in which fundamental features of this world are split into dichotomous independent elements [Bernstein, 1983; Descartes, 1641/1996]. Conceiving of the universe in this fashion entails the ontological and epistemological concepts presented on the right side of Table 1. The Cartesian-Split-Mechanistic paradigm asserts that there is an ultimate bedrock reality (*atomism and realism*) that is *fixed* – in the sense of exhibiting no independent activity – and *material* in nature. This reality is also inherently *static and uniform*. Any observed change or organization is presumed to be explained by *extrinsic* (i.e., internal bio-

DOI: 10.1159/000490160

logical and external environmental) forces (i.e., causes). Arriving at this reality entails a *split understanding* of the world as independent elements: one constituting the fixed foundational reality and the other a derived appearance of reality. The movement from the apparent to the real is accomplished through the mechanism of *reductionism*, which entails objectively observing the phenomenological (i.e., apparently real) world and analyzing this world down to the reality of fixed, static, uniform, *monistic,* and *material* elements, as well as the forces operating on them.

In contrast to the Cartesian-Split-Mechanistic paradigm, the Process-Relational paradigm models the universe not after a clock, but rather after an *endogenously active and changing complex organic system*. Conceiving of the universe in this fashion entails the ontological and epistemological concepts presented on the left side of Table 1. The Process-Relational paradigm asserts that the universe is an *organic holistic system* in which every part (not element) implies every other part, and an alteration of any part would alter every other part. Or to state this slightly differently, "holism" asserts that the identities (meanings) of entities and events derive from the context in which they are embedded. The whole is not an aggregate of discrete elements, but an organization of parts, each part being defined by its relations to other parts and to the whole. The holistic character of the system mandates a *relational* understanding where the focus is not on things, but on the relation among things. This contrasts with the split understanding of the Cartesian-Split-Mechanistic paradigm. Given this relational understanding, the paradigm also permits *multiple standpoints of analysis*, beyond the split objectivism vs. subjectivism, and *multiple forms of explanation*, beyond extrinsic causal explanation.

A key ontological feature of a holistic system is that it is *endogenously active*. There is no external force driving the system; rather, it is by its organic nature self-active. It is this activity of the system along with the system's *organization* that identify the system as one that is constantly *changing* in a *dialectical* manner. System activity becomes *process* when it is holistically located in a temporal order of duration (i.e., the length of time the activity continues). As a consequence, in the Process-Relational paradigm, *nature is understood as process*, rather than the fixed matter of the Cartesian-Split-Mechanistic paradigm. Further, all actual objects – from subatomic particles to trees, houses, acts of persons – are understood as *acts of perception*. These objects, which are continually in the process of becoming and passing away, constitute the *real*. Actual objects cannot be reduced to something more real. Thus, the Process-Relational universe is pluralistic and not monistic, as in the Cartesian-Split-Mechanistic paradigm.

As stated earlier, when we move from the paradigm to the *metamodel* level of metatheory, concepts – while deriving from the paradigmatic level – are more specific to observational domains of interest. For developmental science, the observational level of interest is the living organism. Metamodels derived from the Cartesian-Split-Mechanistic paradigm (e.g., the computational mind, cognitivism) characterize living organisms as *inherently stable, fixed*, and *unchanging*. Both movement (behavior) and development are understood to be the result of *extrinsic* (i.e., internal biological and external environmental) *forces,* often termed *mechanisms, antecedent conditions,* or *independent variables*. The Cartesian organism is complicated, but not complex. It is complicated in the sense that it can be described in terms of independent pieces. Biology is a piece, culture – a piece, cognition, motivation, and affect are all pieces. Pieces combine – add together, interact – to form a whole that is no different than the sum of its pieces. There can be no real novelty, as apparent reality must, in principle, be reduced to the pieces. The Cartesian organism is *linear* both with respect to behavior and development; inputs are strictly proportional to outputs. Linearity means that the behavior and development of the organism are *deterministic* and, hence, in principle, completely *predictable.*

In contrast, metamodels derived from the Process-Relational paradigm all center on the concept of system, which is understood as an organization of parts, each part being defined by its relations to other parts and to the whole. *Relational-Developmental system* is the most inclusive of several such metamodels, including *developmental* systems [Ford & Lerner, 1992], *dynamic* systems [Witherington, 2015], *psychobiological* systems [Lickliter & Honeycutt, 2015], *dialectical* and *transactional* systems [Kuczynski & De Mol, 2015], and the metamodel of *enactivism* [Di Paolo, Buhrmann, & Barandiaran, 2017; Stewart, Gapenne, & Di Paolo, 2010].

