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The Future of Research on Executive Function and Its Development: An Introduction to the Special Issue

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ABSTRACT

Over the last several decades, research on executive function in children has flourished, producing a wealth of empirical findings. These findings have raised many theoretical and methodological questions that warrant attention and are addressed in this special issue. This introduction to the special issue reviews some of the recent history of the field before introducing the seven target articles. We introduce these articles in the context of current theoretical and methodological issues: domain generality versus domain specificity of executive function, ecological and cultural validity of executive function measures, executive function training and transfer, and the nature of relations between executive function and achievement and other outcomes. This diverse set of articles collectively provides many fresh, testable ideas that promise to advance the field and usher in the next wave of theory-guided executive function research.

Cognitive scientists have long been fascinated by the human capacity to think and act thoughtfully and flexibly, and behave according to goals instead of being driven by environmental cues, habits, desires, and impulsive emotions. Even infants appear to use executive function in some contexts (Bell & Fox, 1992; Diamond, 1988), although infants and children are better known for their *lack* of control. What changes, across development, that allows children to become increasingly goal-directed and flexible? And how can we use such knowledge to foster healthy development and adaptation in all children?

Descriptions of the surprising behaviors of patients with frontal lobe injuries reveal how devastating it is for human functioning when the neural substrates supporting conscious, flexible thought and action are compromised (Diamond & Taylor, 1996; Milner, 1963; Zelazo, 2020). Young children's behavior has long been compared to that of neuropsychology patients, particularly in contexts where children appear to know their goal but nevertheless fail to act in light of it (e.g., so-called "knowledge-action dissociations," Diamond & Taylor, 1996; Zelazo, Frye, & Rapus, 1996). On executive function tasks and in the real world, children often appear to lack the conscious awareness and control that healthy adults can usually take for granted. The field of developmental neurocognitive psychology emerged to explain what changes in children's brains and minds that allows them to increasingly organize thought and behavior in pursuit of diverse goals.

In the first wave of developmental research on executive function, there was much focus on theory testing, often in the context of explaining the nature of age-related

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changes in performance on laboratory measures of executive function. For example, multiple theories were developed to account for performance on the Dimensional Change Card Sort task, a widely used global assessment of executive function in young children (Zelazo, 2006). On this task, children are initially instructed to sort picture cards (e.g., blue boats and red rabbits) by one dimension, such as shape, and then after several trials they are instructed to sort the same cards by another dimension, such as color. It is now widely known that most 3- to 4-year-old children "perseverate," sorting the cards by the initial sorting rule, despite being reminded of the new rules; however, by 5 and 6 years of age, most children successfully switch to sorting by the new rules (Doebel & Zelazo, 2015). One prominent theory focused on the development of reflection as a mechanism through which children overcome the prepotent tendency to sort by the old rules, allowing them to notice the task structure and how the two sets of rules related to one another (Zelazo et al., 2003). Another prominent theory proposed that developmental increases in active memory allowed children to successfully maintain and use the new rules (Morton & Munakata, 2002). Yet another account posited the development of an inhibitory mechanism that allowed children to stop thinking about the old rules (Kirkham, Cruess, & Diamond, 2003). Similarly, multiple theoretical accounts were proposed to explain infants' perseveration on the A-not-B task (e.g., Clearfield, Diedrich, Smith, & Thelen, 2006; Marcovitch & Zelazo, 1999; Munakata, 1998). Many clever experiments were conducted to test these and other accounts, but studies often fell short of adjudicating among competing accounts.

Alongside this theoretical work, many proposals emerged that posited executive function as a mechanism – and individual difference – that could support domain-specific developmental change, including social, logical, and biological reasoning (e.g., Benson, Sabbagh, Carlson, & Zelazo, 2013; Carlson & Moses, 2001; Case, 1992; Doebel, Rowell, & Koenig, 2016; Richland & Burchinal, 2013; Zaitchik, Iqbal, & Carey, 2014). Here, executive function seemed to show promise as an alternative to other, underspecified mechanisms (see Carey, Zaitchik, & Bascandziev, 2015 for discussion).

