FROM EARLY STEPS TO LIFELONG PATHWAYS: EXAMINING THE ROLE OF DEVELOPMENTAL CASCADES IN EARLY CARE AND EDUCATION

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The development cascades theoretical framework has taken a foothold in developmental psychology research by allowing the examination of the biological and contextual factors that impact learning and growth. Early childcare and education fields worldwide have tended to rely on predominantly male, mostly European theorists for exploring child and human development from an ages-and-stages framework. Several developmental psychologists utilized waves and cycles (Siegler, 1996) and developmental cascades (Oakes & Rakison, 2020; Tamis-LeMonda & Lockman, 2023) to reconsider the dynamic nature of child development and regression. This literature review synthesizes existing research to expand on the complex interconnections of how developmental domains build upon each other and factors that constrain emerging abilities. The vivid language of developmental cascades represented as waves and cycles describes child development and confers optimal insights to early childhood caregivers and educators.

Keywords: child development, developmental cascades, early childhood

Traditional child development models often rely on discrete stages characterized by rigid boundaries and linear progression. However, recent scholarship suggests this approach lacks the complexity for fully explaining child development (National Association for the Education of Young Children [NAEYC], 2020, p. 10). Developmental experiences are likely fluid and include periods of rapid growth, or *waves*, interwoven with periods of consolidation (NAEYC, 2022, p. 36). A preliminary review of early childhood education journals revealed a lack of existing research addressing these waves, or *developmental cascades* (DC; Oakes & Rakison, 2020; Tamis-LeMonda & Lockman, 2023).

We present a potential shift in the language used to describe child development. We propose moving away from the traditional ages-and-stages framework and incorporating the concept of DC. To support the argument for the language shift, we established a collaborative group comprised of early childhood teacher educators, educational policymakers, developmental psychologists, and Montessorians. Our collective expertise allowed us to explore the potential of DC as a framework for understanding child and human development over time and across domains.

Critically analyzing existing literature situates empirical research in the broader field context, ensuring our work builds upon and strengthens existing knowledge. This literature review involved systematically examining existing scholarly works on DC. This in-depth exploration

generated a comprehensive understanding of developmental psychology's current knowledge of DC. Based on the review, we suggest research gaps and areas for contributing new insights to developmental psychology and education.

We begin the review by recognizing that observers of infants and preschool children often view them through a lens of firsts, such as first smiles, first words, and first steps. These eagerly awaited and impressive accomplishments are important milestones. Parents record these milestone events with photos shared on social media or in a scrapbook. Pediatricians monitor these milestones to detect developmental delays. Early childhood educators track these milestones to chart the learning process, and developmental psychologists study milestones to note changes that occur throughout the lifespan (Centers for Disease Control and Prevention [CDCP], 2004).

Milestone lists are a consistent feature of the content found in textbooks on child development for students studying to work with young children as medical professionals, educators, or developmental psychologists. A milestone is generally reported based on the mean age at which children acquire specific skills, and checklists are surveillance tools to identify atypical development or concern about a potential developmental delay (CDCP, 2004). While discrete behavior patterns are used to chart developmental progress, an understanding of the origination of milestones for the understanding of child development during the last century is essential to a shift in the language of child development.

Brief Review of Child Development Theory

In 1928, Gesell was the first theorist to study systematically the stages of development. Gesell published the original developmental schedule based on observations of approximately 12,000 children of various ages from birth through late adolescence. The four areas of development included motor skills, adaptive behavior, language development, and personal and social skills. Gesell's fixed stages of development formed a maturational-developmental theory. In this first large-scale study of children's behavior, Gesell observed behavior behind one-way viewing screens and made recordings that did not distract the children who worked or played. This revolutionary research formed the basis of many observation techniques used in the 21st century.

In 1992, developmental psychologist Ireton published the first standardized questionnaire for assessing and screening children 15 months to 6 years of age. Ireton's Child Development Inventory is a 300-item survey in which a parent reports detailed observations of a child's skills in eight areas: (a) social, (b) self-help, (c) gross motor, (d) fine motor, (e) expressive language, (f) language comprehension, (g) letters, and (h) numbers. The parent also answers questions about the child's health, growth, vision, hearing, development, and behavior. The Child Development Inventory was created from the findings of the longitudinal studies Ireton began in the 1970s. One of the most important objections to the Gesell (1928) and Ireton studies involves their inclusion of only White, middle-class parents and children and a lack of consideration for individual and cultural differences that could have been observed in children and parents of other races and socioeconomic statuses.