The Relational-Developmental systems metamodel characterizes the living organism, which is itself a relational developmental system, as an *endogenously active and changing organization of part-whole relations.* The system requires no guiding forces to act, and its embodied acts operating coactively in a lived world of physical and sociocultural objects constitute the basic change process *(i.e., the sufficient condition of development)*. Such capacity for change illustrates the *relative plasticity* of the system. The Relational-Developmental system is *self-creating (autopoietic, enactive)* in the sense that it operates according to its own processes. The system is also *self-organizing and self-regulating.* Self-organization refers to the fact that the system's order or organization (i.e., structure-function relations) proceeds from local embodied co-actions between smaller components of the system, and self-regulation connotes the fact that the embodied actions of the system regulate the environment, and the coacting environment regulates the system. The coaction of system and environment ensures that the system is completely contextualized and situated – i.e., time and place matter.

The Relational-Developmental system is complex in that the system is not decomposable into elements arranged in additive sequences of efficient-material causes and their effects. The system is, therefore, a *nonlinear* system. Any complex dynamic system is an *adaptive* system in the sense that the system (whole) coacts with its environment to grow (develop) from lesser to greater levels of complexity. It is this development of increasing complexity that introduces nonreducible novelty, or the emergence of systemic properties that are not characteristic of any of the parts of the system. Further, the search for efficient-material causes and mechanical mechanisms that is characteristic of the metamodels derived from the Cartesian-Split-Mechanistic paradigm is instead replaced in Relational-Developmental systems by the identification of dynamic action *patterns* – both in real-time as actual action events and across developmental time as organized, sequential, directional, relational developmental systems. This identification of action patterns and of the processes they entail is logically prior to the identification of necessary conditions and resources for development. It is, in fact, the specific relational developmental system under investigation that defines both conditions and resources.

With this brief, conceptual backdrop in place for understanding the metatheoretical divide in developmental science, we now turn to concrete instantiations of the divide from three important domains of investigation: the study of epigenesis in development; the study of embodiment and, specifically, embodied cognition; and the

DOI: 10.1159/000490160

construction of baselines for what constitute typical human nature and development. For each domain, we will examine a central issue or point of theoretical debate – one that has inspired empirical activity designed to adjudicate its resolution – to reveal its foundations as a metatheoretical issue or debate, intractable to empirical scrutiny.

Epigenesis

Epigenesis refers to the increase in novelty and complexity of structure and function seen over the course of development. The roots of our present understanding of the concept of epigenesis can be traced back more than 2,500 years to the ancient Greeks. According to the Hippocratic school of ancient Greece, each fertilized egg was thought to contain all the organized structures of the adult organism, but in miniature form. Development simply involved growth of this preformed homunculus. From this perspective, development did not involve an increase in overall complexity over the course of the individual's lifetime, as all the parts and organs were present and in their proper form from the outset. This view was not without its critics. Based on his observations of animal embryonic development, Aristotle (384–322 BC) questioned this decidedly preformationist explanation of development, noting in his text *The Generation of Animals* that in their earliest stages eggs appeared formless and only gradually did embryonic structure take shape. He argued that adult parts were not present at the beginning of development, but rather appeared sequentially as development proceeds, a core tenet of what came to be known as epigenesis.