Over decades now, developmental research on executive function has continued unabated, with a vast collection of empirical findings linking executive function – as measured by standard laboratory tasks – to a variety of predictors and important outcomes. Interest has only increased over time, as executive function has been consistently linked to academic achievement (e.g., Spiegel, Goodrich, Morris, Osborne, & Lonigan, 2021) as well as socioeconomic status (e.g., Finch, 2019; Obradović et al., 2019; Raver, Blair, & Willoughby, 2013; Rosen et al., 2020). As a result, there have been many intervention studies targeting executive function to improve associated outcomes (Diamond & Lee, 2011; Takacs et al., 2019). There have also been efforts to train executive function in economically disadvantaged populations to address disparities in associated outcomes (e.g., Blakey et al., 2020; Distefano et al., 2020; Zelazo, Forston, Masten, & Carlson, 2018). The notion of executive function as more malleable and predictive of school-readiness than IQ has also been key to this interest in intervening to improve it (Zelazo & Carlson, 2020).

Yet, as long as cognitive scientists have been studying executive function, there have been concerns about how to effectively conceptualize and measure it. Baddeley (1996) famously suggested that the construct of executive function was a "ragbag" of too many complex skills, amounting to a theoretical "homunculus"—a little person inside the head who mysteriously

accomplishes all the complex things – that failed to explain how executive function actually worked. According to Baddeley, the field needed to tame the homunculus with more reductionist accounts if it was going to make progress. Miyake et al. (2000) answered the call, with a data-driven model suggesting three separable-but-related executive function components – working memory (updating), shifting (cognitive flexibility), and inhibitory control. Developmentalists also conducted their own analyses and argued the components become differentiated with age (Wiebe, Espy, & Charak, 2008; but see Karr et al., 2018; Camerota, Willoughby, & Blair, 2020). Today, the tripartite model has been largely reified as what executive function "is" (e.g., Diamond, 2013; cf. Doebel, 2020).

The proliferation of empirical work has laid bare the field's theoretical and conceptual challenges. For example, there are countless papers reporting correlations between executive function(s) and other variables, yet few papers examining the nature of these relations. Frequent claims that executive function supports a broader range of social and behavioral outcomes (e.g., Zelazo & Carlson, this issue) are based on research measuring *not* executive function but related constructs (e.g., self-regulation and self-control, Moffitt et al., 2011; Robson, Allen, & Howard, 2020). A recent meta-analysis confirmed relations between executive function in early childhood and some social and behavioral outcomes concurrently and longitudinally, but these zero-order associations are relatively weak and it remains unclear what is driving them (Stucke & Doebel, under review).

Moreover, findings related to interventions have been inconsistent and underwhelming. Computerized training has generally failed to find compelling evidence of durability and far transfer (Kassai, Futo, Demetrovics, & Takacs, 2019; Takacs & Kassai, 2019) and the results of other kinds of interventions do not convincingly suggest that exercising or challenging executive function in specific ways (e.g., in pretend play) strengthens executive function components (see Doebel & Lillard, 2023; Lillard et al., 2013 for reviews).

The view of standard laboratory executive function measures as assessments of universal, neurocognitive processes or skills has also contributed to the use of deficit models to explain group differences in performance on these tasks. As noted, even young children have been viewed through a kind of "deficit" lens – as similar, cognitively, to individuals with executive deficits due to frontal lobe injury. Lower executive function scores among children from specific socioeconomic, cultural, and racial/ethnic backgrounds have often been viewed as reflecting brain-based deficits due to various kinds of deprivation (e.g., in the child's environment and relationships) (e.g., Hackman, Gallop, Evans, & Farah, 2015) as opposed to other factors, such as differences in what is valued and learned.

The field is arguably at a crossroads. While executive function, broadly construed, is crucial to human functioning and achievement, there remains much to be learned about how it develops and whether it can be improved in meaningful ways through targeted training. We suggest that a renewed focus on theory development has the potential to pave the way forward to a better understanding of executive function development and the degree to which it is a promising target for interventions.

To this end, this special issue brings together a collection of articles that have the potential to generate new testable theories and knowledge about executive function and its development that may advance the field. In particular, each of the articles in this special issue addresses key theoretical and conceptual issues that have arisen in recent research.

Mechanisms of executive function development

While executive function has often itself been posited as a mechanism of development in specific domains, research proposing, and examining mechanisms underlying the development of executive function has been relatively scarce in recent years. Several articles in this special issue aim to revive interest and research in this area.