In the mid-1990s, the Carnegie Corporation of New York (1994) offered millions in grants to specifically research children's first 3 years of development and identified a quiet crisis facing the families of young children that spurred a national conversation about the needs of babies and toddlers. Around this time, innovations in positron emission tomography scans allowed scientists to watch the brain in real time to see how its tissues changed based on introductions of specific

stimuli. Brain imaging and other technologies offered new insights into the neurobiological basis of child development.

In 2004, the CDCP released developmental milestone checklists for infants and young children. The milestones were formulated around average instead of within normal limits. For example, most people agree that the milestone for walking is 12 months of age. Parents of a 17-month-old child who has not taken their first steps may begin panicking while parents of the 9-month-old walker beam with pride. Moreover, parents of children who walk at 12 months feel relief that their children are average. All three examples represented children who first walked within the normal limits of development. However, the 50th percentile guidelines often worried parents when their children did not meet developmental expectations based on milestone guidelines. Additionally, the use of developmental checklists as surveillance tools has increased with federal legislation in Part C of the Individuals with Disabilities Education Act of 2004 that supports early identification and intervention of developmental problems in young children.

Nearly 20 years later, the CDCP and the American Academy of Pediatrics convened to revise their surveillance checklists (Zubler et al., 2022). In addition to a better understanding of the need for an individualized approach, shifting from rigid timelines to a focus on the uniqueness of each child's development and individual differences, current guidelines include the cultural and socioeconomic factors that shape children's developmental trajectories. The primary purpose of the revised checklists was to discourage a wait-and-see approach based on the idea that the child is likely to catch up to their peers on their own with no intervention. Instead of an average, the checklists reflect what most children, at least 75%, would be expected to achieve by the specified ages.

DC

In child development, DC refer to the domino effect of early experiences on later development. It is the notion that achievements or challenges in one area can trigger a chain reaction, influencing the growth of other seemingly unrelated skills and abilities. Like building blocks, each new block creates a foundation for the next, shaping the overall structure. Key factors that highlight the interconnected nature of DC include (a) bidirectional effects, (b) interconnectedness across domains, (c) cumulative effects, and (d) nondeterministic nature.

First, bidirectional effects refer to the early developmental milestones that can significantly impact later development and, conversely, to the later experiences that can reinforce or reshape earlier skills. For instance, strong language skills in early childhood can facilitate reading success. Reading success can, in turn, influence enhanced language abilities. Second, an interconnectedness across domains for cascades occurring within a single domain, such as motor skills leading to improved coordination and athleticism, or between domains, such as age-appropriate social skills contributing to better academic performance, influence development in more than one domain. This interconnectedness highlights the complex interplay or interconnectedness of various developmental events. Third, cumulative effects provide early successes or disappointments that influence extensive advantages or disadvantages later in life. For example, failing to grasp key mathematical concepts in early grades can increase students' difficulties learning complex mathematical concepts presented in later grades.

Fourth, cascades have a nondeterministic nature. While the DC suggest a path of influence, they are not predetermined. Children are adaptable, and environmental factors, interventions, and individual differences can modify the course of development for the better or worse. This

nondeterministic nature underscores the importance of considering the dynamic and multifaceted nature of human development (Masten & Cicchetti, 2010; Oakes & Rakison, 2020). The DC encompass the interconnectedness of child development. An understanding of how DC operate implies a greater likelihood of children receiving support for success with early milestones across different domains. Additionally, this understanding suggests a greater likelihood of providing early interventions that proactively address potential challenges and promote positive developmental trajectories.

DC as a Metaphor

Many metaphorical devices exist among the various fields of study that address childhood. The image of growth from seed to sprout to sapling describes aspects of child development that are linear and sequential. Delightful views of the child as a ray of sunshine, a garden in bloom, an open book with many chapters to unfold, or a song sung in the key of life evoke joyful associations with childhood. Less favorable perspectives use puzzles, a blank slate, or pesky animals to signify the writers' disdain for or lack of understanding of child development.