The refutation of a strict view of preformationism was given a substantial boost in the 18th century with the advent of improved microscopes. This new technology allowed careful observations of embryonic development by Caspar Friedrich Wolff (1733–1794), who documented that different organ systems differentiate and take form consecutively over the course of prenatal development. He emphasized that when organs first become observable, they do not appear in their final form. For example, the intestine of the chick embryo starts as a flat sheet and then becomes a tube. Wolff's findings were confirmed and extended several decades later by Karl Ernst von Baer (1792–1876), whose detailed descriptions of the embryological sequences of fish, birds, and mammals in his 1828 monograph, *On the Development of Animals*, provided an initial map of the process of differentiation, further documenting and providing support for the epigenesis view that development proceeds from the general to the more specific, from the simple to the complex. Von Baer's work supported Aristotle's original insights, providing compelling evidence that every step in development is possible only through the conditions preceding it. The more fine-grained observations allowed by better microscopes essentially resolved the preformationism/epigenesis debate, such that by the middle of the 19th century no scientist could reasonably argue for a strict form of preformationism, given the empirical evidence provided by the emerging science of embryology.

However, the processes or forces by which structural or functional transformation takes place over the course of development were still very open to debate and by the last decades of the 19th century, a new and more nuanced version of preformationism had emerged in biological thought. This view of development held that fertilized eggs contained an array of tiny substances that somehow specified and guided the development of adult form. Perhaps the most well-known version of this argument was promoted by the German biologist August Weismann (1834–1914). Weismann proposed that inherited "determinants," a preformed entity inherited in reproduction each new generation, regulated the course of development. Weismann rejected the notion of epigenesis in favor of his deterministic model of development in which properties of each cell were predetermined in the fertilized egg. In response to Weismann's model, the German zoologist Oscar Hertwig (1849–1922) argued that allocating the casual factors that regulate development to determinants that could not be directly observed was contrary to the scientific method. He argued that the way embryos respond plastically to changing environmental conditions and experimental manipulations posed substantial problems for Weismann's deterministic view. Nevertheless, Weismann's conceptual framework prevailed, thanks in part to the rediscovery of Mendel's work early in the 20th century and the rise of the gene-centric neo-Darwinian view of evolution that coalesced in the 1930s and 1940s. Indeed, Weismann's views provided the basic causal structure used to articulate ideas and distinctions between genotype and phenotype, heredity and development, and evolution and selection for most of the 20th century. A key assumption of these distinctions was that some phenotypic outcomes could be prespecified in the genes, independent of environmental factors and already determined at conception.

Nearly 50 years ago, Gilbert Gottlieb [1970] termed this prespecified conception of development *predetermined epigenesis*. From the predetermined epigenesis perspective, genetic activity gives rise to neural (and other) structures that begin to function when they become mature in the unidirectional sense of genetic activity → structure → function. This notion of a genetic program for development that is directly responsible for many of an individual's phenotypic characteristics was widely embraced across much of 20th century biology and psychology. Concepts such as *instinctive* or *innate* or *hard-wired* behavior came from this framework and are still in play in some quarters of contemporary psychology, notably cognitive psychology and evolutionary psychology. In contrast to this predetermined epigenesis view of development, Gottlieb [1970] outlined a *probabilistic epigenesis* framework that emphasizes the holistic reciprocity of influences within and between levels of an organism's developmental manifold (genetic activity, neural activity, behavior, and the physical, social, and cultural influences of the external environment) and the ubiquity of gene-environment coaction in the realization of all phenotypes. In line with the evidence now available at all levels of analysis, probabilistic epigenesis holds that there are bidirectional influences within and between levels of analysis so that the appropriate formula for developmental analysis becomes genetic activity ↔ structure ↔ function. This insight is consistent with a Process-Relational research paradigm, with its emphasis on process, activity, change, emergence, and self-organization. Probabilistic epigenesis emphasizes that the roles played by any part process of a Relational-Developmental system – gene, cell, organ, organism, physical, social or cultural environment – is a function of all coacting parts and processes of the system. Gottlieb termed this perspective *relational causality* [Gottlieb & Halpern, 2004]. As such, probabilistic epigenesis provides a powerful antidote to enduring attempts to partition developmental cause or explanation into individual elements, such as nature or nurture, genes or environment, inherited or acquired (i.e., the split understanding of the Cartesian-Split-Mechanistic paradigm [Overton, 2015]).