Frick and Chevalier (this issue) provide a new account to explain how self-directed executive function skills develop. Self-directed executive function involves engaging control in light of one's own goals and internal cues as opposed to external cues (e.g., reminders, instructions), and has received increasing attention in recent years. Part of the increase in research interest is likely due to dissatisfaction with executive function measures that provide explicit and repeated directions, and thus do not allow for assessment of children's ability to engage control on their own, without adult instruction. Self-directed executive function skills are thought to develop relatively late compared to externally cued executive function skills, possibly supported by age-related increases in experiences making independent choices (Barker et al., 2014). However, much remains unknown about the cognitive processes that underlie children's increasing self-directedness. Frick and Chevalier propose that these forms of control exist on a continuum, and that skills in self-directedness are driven by dynamic interactions among context-tracking, task selection, and task execution, each with their own developmental trajectories. Their model also identifies roles for working memory, meta-cognition, and prospective memory.

Drawing on neuroscience and using insights from research on categorization and language development, Ibbotson (this issue) suggests a new way of thinking about the development of executive function. He identifies three phenomena that a developmental account needs to explain: (a) the development of executive function is cumulative in the sense that later executive function builds on and integrates into a more complex whole earlier executive function; (b) executive function is partially dissociable such that it has a differentiated structure at both macro and more granular levels; (c) with development, proactive control increasingly replaces reactive control. Ibbotson argues that these phenomena can be explained by conceptualizing the development of executive function as a process of differentiation and integration that culminates into a complex network of functional hierarchies that vary along a continuum of abstraction. Domain-general analogy-making plays a key role in this bottom-up process by generalizing from instances of applying executive function in specific contexts (e.g., not hitting someone) to more general abstract functions (inhibitory control). Ibbotson draws out interesting implications of his account for a variety of areas, including interindividual and group differences in executive function and training and transfer.

Zelazo and Carlson (this issue) discuss their long-standing view that reflection may be a key mechanism of executive function development (not simply a correlate of it), and that its neglect may be a reason for the lack of transfer in some intervention studies. That is, encouraging reflection in one task context could foster doing so in another. The tendency to reflect is likely temporarily impaired in contexts of stress, fatigue, and limited prior experience with a particular task situation (Zelazo & Carlson, this issue), all of which are potential targets for improving executive function engagement (Niebaum & Munakata, this issue) if not executive function itself.

Domain-generality versus specificity in executive function

To what extent is executive function domain general versus deeply influenced by context? This is an exciting topic in the field, and Ibbotson (this issue) and Zelazo and Carlson (this issue) contribute different perspectives that seek to reconcile these two conceptions. According to Ibbotson, the hierarchical function model reconciles domain-general and task-specific aspects of executive function, as the latter are retained when more complex and abstract hierarchical structures emerge. A key issue that requires further research concerns the characterization of the abstract hierarchical structures that emerge in the course of development, and potential interindividual (and cross-cultural) differences in the development of these structures.

Zelazo and Carlson, in turn, review the research supporting the notion of executive function as domain general, with specific neural correlates and stable individual and developmental patterns. While the predictive value of executive function may be overstated (Stucke & Doebel, under review), there is no doubt that executive function defined as domain general, and measured via standard tasks, captures something true and of value, as their review makes clear.

Zelazo and Carlson also argue that the field has made great progress in understanding executive function as a set of component skills (i.e., the tripartite view), and that an alternative view of executive function as a single general capacity for executive control that is importantly influenced by contextual variables (Doebel, 2020) is undesirable not least because it threatens to bring back the homunculus problem. This is a much-needed discussion. Their worry is understandable, but may be unfounded. For example, rejecting the reductive view of executive function as a small set of components that supports self-control broadly, while acknowledging that executive function is in some important sense domain general, allows one to consider other models that may ultimately have more explanatory power, be better supported by the data, and yield more effective ideas for intervention. While it may seem like a step back, it may be that there is some sense in which executive function *cannot* be reduced—e.g., as a capacity that we can engage in a variety of ways but not necessarily decompose or directly "strengthen." Exploring contextual or knowledge effects may be our best bet in terms of learning how to influence it. See Niebaum and Munakata (this issue) for thoughtful discussions along these lines.

Additionally, acknowledging the possibility that executive performance can be deeply influenced by goal-relevant knowledge, values and more need not imply that standard measures have little value or that there is no way to assess executive function skills in non-idiosyncratic ways. Instead, a view that takes context seriously has the potential to generate new ideas and insights about how executive function skills develop in culture-specific ways (Doebel & Lillard, 2023). Zelazo and Carlson offer one way to reconcile contextual influences and domain generality, which we hope will generate thoughtful discussion and theory-guided tests.