Teachers often look at their work with young children as if they are gardeners, sculptors, or potters. They may consider their role as the key that unlocks imagination or the map maker who guides the child through development. Using metaphors helps teachers engage with children in ways that logical, cognitive understanding or emotional, empathetic feelings cannot fathom. The metaphor of DC may help some teachers grasp a deeper understanding of the children they know, but they cannot quite get their finger on what is going on in there.

The DC metaphor has been used in developmental psychology for a few decades. However, genetic biologists utilized the term as early as 1983 to describe the morphogenesis of genetic expression that could have a cascade of effects, turning development one way or another (Oakes & Rakison, 2020). In 1996, Fry and Hale applied the term to childhood and indicated that change in one domain influenced change in others because the "increase in fluid intelligence was mediated by developmental changes in processing speed and working memory, and . . . improvement in working memory was mediated by developmental changes in processing speed" (p. 238).

The term grew in resonance, and a leading journal published two special issues on DC edited by Masten and Cicchetti (2010). In the included articles, the authors explored metaphor to understand diverse topics in developmental psychology, such as peer relations, social and emotional competence of teens, psychopathology, interparental conflict, and many others. Such effects have been named differently in the literature, including chain reactions, snowball, amplification, spillover or progressive effects, and DC (Masten & Cicchetti, 2010).

Siegler (1996) sought better metaphors for describing children's cognitive development. Siegler (1996) described DC using a different term: *overlapping waves*. By 1998, Siegler (2016) expanded the contrast between the Piaget-like staircase metaphor and what he referenced as the overlapping waves metaphor.

By adopting alternative-orienting assumptions about development that are both more consistent with data and more helpful in understanding change, children can be observed as using multiple approaches in their cognitive development over prolonged periods (Siegler, 2016). Rather than development involving stepping up from Level 1 to Level 2 to Level 3, the overlapping waves metaphor depicts development as a gradual ebbing and flowing of the frequencies of alternative ways of thinking with new approaches added and old ones eliminated. This perspective can be

represented as a visual metaphor with a series of overlapping waves where each wave corresponds to a different rule, strategy, theory, or way of thinking (Siegler, 1996, pp. 86–87).

The NAEYC (2020) position statement regarding developmentally appropriate practice references Siegler's (1996, 2016) theoretical perspective. The NAEYC asserted that while typical development follows predictable patterns within a certain timeframe, individual variations should be acknowledged and appreciated. NAEYC, in Principle 4 of the nine principles, noted the existence of general developmental progressions but emphasized the importance of recognizing the diversity of developmental trajectories resulting from cultural contexts, experiences, and individual differences. NAEYC acknowledged that developmental stages have limited utility and encouraged using Siegler's (1996) concept of waves of development to reduce adherence to fixed boundaries. NAEYC's position statement reframed child development from the ages-and-stages metaphor to nonlinear, nonsequential, overlapping, and intersecting waves of development.

An extensive search of academic literature in education sources revealed no mention of waves, cycles, or DC in education journals. Meanwhile, two books have been published recently by developmental psychologists Oakes and Rakison (2020) and Tamis-LeMonda and Lockman (2023).

Oakes and Rakison (2020) explored in 11 chapters the intersecting components for reframing the discussion of child development around an emergent design, such as mechanisms, constraints, looking, object knowledge, and animate and inanimate objects. In Chapter 1, they expressed the following:

> Little doubt that the emergence of individual skills reflects the cumulative effects of multiple events and mechanisms. Adopting a cascade approach forces us to explain development through multiple mechanisms and factors that induce change at different points in a trajectory. Development involves changes that occur throughout the whole child, and the emergence of any behavior reflects the many developmental achievements that occurred before. (p. 5)

After laying out their framework (Chapter 1), identifying mechanisms (Chapter 2), positing the dilemma of a new paradigm (Chapter 4), and exploring the role of constraints (Chapter 4), Oakes and Rakison expounded on the metaphor DC to explain human child development in Chapter 5:

> Typically, developmental cascades have two key characteristics. First, they are used to explain developmental outcomes over very long periods, and second, they reflect trajectories across domains or abilities, and often, the longitudinal connections involve early events influencing later outcomes in non-obvious ways. (p. 104)

Oakes and Rakison provided a visual of a cascade of falling water over rocks, which can be interpreted as addressing how different individuals, like the flow of the water, respond to similar circumstances, depending on specific obstacles or impediments like the rocks in the river, that affect each person. Common to all individuals is the force driving development, similar to the case of water curving over rocks as the flow of various streams, or individuals, flows along different paths.