Within the domains of perceptual and cognitive development, attempts at such partitioning or splitting have centered around the issue to what extent humans are innately prepared to interpret and act on the world and to what extent they rely on learning and experience. Such nativistic perspectives on perception and cognition typically rely (often implicitly) on the assumption of the poverty of the stimulus; that is, the developing individual simply displays too much knowledge or too much skill for experience or learning to be an adequate explanation of outcome. Thus, nativists have proposed that there is a core set of innate concepts – here the term *innate* meaning "biologically determined" rather than its strict definition "present at birth" – that provide the foundation for later learning [e.g., Carey & Markman, 1999; Landau, 2009; Spelke & Kinzler, 2007]. These core concepts are thought to be present in early infancy in the absence of obvious experience and are thus presumed to be biologically prespecified. For example, Spelke and Newport [1998] argued for differential roles of biology and experience, suggesting that a solution to the nature/nurture debate is the "thesis that human knowledge is rooted partly in biology and partly in experience and … that successful explanations of the development of knowledge will come from attempts to tease these influences apart" (p. 323).

The above quote highlights the assumption, still evident in cognitive and evolutionary psychology, as well as behavioral genetics, that "biology" and "experience" are somehow separate, independent elements that provide distinct additive contributions to human development. Importantly, this assumption is not an empirical issue to resolve, but rather is a conceptual one, centering on how developmental "interaction" is characterized. As Lerner and Overton [2017] point out, within a Cartesian-Split-Mechanistic paradigm, "interaction" is conceptualized as two or more entities that function independently in cooperative or competitive ways. For example, assumptions are made that some components (i.e., genes) serve as the informational source for construction of a developmental outcome, whereas other components (i.e., environment) merely serve to actualize (or not) that source information. In contrast, probabilistic notions of "interaction" – framed within a Process-Relational paradigm – emphasize the relational interpenetrations of hierarchical levels and processes, such that the components of a relational developmental system cannot be defined independently of the relations to other components and to the system as a whole. As such, the focus of probabilistic epigenesis notions of interaction is on the relations themselves, not what the components bring to these relations construed independently of the relations. From this framework, the influence that any component may have on other parts can extend to higher or lower levels, or remain at the same level.

Keller [2010] captured the tension between these contrasting conceptualizations of interaction, noting that:

> Not only is it a mistake to think of development in terms of separable causes, but it is also a mistake to think of development of traits as a product of causal elements interacting with one another. Indeed, the notion of interaction presupposes the existence of entities that are at least ideally separable – i.e., it presupposes an a priori space between component entities – and this is precisely what the character of developmental dynamics precludes. Everything we know about the processes of inheritance and development teaches us that the entanglement of developmental processes is not only immensely intricate, but it is there from the start. From its very beginning, development depends on the complex orchestration of multiple courses of action that involve coactions among many different kinds of … components. (pp. 6–7)

Despite the fact that predetermined epigenesis and its unidirectional argument have been empirically refuted across multiple disciplines, conceptual vestiges of the preformationism/epigenesis debate remain in play in contemporary developmental psychology (more often than not, implicitly) because two fundamentally different conceptualizations of how to characterize the relations between biology and experience are routinely applied within our discipline. These alternate conceptualizations of gene-environment relations reviewed above are not limited to psychology, but also extend to biology and are particularly evident in the growing field of *epigenetics* [Witherington & Lickliter, 2017]. Despite the fact that empirical findings from epigenetics demonstrating the fallacy of partitioning genetic and environmental contributions to development could be viewed as an endorsement of Process-Relational metatheory, epigenetics research often emphasizes molecular levels of causality. Indeed, some quarters of epigenetics continue to regard genes and their environments as independent sources of information for the "shaping" of developing organisms [for examples, see Lickliter & Witherington, 2017]. This contemporary instantiation of the "interaction debates" [Tabery, 2014] demonstrates a key theme of our argument that such debates are metatheoretical in nature and as such require conceptual and not empirical analysis for successful resolution. Given that conceptualizations of development within contemporary epigenetics still routinely trade in a reductionist privileging of molecular over molar levels of explanation *and* in a continued reductionist focus on separate and distinct roles for genes and environment in any given developmental relation [Lickliter & Witherington, 2017], data alone will not resolve how to include a developmental point of view in contemporary epigenetics. To render epigenetics truly developmental, we need to dismiss the idea that any component of a system is a privileged informational source of new levels of phenotypic organization in development, relative to any other component of the system. This reconceptualization emphasizes that epigenetic processes are always emergent properties of historical and situated relations across multiple levels of biological organization.