Ecological validity of executive function tasks and models

Another current issue relates to the ecological validity of standard executive function tasks (Doebel, 2020; Gaskins & Alcalá, this issue; Holochwost et al., this issue; Müller & Kerns, 2015; Zelazo & Carlson, this issue). While we know that executive function tasks *do*

consistently relate to some important "real world" outcomes – notably, academic achievement (Spiegel, Goodrich, Morris, Osborne, & Lonigan, 2021), many laboratory tasks look quite unlike self-regulation as it is often used in the real world (e.g., raising one's hand before speaking or resisting the urge to run across the street to see a friend). Yet one can see how the standard tasks *do* bear resemblance to certain real-world activities – for example, maintaining adult's instructions or arbitrary rules in mind and using them at the appropriate time to guide one's actions.

The concern that executive function tasks may lack ecological validity feels most pressing when one considers real-world uses of executive function that bear very little resemblance to what is involved in performing the tasks. The lack of semblance has been explained in terms of standard tasks measuring the more basic component (neurocognitive) skills that ostensibly underlie the broad variety of complex uses of executive function that we see in the world (Diamond, 2013; Miyake et al., 2000; Zelazo & Carlson, this issue). Zelazo and Carlson (this issue) make about as strong a case as there is to be made for the current widely used standard measures, arguing for common measures that are "minimally and systematically" adapted to different contexts and raising important questions concerning the implications of measure modification. In contrast, Holochwost et al. (this issue) suggest that standard measures assess children's state-like (as opposed to trait-like) executive function performance at a given point in time and in a particular (and "peculiar") context. They argue for the importance of distinguishing state- and trait-like executive function skills. Using an ecological systems framework and multi-level modeling, they propose a way forward to evaluate state and trait contributions to executive function performance, and provide examples of applications as well as implications for interventions.

Assessing executive function meaningfully across (and within) cultures

Related to concerns about ecological validity are concerns that standard executive function tasks do not meaningfully assess executive function in populations that differ markedly from the population on which the tasks were developed. The classic view is that standard tasks get at a universal feature of human cognition—i.e., a core set of "neurocognitive skills" (Zelazo & Carlson, this issue) that can, in principle, be measured across cultures if researchers approach translating the tasks in a careful, conservative manner (e.g., Dutra et al., 2022; Obradović et al., 2019; Zelazo & Carlson, this issue). For example, Zelazo and Carlson (this issue) propose translating tasks in such a way that involves minimal adaptation and retains core aspects (e.g., a task in which children are instructed to sort beads of different shapes, sizes, and colors in different ways).

The paper by Gaskins and Alcalá (this issue) suggests, on the other hand, that standard tasks are much more culturally embedded than is commonly recognized, and that common recommendations for adapting tasks, insofar as they do not examine what counts as a meaningful use of executive function from the perspective of the target population, risk measuring executive function in ways that result in children performing poorly and contribute to deficit models of their performance. The authors describe lessons learned from efforts to assess executive function in Yucatec Mayan children, finding that even the most seemingly trivial assumptions of the standard tasks were inconsistent with the children's experiences, beliefs, and practices. The authors suggest that culturally meaningful assessments of executive function require a deep understanding of the population and the uses of

executive function that are valued within the culture. This point is relevant not only to research across cultures but also when considering different groups within a culture (Miller-Cotto et al., 2022; Rogoff et al., 2017).

Can we train executive function?

Another pressing question addressed by articles in this special issue is the extent to which executive function be trained, improving other skills that involve executive function (e.g., so-called "far transfer"). One might expect – if executive function is best thought of as general neurocognitive skills that are not deeply influenced by contextual factors – that training executive function via practice on tasks that correlate with real-world outcomes, like academic achievement, would be beneficial to those outcomes. However, this is not what has generally been found (Kassai, Futo, Demetrovics, & Takacs, 2019). Niebaum and Munakata (this issue) suggest that attempting to strengthen executive function through practice in the context of laboratory tasks is unlikely to work, in part because the way that executive function is engaged on laboratory tasks (e.g., switching among sorting rules) is not relevant to how it is used in the target outcomes (e.g., solving a challenging math problem), despite being correlated with some of those outcomes. Instead, engaging executive function in a way that is reinforced and contextually relevant to the targeted outcome may be more fruitful. Based on his functional hierarchy approach, Ibbotson (this issue) proposes that the functions that are close to each other in the hierarchy are more likely to transfer than functions that are further apart. Accordingly, a careful functional mapping between the training and target domains is a prerequisite for detecting transfer. Zelazo and Carlson (this issue) also discuss transfer, suggesting that encouraging reflection on the skills being trained may be crucial for far transfer to occur. The evidence for this is sort of transfer, to date, is limited, but it is an area where more theory-guided research could be informative. Zelazo and Carlson suggest reflection-based executive function training may transfer to theory of mind skills, but findings have been inconsistent (Espinet, Anderson, & Zelazo, 2013) or non-significant when compared to a control group (Kloo & Perner, 2003). Their discussion highlights the need for further well-powered research to understand if and when reflection-based training yields transfer.