Oakes and Rakison (2020) added a further interpretation of the waterfall metaphor to child development:

> Abilities begin at the top of the cascade and move down along different trajectories depending on which rocks and obstacles are encountered. All drops of water, or developing abilities, end up in the pool below, but the position in the pool depends on the path traveled, which reflects the events and objects encountered along the path. (p. 103)

Using this waterfall metaphor to reframe the discussion about typical child development focuses on domain-specific and domain-general elements.

Oakes and Rakison (2020) claimed that development progresses and regresses, like ocean tides. They noted that children across cultures and geographies follow predictable time frames and schedules of development and experience sensitive periods in which they need to acquire specific skills along the developmental schedule. Another notable contribution of the DC metaphor involves the recognition of children's bursts of development that enrich progression and address regression.

There are cumulative effects that cross domains directly related to time passage. They reflect multiple interconnected nature and nurture occurrences in the pathway or trajectory of development. A child can be redirected on another pathway due to an occurrence in the environment. A child who lives in a rural area with extensive access to outdoor play and spaces can move to the city and live in a high-rise building, but the child loses easy access to outdoor play. This environmental change could impact this child's developmental trajectory and development.

Another example is a child who loves to listen to the stories in books read aloud by their parents. When this child enters kindergarten and struggles with reading (e.g., the child has dyslexia), the next set of events and developmental trajectories will go on a separate pathway than if the child could easily read and write. This process of development is nonlinear and cannot be boxed into the ages-and-stages framework taught to many professionals in education and psychology. While the ages-and-stages framework is appreciated and remains dominant in psychology and early childhood education, there are better ways to inform teachers' views of the child development happening around them in multiple domains over extended periods. In other words, child development is complex and multifaceted.

Each unique child's experience shifts and changes as they grow and develop based on their genetic makeup and predispositions as well as their environment and the nurture they receive in their lives. Parents can easily report and describe the period when their children could not walk and how their lives changed when their children began to walk. To children's parents, the shift to walking is unremarkable and typical. Typically, developing children walk in the range of 12 to 18 months. However, using the framework of DC when looking at developing children walking, for example, a professional who works with young children would understand that as they develop in the physical domain, they progress in the social-emotional and cognitive domains. As one domain develops, other domains are affected and propelled forward.

Progression and regression affect a typically developing child. The child may experience bursts of motor development, language expression and reception, and social and emotional regulation along with regressions in some of the same domains. In addition, the relationship between biological drives and temperament, coupled with environmental events and occurrences considered over time, suggests a holistic and more comprehensive view of child development. When professionals and parents understand the interconnectedness of the developmental domains, the fact that children learn more than mere motor skills to walk becomes highly remarkable to all children, an image of children requiring a whole child view of growth.

As we have talked with educators and other child development professionals about the DC experienced in early childhood, many have regarded the shift in language as better describing their observations of children's growth from a holistic and organic viewpoint. This representation mirrors their real-life practice, but they need help accessing the DC vocabulary. Early childhood educators, caregivers, and professionals formally trained in American higher education have

learned child development according to age and stage categories within fixed sequences and outcomes. The DC model provides a nuanced explanation of the phenomenon of child development to a child on a growth pathway that includes waves of progression and regression throughout the developmental pattern.

DC as a Theoretical Framework for Examining Change

What we know directly impacts what we see. The DC conceptual framework stands at the precipice of an imminent paradigm shift underpinned by an epistemological and technological revolution (Kitchin, 2014; Tamis-LeMonda & Lockman, 2023). This new way of thinking and learning about human development can transform how we see ourselves and the children in our care.

Kitchin (2014) observed that before the emergence of the internet and opportunities to use big data in scientific inquiries, researchers focused on defining chains of cause-and-effect relationships that led to specific outcomes. These chains operated as sequential one-way paths illuminated by isolating one independent variable at a time and analyzing that variable's influence upon a single dependent variable (Kitchin, 2014). This structure of inquiry conjures a mental image of many children navigating a single path with many branches. Where the path diverges, theoretically, good choices lead to objectively positive outcomes, and bad choices lead to objectively adverse outcomes. Within this paradigm, educators ensure that each student remains on the path toward positive outcomes.