Embodiment

The conceptual domain of embodiment concerns itself with the nature of the body's role in the functioning of the organism. Although the origins of research on embodiment go back much further, calls for a more embodied cognitive science became increasingly widespread in the early 1990s [e.g., Brooks, 1991; Hutchins, 1995; Varela, Thompson, & Rosch, 1991]. This paved the way for the field of "embodied cognition" and its growing prominence within psychological and developmental science today. Although there are various flavors of embodiment, proponents of an embodied approach to cognition are united in their dissatisfaction with the cognitivist metamodel of mind that arose during the "cognitive revolution" of the mid-to-late 20th century. In the cognitivist metamodel, the mind is an information processor that carries out computations over representations to which meaning has been preassigned. Such a view of the mind was encouraged by an emphasis on cognitive processing as a separate level of analysis [Marr, 1982] in combination with the functionalist idea that computational approaches to cognition could be pursued independently from considerations of the bodies and brains of living, acting individuals.

The central premise of embodiment presents a distinct challenge to the idea that cognition can be split off and studied at an isolated level of information processing. Instead, the processing of information can only be understood in the context of an active, agentive individual, which challenges the cognitivist notion of the individual as a passive receiver of information that is processed by a computational mind. In the

DOI: 10.1159/000490160

late 1990s, one highly visible direction in embodied cognition attempted to extend the scope of computation to include objects in the local environment [Clark & Chalmers, 1998]. Instead of computations being carried out solely within the head, Clark and Chalmers proposed that they are carried out across a distributed system involving brain, body and trusted, local resources (e.g., a notebook or smartphone). However, on this view of the "extended mind," the body still only acts as a causal influence on the mind, and the account of cognition it provides is still fundamentally a computational one. Other approaches to the study of embodiment, in contrast, have rejected Cartesian grounded computational approaches and see the body as not merely a causal influence on cognition but as *constitutive of* cognition. These approaches generally fall under the umbrella of *enactivism*, a central premise of which is that the nature of the body an organism has – or more accurately, the nature of its embodiment – affords a range of possibilities for action, and it is this range of possibilities that gives rise to the particular world that is brought forth or "enacted" by the activity of the individual [Di Paolo et al., 2017; Stewart et al., 2010].

This question over whether bodies are constitutive of, or simply causally related to, cognitive processing remains a focal point of debate within scientific discourse on embodied cognition [Marshall, 2018; Menary, 2010; Rowlands, 2010; Wheeler, 2005]. However, the debate itself begs another, more pressing (but largely ignored) question: what level of conceptual inquiry – theoretical or metatheoretical – is appropriate for the debate's adjudication? Proponents on both sides routinely marshal empirical evidence to support their position and just as routinely frame the debate in terms of competing hypotheses [e.g., Aizawa, 2007; Block, 2005; Noë, 2004]. Shapiro [2011], in an extensive review of the debate, has explicitly characterized the debate as theoretical in nature, situating it squarely within the realm of data interpretation and testability. Generally speaking, orthodox sentiment within embodied cognition circles seems inclined to regard the field's central debate as one of theoretical, rather than metatheoretical, concern. Such sentiment, however, is itself predicated on the philosophical-metatheoretical belief that psychological attributes, such as thinking, can be sensibly applied to parts of an organism – that it even makes sense to consider the possibility. And such a belief is rooted in the conceptual confusions of a Cartesian paradigm [Bennett & Hacker, 2003].