How is executive function related to academic skills and achievement?

Many correlational and longitudinal studies attest to the relation between performance on executive function tasks and academic achievement (e.g., Allan, Hume, Allan, Farrington, & Lonigan, 2014; Spiegel, Goodrich, Morris, Osborne, & Lonigan, 2021), yet experimental work testing specific causal hypotheses concerning the nature of these relations is limited. Together with limited evidence of far transfer of training to academic domains (but see Zelazo & Carlson, this issue), this suggests a need for new ideas and research into how executive function skills and performance in specific academic domains are related. Niebaum and Munakata (this issue) provide a new contextual account that executive function performance benefits from familiarity with task content through personal and cultural contexts, and this same content may be relevant to academic achievement. Medrano and Prather (this issue) consider in detail the case of inhibitory control and mathematics. They review theoretical accounts and empirical

work on the role of inhibitory control in various mathematical tasks and skills, and, in light of inconsistent and surprising findings (e.g., weaker than expected associations between inhibitory control and mathematics in some contexts), suggest that future work ought to develop and test new conceptualizations of the link between inhibitory control and mathematics that account for contextual factors. Such work would have the potential to inform new approaches to improving mathematical skills via inhibitory control.

Conclusion

The contributions to this special issue identify several important issues that, we hope, receive increased attention in the next wave of research on executive function. Theory-building in this area of research has largely given way to the proliferation of correlational studies and small sample experimental studies, with the risk of leading to a fragmentation of the field and difficulty in interpreting these (not infrequently inconsistent) findings. By taking stock and questioning assumptions about the structure and measurement of executive function, the field can revitalize efforts to chart a comprehensive theoretical framework that outlines the development of executive function and the processes that influence it.

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References

Allan, N. P., Hume, L. E., Allan, D. M., Farrington, A. L., & Lonigan, C. J. (2014). Relations between inhibitory control and the development of academic skills in preschool and kindergarten: A meta-analysis. *Developmental Psychology*, *50*(10), 2368. doi:10.1037/a0037493

Baddeley, A. (1996). Exploring the central executive. *The Quarterly Journal of Experimental Psychology Section A*, *49*(1), 5–28.

Baddeley, A. D. (1996/2017). Exploring the central executive. In *Exploring working memory* (pp. 253–279). Routledge.

Barker, J. E., Semenov, A. D., Michaelson, L., Provan, L. S., Snyder, H. R., & Munakata, Y. (2014). Less-structured time in children's daily lives predicts self-directed executive functioning. *Frontiers in Psychology*, *5*, 593. doi:10.3389/fpsyg.2014.00593

Bell, M. A., & Fox, N. A. (1992). The relations between frontal brain electrical activity and cognitive development during infancy. *Child Development*, *63*(5), 1142-1163.

Benson, J. E., Sabbagh, M. A., Carlson, S. M., & Zelazo, P. D. (2013). Individual differences in executive functioning predict preschoolers' improvement from theory-of-mind training. *Developmental Psychology*, *49*(9), 1615. doi:10.1037/a0031056

Blakey, E., Matthews, D., Cragg, L., Buck, J., Cameron, D., Higgins, B., … Carroll, D. J. (2020). The role of executive functions in socioeconomic attainment gaps: Results from a randomized controlled trial. *Child Development*, *91*(5), 1594–1614. doi:10.1111/cdev.13358

Camerota, M., Willoughby, M. T., & Blair, C. B. (2020). Measurement models for studying child executive functioning: Questioning the status quo. *Developmental Psychology*, *56*(12), 2236. doi:10.1037/dev0001127

Carey, S., Zaitchik, D., & Bascandziev, I. (2015). Theories of development: In dialog with Jean Piaget. *Developmental Review*, *38*, 36–54. doi:10.1016/j.dr.2015.07.003

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, *72*(4), 1032–1053. doi:10.1111/1467-8624.00333