These paths toward positive outcomes suggest that developmental growth in size and complexity occurs in children over time as their biological ages increase (Oakes & Rakison, 2020). For example, Piaget offered a stair-step development model that provides broad categorical expectations for human development in which cognitive ability gains complexity and breadth with each step up the stair of development beginning with sensorimotor at birth to 2 years of age, preoperational from ages 2 to 7, concrete operational from ages 7 to 12, and reaching formal operational at 12 or older (as cited in Siegler, 1996).

Siegler (1996) visualized child development as a more fluid and cyclical process. Siegler (1996) described children as interacting with environmental inputs by processing information internally through observation that influences cognitive transformation and leads to implementing new behaviors, suggesting children reach milestones or benchmarks. Achieving transformation suggests the cyclical process repeats itself as children elicit feedback that causes them to receive new input from the environment that they process or evaluate as feedback to improve their strategy selection, supporting their development of increasingly complex and robust behavioral responses (Siegler, 1996). Siegler's (1996) overlapping waves model suggests that children undergo many cycles between receiving inputs and processing information before they settle on outputs or strategies for behaviors.

Siegler's (1996) depiction of waves and cycles of development collapse from a longitudinal view that suggests child development appears similar to the Piagetian stair-step model. Waves and cycles of development highlight the importance of dimension, scale, and perspective of human development because the macrolevel of development suggested by Piaget does not fully capture the cycles and waves of learning experienced developmentally by children at the microlevel. DC explain child development as a continuous negotiation between input, process, and output (Oakes & Rakison, 2020; Siegler, 1996), occurring in children's daily experiences with the environment on a microlevel.

Vygotsky's zone of proximal development (Vygotsky et al., 1978) is compatible with the DC model. Children's development benefits when they receive inputs for which they are ready because they can cognitively process and demonstrate change behaviorally in the zone of proximal development. They begin to scaffold or build on the initial change as they increase their capacity for reaching more complex zones of proximal development.

Scaffolding can significantly affect children's capacities for development and learning (Shabani et al., 2010). However, the zone of proximal development is limited to representing only a finite period. At any point along Siegler's (1996) wave, the presence or absence of scaffolding affects the strategies children select for processing inputs that lead to outputs. To further complicate the issue of scaffolding and strategy selection, Bronfenbrenner (1986, 1996) demonstrated that the source of the scaffolding and sociocultural context matter to children's developmental growth.

Development occurs within or perhaps due to a highly complex, dynamic, multidimensional, multifaceted system comprising many domains (Oakes & Rakison, 2020; Smith & Thelen, 2003). Variables exist within a web of multidirectional cause-and-effect relationships with varying levels of strength and significance (Meadows, 1977; Oakes & Rakison, 2020). Children do not navigate a branching labyrinth that unfolds as they develop. Each child carves a unique path through the ever-expanding ether of unlimited possibilities based on each microlevel input-process-output wave cycle.

Within the DC framework, beneficial causal relationships can be untangled from messy dynamic systems (Oakes & Rakison, 2020; Otten et al., 2019; Smith & Thelen, 2003), revealing ideal moments and methods for powerful interventions (Masten & Cicchetti, 2010). Individual goals, passions, needs, hopes, and struggles demand unique strategies and solutions. Children operate as explorers, mapping out their one-of-a-kind trajectories.

DC: Events Set the Stage

The DC model indicates that functioning in one domain as a child could impact functioning in a separate domain when the child is older (Masten et al., 2005; Oakes & Rakison, 2020). Outcomes in relatively later childhood and beyond culminate in the impacts that happen as a younger child. The experiences that have far-reaching effects include interparental conflict, resilient personality, and school contexts.

Interparental Conflict

Interparental conflict is a known predictor of child externalizing behaviors (Cummings et al., 2004; El-Sheikh et al., 2009). This conflict may impact externalizing problems during childhood, which then sets the stage for later learning and psychosocial outcomes, such as academic achievement, substance use, and mental health (Mason et al., 2007; Schwartz et al., 2008). Reviewing longitudinal research on this topic is essential as interparental conflict is not necessarily constant throughout a child's life.