As noted by Di Paolo et al. [2017], considerations of embodiment are often "interpreted as amendments, improvements to the computational metaphor of the mind, but not as alternatives to it" (p. 13). However, viewing embodied cognition as an interesting add-on to mainstream theorizing fails to acknowledge that embodiment *as a concept* challenges the severing of mind and body that originated with Descartes and that forms the basis of the Cartesian-Split-Mechanistic research paradigm on which the metamodel of cognitivism is based. This incompatibility presents a distinct problem, one that can only be addressed through recognizing that the *metatheoretical* foundation of embodiment cannot be the "Cartesian organism" metamodel of cognitivism. A full consideration of embodiment, in other words, necessitates a radical, metatheoretical shift away from mainstream conceptualizations of mental life. Such a shift is evident in enactivist accounts. According to enactivism, there is no external world to be represented in the way that cognitivism assumes, and there is a rejection of the Cartesian notion that knowledge given by the external world is stored inside individual minds. In the enactivist account, the knower and the known world mutually specify each other. This idea has profound implications, since it suggests that the world experienced by an organism depends more on its own embodied activity than on internalizing the facts that are "given" by an independent external world. At this point, the complete incompatibility of embodiment with cognitivism and the metatheoretical assumptions on which it is based become very apparent, and a radically different account is required.

By emphasizing the codetermination of individual and environment, the enactivist perspective presents a radical solution to the metatheoretical problems of cognitivism. As such, adopting this perspective requires a change in metatheoretical frame, else it risks being untethered from scientific inquiry. One suggestion is that placing the study of embodiment in a relational metatheoretical frame provides a way forward [Marshall, 2018; Overton, 2008]. One specific way forward comes from the Process-Relational paradigm, in which embodiment is seen as a bridge construct relating three standpoints on the relation of the body to mental life. As discussed by Overton [2008], the body as form references the biological standpoint, the body as lived experience references a phenomenological or personal psychological standpoint, and the body as actively engaged with the world references a sociocultural or contextual standpoint. Seen in this way, embodiment bridges between a subpersonal level of ongoing physiological activity – the biological processes going on in the body at any given moment – and a personal level of acts that are intentional and goal-directed. It is through these acts that meaning is projected, and it is these acts that transform the objective world into the world the individual actually experiences. In contrast to the cognitivist perspective, a relational view of embodiment therefore allows consideration of how the world comes to have meaning for the developing individual [Marshall, 2016, 2018]. This rejection of the Cartesian split of cognitivism thus allows embodiment to play a key role in an integrative science of mental life that now enables considerations of identity, autonomy, and meaning.

Although much of the extant work on embodied cognition has not included a developmental aspect, it is clear from the above discussion that the construct of embodiment is closely intertwined with considerations of ontogeny. That said, there may be a bias in developmental science toward seeing notions of embodiment as most applicable to the study of infants. This bias perhaps stems from the notion that sensorimotor influences on cognition are more salient in the prelinguistic period, with later representational thought being more abstract and disconnected from the body (i.e., split off from embodiment). In addressing this bias, we should note that the construct of embodiment is indeed particularly relevant to the question of how intentionality, in terms of symbolic, reflective knowledge, feeling, and meanings, emerges from engaged and embodied actions in the first months and years of life [Overton, 2008]. However, embodiment should not be considered to be more salient to one particular stage of development. As a core construct in the Process-Relational paradigm, embodiment constitutes a necessary defining feature of *all* developmental change processes [Overton, 2015]. As such, it is the activity of the fully embodied individual that allows for the construction of meaning across the lifespan. Furthermore, the thread of embodiment runs not only throughout the individual lifespan, but across phylogenetic time [Marshall, 2016]. As we note below, achieving clarity in the understanding of evolutionary influences on human development can only come through closely considering embodied interrelations between brain, body, and culture. A wider acceptance of these deeper understandings about embodiment has the potential to inform and connect multidisciplinary research across all domains of human development.