Varying interparental conflict may have different implications for child development. In a longitudinal study, Kouros et al. (2010) investigated this idea in children and their parents yearly when the children were approximately 6 through 8 years old and once again at approximately 12 years old. They found that increases in interparental conflict and child externalizing behavior were positively related. For instance, children whose parents engaged in increasingly more conflict over

time scored higher on externalizing behavior than their peers whose parents demonstrated stable levels of marital conflict. In addition, increased interparental conflict during childhood indirectly affected social problems in early adolescence through its impact on child externalizing behavior. Although boys had higher externalizing problems than girls, these patterns of change did not differ between genders. These results demonstrated the magnitude of impacts that interparental conflict during children's elementary years can have years later. Questions remain as to how interparental conflict is related to children's externalizing behaviors and whether a third variable—such as internalizing behaviors, child anxiety, and child temperament—mediates or moderates the relationship. Additionally, Kouros et al. suggested that an opportunity exists to investigate ways to protect children from long-term social problems once they have experienced interparental conflicts.

Resilient Personality

Shi et al. (2021) investigated different types of resilient personality trajectories in children from Grades 1 through 12 and the impact of resilience on socioemotional functioning and academic achievement. In the longitudinal data, Shi et al. conducted personality assessments of children in Grades 1, 2, and 3 and identified three groups of resilient personality trajectories. Approximately 27% of the children were characterized as ego-brittle or exhibiting low resiliency, approximately 22% as ego-resilient or displaying high resiliency, and approximately 51% as ordinary or demonstrating moderate resiliency. Within each group, the children's resiliency levels remained consistent over time.

Regarding conduct problems, hyperactivity and inattention, emotional problems, and problems with peers, the ego-brittle group had the highest reports throughout childhood and adolescence (Shi et al., 2021). In contrast, the ego-resilient group had the lowest reports of conduct problems. Regarding prosocial behavior and reading and math scores, ego-resilient children had the highest scores at each time point whereas ego-brittle children had the lowest scores. Shi et al. suggested that resiliency during childhood typically does not change and can harm social and academic outcomes throughout childhood and adolescence. The findings suggest there are research opportunities for the following questions: (a) What intervention or support given to young children will improve their resiliency and, therefore, improve their later social and academic outcomes? (b) Can children read a storybook in early elementary school that teaches about resiliency and discourages conduct problems? (c) Can children's parents train them to be more resilient in the face of hardship through modeling behavior or in some indirect way?

School Contexts

Other researchers set out to identify which childhood behaviors and environmental factors might predict adolescent prosocial behavior, particularly in the school context. Farrell and Vaillancourt (2020) used longitudinal methods to examine differences in empathic concern and perspective-taking skills in early adolescence. They examined child reports of bullying perpetration, peer victimization, and perceived school climate as well as both parent and child reports of hyperactivity and anxiety when the children were approximately 11 and 12 years old. Outcomes included empathic concern and perspective-taking skills at 13, 14, 15, and 16 years of age. Most adolescents reported heterogeneous prosocial behaviors that included high empathic concern and high perspective taking, moderate empathic concern and moderate perspective taking, or low

empathic concern and low perspective taking. Bullying perpetration was highest in the low empathic concern and low perspective-taking group, indicating that children who bully their peers may end up as adolescents who lack prosocial behaviors. Peer victimization did not predict any patterns of change in prosocial behaviors. Perceived school climate was higher in the moderate group than the low group and higher in the high group than the moderate group, indicating that children who experience their school as a socially supportive place reported higher prosocial behaviors as older adolescents. Hyperactivity was higher across each group (low vs. moderate and moderate vs. high), suggesting that children who were more active as younger adolescents were more prosocial as older adolescents. Finally, anxiety in younger adolescents predicted more empathic concern and perspective taking, which demonstrates that children with increased emotional arousal may also express more concern for others, even years later.

Based on the results by Farrell and Vaillancourt (2020), certain levels of bullying, school climate, hyperactivity, and anxiety impact prosocial behaviors. However, more investigation of these pathways is needed. Research on what schools can do to mitigate the impacts of bullying and improve the school climate is needed. Moreover, although Farrell and Vaillancourt provided a favorable implication for anxiety, anxiety is certainly not a behavior that society should encourage. There may be a third variable mediating or moderating the relationship between anxiety and prosocial behaviors that needs to be identified. Finally, researchers could discover how parents and teachers can bolster children's prosocial behaviors to keep anxiety at bay.

The Role of Constraints in DC

The concept of *constraints* operates when development unfolds through a series of interrelated events with earlier events influencing and shaping later ones. These constraints are crucial in the DC and act as limiting or shaping factors that guide and channel development (Oakes & Rakison, 2020). The three main categories of constraints that influence DC include (a) biological constraints, (c) environmental constraints, and (c) experiential constraints.

First, biological constraints are inherent limitations in children's biology and include genetic makeup, brain development, and physical capabilities (Oakes & Rakison, 2020). For example, an infant's limited muscle strength and motor control constrain the ability to crawl or walk, affecting opportunities to explore the environment and interact with objects. Second, environmental constraints refer to aspects of a child's surroundings that limit or influence development, including socioeconomic status, family dynamics, and access to resources (Oakes & Rakison, 2020). For instance, children living in poverty may have limited access to educational materials or healthy food. Lack of education and nutrition can constrain cognitive and physical development. Third, experiential constraints are limitations arising from a child's past experiences that can shape future learning and development (Oakes & Rakison, 2020). For example, a child not exposed to books may have difficulty developing literacy skills.

These three types of constraints are not static. They can change over time. For instance, a child's biological constraints may change as they grow and develop physically, and environmental and experiential constraints may be modified through interventions or changes in circumstances.

The theory of DC emphasizes that the three types of constraints interact with each other in complex ways (Oakes & Rakison, 2020). A child's biological limitations may make them more susceptible to the adverse effects of a poor environment. Conversely, a stimulating environment can mitigate the impact of certain biological constraints. Understanding the role of constraints in

DC is essential for supporting healthy development in children. Children can reach their full potential when the constraints limiting their progress are identified and addressed.

Limits of the Notion of DC

While understanding the DC is valuable, the theory has limits and considerations. A vast amount of theoretical framework for this notion is missing. The DC represent a relatively new construct that has added new ways of thinking about child development and developmental science by detailing each component of the developing system with its trajectory of change (Iverson, 2021).

DC may have positive or negative consequences, and behavior problems in early childhood could be related to poor parenting and continue during a child's K–12 schooling. These early behavior problems lead to problems in domains that include academics and social competencies (Masten & Cicchetti, 2010). While the meaning of the DC model explains developmental outcomes from birth to later life, the model fails to show a causal effect even as it shows interconnectedness (Oakes & Rakison, 2020).

The effects of the interconnections between domains can be unidirectional, direct, and bidirectional. Any one domain can alter development in another domain, causing the theory to be extremely complex and lengthy. The DC predict that early childhood problems may continue into adulthood (Masten & Cicchetti, 2010). Consequently, one of the characteristics of the DC model is that a longitudinal study of child development would be expensive to conduct (Oakes & Rakison, 2020). Oakes and Rakison stated that model testing can be time-consuming and expensive. Longitudinal studies of child development have spanned from birth to preschool, and others have lasted into adolescence. However, these extraordinary studies are fiscally and practically unachievable for most researchers.

Nonetheless, the DC are important because establishing and joining the abundant dots of motor development and other changes is intricate with multiple, interconnected developmental pathways or factors influencing development and leading to a singular endpoint (Adolph & Hoch, 2019). The continuous research and practice of the DC model make the phenomenon valuable and applicable to child development. Using the statistical models of the social and behavioral sciences to establish causality for the interconnectedness of development or domains is challenging. The DC offer opportunities to refine research methods and explore variables in the interconnected domains.

Comparison of DC to Other Approaches

Child development is a complex life phase that affects the cognitive, motor, emotional, and social domains and has been studied from different perspectives and disciplines. The approaches to explaining child development differ in valid and reliable ways but make advancing toward a practical solution for understanding how children grow and develop challenging. This challenge is why it is worth rescuing and discussing some of the foundations and perspectives surrounding human development and the DC approach.

Aristotle discussed knowledge as obtained through the senses and regarded the correct attainment of happiness as guaranteeing supreme good (Aristotle & Crisp, 2014). Thus, developmental growth relies on wisdom and morality. The relationship between philosophical interpretations and developmental psychology can set out to recognize a particular similarity

between both disciplines. However, Aristotle did not provide a systematic theory, and most theories advanced throughout the 20th century lacked holism across domains.