Baselines for Human Nature and Development

A critical task for any responsible science is the construction of baselines, or starting points for measurement against which manipulated data or multiple samples can be compared. Developmental scientists routinely align the notion of baseline measurement with what constitutes normal or typical psychological functioning in some domain of interest and just as routinely take for granted that samples tested are representative of "normal" human beings who are, in turn, representative of their species. To gauge such baselines for normality – for what constitutes the "natural," species-typical human – they frequently employ statistical analyses of central tendencies, leaving the discipline with the hope that baselines can be established (and adjudicated) *empirically*, without further information. But such a hope flies in the face of a stark reality. Metatheoretical considerations guide the very question of what constitutes proper data for construction of a baseline measurement. After all, what researchers choose to empirically sample necessarily depends on a set of pre-empirical assumptions that guide their notions of "normality." How, for example, do oceanographers today avoid assuming that it is normal for oceans to be acidic or a soil biologist avoid the idea that farmland soils are typically nutrient poor? They take in the larger picture – a view across generations – and focus on the complexities of a well-functioning ecological system that is comprised of many entities. From this broad and deep perspective, they construct what a healthy ocean or healthy soil looks like. They construct the complexities of a healthy ecological system and the limited range in which it functions. They then come to regard the ecological systems that oceanography and soil science are working with today as fundamentally broken. So far, within psychology only those on the margins have noted the broken nature of humans studied by the discipline [e.g., Kidner, 2001]. Instead, the widespread psychopathologies documented throughout psychology are assumed to be "normal" for humanity by those who study them [e.g., Cicchetti & Toth, 2009].

What sort of philosophical-metatheoretical beliefs guide baseline construction in developmental science? Conventionally, psychologists have adopted a baseline for human nature grounded in notions of "civilization" and "progress." They have, in other words, appealed to assumptions shaped by Abrahamic religions as well as Greek and Enlightenment philosophies, assumptions that regard humanity's nature as discontinuous (i.e., split) from, and more intelligent than, that of other animals. In the realm of modern scientific inquiry, such a metatheoretical stance can be traced directly to Descartes and his over-intellectualized, rationalist assertions that only humans possess thought, true feeling, and conscious awareness [Malcolm, 1977]. It is a stance that regards the "natural" human as detached observer of both the world and her or his own body, a view that considers as baseline for everyday psychological functioning the Western ideal of the dispassionate, scientific or reflective attitude, considered the pinnacle of "civilized" functioning. Such a view is emblematic of the Cartesian-Split-Mechanistic paradigm and undoubtedly underlies assumptions – still all too common in developmental science – that date from WEIRD societies (Western, Educated, Industrialized, Rich, Democratic – 12% of the world's population [Henrich, Heine & Norenzayan, 2010]) are perfectly representative of baseline psychological functioning because they come from societies with the most "progress."

What is missing from this "civilization" and Cartesian-inspired perspective is a sense of humanity across time and *within* a natural ecology (e.g., a sense of humans as social mammals). For most of human genus history, an *indigenous* perspective has prevailed among human societies, one that is grounded in notions of "relation" and "embeddedness" [Narvaez, 2013; Four Arrows & Narvaez, 2016]. It is a perspective that considers humans as part of and partnered with Nature, not split off from or superior to it [Christen, Narvaez & Gutzwiller, 2017]. Nature preserves humans just as the ecologies of the landscape require careful attention and humble usage to preserve the well-being of the biocommunity. Such a focus of native science is one of partnership not dominance – of respectful relations [Cajete, 2000]. From its vantage point, "civilized" humans look uprooted and improperly reared, even crazy and immoral – a poor representative of humanity's potential [Sahlins, 2008]. In the realm of modern scientific inquiry, this relational alternative clearly maps onto the Process-Relational research paradigm.

Adopting a Process-Relational paradigmatic approach to the construction of species-typical baselines for human functioning and development necessitates a transdisciplinary, historically-rich approach. From ethology, anthropology, and archeology, we learn that humanity spent 99% of its existence in small-band hunter-gatherer communities (SBHG). These societies have been studied all over the world by anthropologists in the past century or so, and they are described in first-contact diaries from explorers and others who invaded their lands. Interestingly, these societies display among themselves similar adult personalities. That is, SBHG are typically described as calm, content, generous, independent, and communal [Ingold, 2005; Narvaez, 2013]. One of the key influences for such uniformity in personality appears to be the similar ways young children are raised and develop. These societies provide humanity's developmental niche [Hewlett & Lamb, 2005].