Children grow and are nurtured in society; caregivers and parents usually transmit values and norms. Many authors adopted value transmission. According to Vygotsky (1981), value transmission as a sociocultural approach shows how social and cultural values affect human beings, especially during early childhood. An essential mechanism of internalization is the collaborative approach in which adults act like tutors and representatives of culture and help children solve problems (Vygotsky et al., 1978). In the sociocultural model, child development begins in infancy based on caregivers' values, interactions, social engagement, and collaboration. At the same time, the DC framework focuses on the cascading effects of influences between one domain and another; this view has implications for how children and adults think about the consequences of early emerging developmental variabilities (Iverson, 2021).

From conception until approximately 6 years of age, children experience many changes (Papalia & Olds, 1988). These are qualitative and quantitative changes; quantitative changes are straightforward and observable like height and weight. On the other hand, qualitative changes "are those changes that distinguish babies to those toddlers that have learned to walk to the baby who has not learned yet; changes that trace the growth of intelligence, creativity, sociability and morality" (Papalia & Olds, 1988, p. 3).

For years, psychologists and scientists have debated how essential and transcendental early experiences are in human development. Children grow and go through the same stages, but not everyone lives or experiences each stage in the same way. For instance, infants were previously viewed as passive recipients of stimulation but are now understood to be active participants in their surrounding environments (Fox & Rutter, 2010). Individual differences affect how children progress into, through, and out of developmental stages. Not all children grow up in favorable circumstances or environments that support development according to averages within normal limits. According to Papalia and Olds (1988), the impact of experiences that occur in early childhood depends on their nature, the context, duration, and the types of experiences that happen in later childhood.

On the other hand, cognitive development refers to how children understand the world around them and acquire skills that allow them to reason and act in front of others. Cognitive development is formed from the first years of life as the child adapts to the environment and occurs alongside motor and psychosocial development. According to the prominent psychologist Piaget (1964), cognitive development has two essential aspects. The first is the figurative aspect, and the second is the operative aspect. The figurative aspect refers to static configurations of memory, such as factual knowledge or rote memory, about categorical information, such as definitions of words or types of shapes and colors that expand with age and exposure (Trepanier & Liben, 1979). The operational aspect involves gaining knowledge from performing actions that lead to learning more complex activities and building upon the original actions. The operational aspect of cognitive development involves learning by transformation, suggesting that information understood in advanced childhood is not understandable in early childhood (Piaget, 1964).

Piaget's (1964) cognitive development theory proposes that children acquire higher stages of cognition linearly as they age; in the DC approach, development occurs under a much broader range of multiple interconnections with multiple domains, not a sole one, and without rigid demarcations of linear stages (Oakes & Rakison, 2020). DC is a powerful concept within development science that can be applied with individual and context relations theories to structure expectations about disparate variables (Lewin-Bizan et al., 2010). The DC borrow from

developmental science for understanding atypical outcomes and change over time; however, in this new framework, the effects of development form ongoing, concurrent, and multifaceted overlapping waves (Oakes & Rakison, 2020).

Various theories of human development provide an open perspective to understand and shape human growth. The theories of development, ranging from ancient Greece's Aristotle to the modern DC, share standard variables and the same roots. However, traditional theories of human development have not fully acknowledged the importance of parenting and children's interactions with the social world and their growing environments on the development of young children. Human development is dynamic, cyclical, and unexpected. Researchers, educators, legislators, and families play essential roles in putting development theories into practice and influencing how children develop.

Conclusion

The primary goal of this literature review was to examine the existing scholarship on the developmental cascades of child development theory. As a collaborative group of early childhood experts and developmental psychologists, we examined the intricacies of the developmental cascades because of their implications for child and human development across various domains.

This comprehensive review forms the foundation for future exploration and research on developmental cascades. We provided a deeper understanding of the current knowledge base and identified critical research gaps. By situating our work within the broader field context, we have contributed novel insights about developmental cascades and strengthened existing knowledge of child development. Our exploration of the developmental cascades engendered a deeper appreciation for the complex and interconnected nature of the learning experiences that influence children's growth. We have informed early childhood education and policy by offering a more nuanced and holistic understanding of child development.

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