Like other animals, humans evolved a developmental niche that matches up with typical developmental patterning of the young and that counts among the many things beyond genes that humans inherit from their ancestors [Gottlieb, 2002; Oyama, Griffiths & Gray, 2001; West-Eberhard, 2003]. Humans are social mammals, a lineage that emerged over 30 million years ago with an intensive niche that includes breastfeeding on request, caregiver responsiveness and affection, and self-directed social play. The human developmental niche adds to the mammalian nest multiple allomothers and positive social support for mother and baby, as well as soothing perinatal experiences. The human developmental nest is particularly intensive due to the move to bipedalism resulting in a narrowed pelvis, requiring children to be born highly immature – looking like fetuses of other animals until around 18 months of postnatal age [Trevathan, 2011]. Humans are highly malleable after birth, more so than chimpanzees, with multiple sensitive periods for development [Gómez-Robles, Hopkins, Schapiro & Sherwood, 2015]. At full-term birth, the baby emerges with only 25% of typical adult brain volume (typical, that is, of a healthy, young adult brain), and the baby's brain grows especially rapidly in the first year, with 90% of adult volume in place by age 5 [Trevathan, 2011]. Systems developed during these years include the stress response, vagus nerve, endocrine systems, neurotransmitters, immune system, and sociality. These are all influenced by the quality of the developmental nest [for reviews, see Narvaez, Panksepp, Schore & Gleason, 2013]. From current evidence, we can surmise that the evolved nest contributes significantly to the SBHG personality and even worldview.

Framing the "natural" human within a Relational-Developmental systems metamodel suggests that modern developmental science is studying and drawing conclusions from species-*atypical* individuals whose behavior represents adjustment to an *atypical* context from birth onwards – a context of domestication in the form of "civilization." According to Kidner [2001], modern industrial society encourages us both to deny that we are a particular kind of animal with an evolutionary history and to pretend that technology frees us from nature and its constraints. Developmental science has long played a role in maintaining this illusion of separation and detachment by implying that "the person studied as an isolated entity separate from culture or nature is either whole or healthy" and that "alternative forms of personhood are somehow necessarily deficient" [Kidner, 2001, p. 56]. In a time of planetary ruin by the dominant culture, it may be especially appropriate for psychologists to re-examine their metatheoretical framework for conceptualizing baselines.

Conclusion

For each of the three developmental domains reviewed in this article, conceptual analysis uncovers the metatheoretical underpinnings of a core issue or theoretical debate within the domain. We cannot overstate the critical importance of conceptual analysis as a necessary first step in any and all research activity. Only through conceptual analysis can questions in science that are legitimately subject to empirical analysis (the theoretical) be readily discriminated from those that require conceptual analysis for adjudication (the metatheoretical). And only when competing theories are established as metatheoretically compatible – are predicated, that is, on the same basic ontological and epistemological assumptions – can empirical investigation deliver theoretical resolution. It has become progressively clear that both the natural and social sciences are now awash in metatheoretical debate, given the prominence enjoyed in recent decades by the Process-Relational research paradigm as a viable metatheoretical alternative to the orthodoxy of a Cartesian-Split-Mechanistic paradigm [Kuhn, 1970; Latour, 2004; Lickliter & Honeycutt, 2015; Overton, 2015; Smolin, 2013]. However, longstanding adherence within developmental science to the instrumentalist tradition, coupled with the ever-increasing sway that state-of-the-art technology holds over disciplinary inquiry, make it easy to forget that some of our field's most critical problems can only be solved through conceptual analysis. Wittgenstein [1958] famously characterized psychology as a science predicated on "experimental methods and conceptual confusion" (p. xiv). Now more than ever, we need to take this characterization to heart – and repair it.

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