Case, R. (1992). The role of the frontal lobes in the regulation of cognitive development. *Brain and Cognition*, *20*(1), 51–73. doi:10.1016/0278-2626(92)90061-P

Clearfield, M. W., Diedrich, F. J., Smith, L. B., & Thelen, E. (2006). Young infants reach correctly in A-not-B tasks: On the development of stability and perseveration. *Infant Behavior & Development*, *29*(3), 435–444. doi:10.1016/j.infbeh.2006.03.001

Diamond, A. (1988). Abilities and neural mechanisms underlying AB performance. *Child Development*, *59*(2), 523–527. doi:10.2307/1130330

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135–168.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*(6045), 959–964. doi:10.1126/science.1204529

Diamond, A., & Taylor, C. (1996). Development of an aspect of executive control: Development of the abilities to remember what I said and to "Do as I say, not as I do". *Developmental Psychobiology*, *29* (4), 315–334. doi:10.1002/(SICI)1098-2302(199605)29:4<315:AID-DEV2>3.0.CO;2-T

Distefano, R., Schubert, E. C., Finsaas, M. C., Desjardins, C. D., Helseth, C. K., Lister, M., … Masten, A. S. (2020). Ready? Set. Go! A school readiness programme designed to boost executive function skills in preschoolers experiencing homelessness and high mobility. *European Journal of Developmental Psychology*, *17*(6), 877–894. doi:10.1080/17405629.2020.1813103

Doebel, S. (2020). Rethinking executive function and its development. *Perspectives on Psychological Science*, *15*(4), 942–956. doi:10.1177/1745691620904771

Doebel, S., & Lillard, A. S. (2023). How does play foster development? A new executive function perspective. *Developmental Review*, *67*, 101064. doi:10.1016/j.dr.2022.101064

Doebel, S., Rowell, S. F., & Koenig, M. A. (2016). Young children detect and avoid logically inconsistent sources: The importance of communicative context and executive function. *Child Development*, *87*(6), 1956–1970. doi:10.1111/cdev.12563

Doebel, S., & Zelazo, P. D. (2015). A meta-analysis of the dimensional change card sort: Implications for developmental theories and the measurement of executive function in children. *Developmental Review*, *38*, 241–268. doi:10.1016/j.dr.2015.09.001

Dutra, N. B., Chen, L., Anum, A., Burger, O., Davis, H. E., Dzokoto, V. A., … Legare, C. H. (2022). Examining relations between performance on non-verbal executive function and verbal self‐regulation tasks in demographically‐diverse populations. *Developmental Science*, *25*(5), e13228. doi:10.1111/desc.13228

Espinet, S. D., Anderson, J. E., & Zelazo, P. D. (2013). Reflection training improves executive function in preschool-age children: Behavioral and neural effects. *Developmental Cognitive Neuroscience*, *4*, 3–15. doi:10.1016/j.dcn.2012.11.009

Finch, J. E. (2019). Do schools promote executive functions? Differential working memory growth across school-year and summer months. *AERA Open*, *5*(2), 2332858419848443. doi:10.1177/2332858419848443

Frick, A., & Chevalier, N. (2022). A First Theoretical Model of Self-Directed Cognitive Control Development. *Journal of Cognition and Development*, 1–14.

Gaskins, S., & Alcalá, L. (2023). Studying executive function in culturally meaningful ways. *Journal of Cognition and Development*, 1–20. doi:10.1080/15248372.2022.2160722

Hackman, D. A., Gallop, R., Evans, G. W., & Farah, M. J. (2015). Socioeconomic status and executive function: Developmental trajectories and mediation. *Developmental Science*, *18*(5), 686–702. doi:10.1111/desc.12246

Holochwost, S. J., Winebrake, D., Brown, E. D., Happaney, K. R., Wagner, N. J., & Mills-Koonce, W. R. (2023). An Ecological Systems Perspective on Individual Differences in Children's Performance on Measures of Executive Function. *Journal of Cognition and Development*, *24*(2). https://doi.org/10.1080/15248372.2022.2160721

Ibbotson, P. (2023). The development of executive function: Mechanisms of change and functional pressures. *Journal of Cognition and Development*, 1–19. doi:10.1080/15248372.2022.2160719

Karr, J. E., Areshenkoff, C. N., Rast, P., Hofer, S. M., Iverson, G. L., & Garcia-Barrera, M. A. (2018). The unity and diversity of executive functions: A systematic review and re-analysis of latent variable studies. *Psychological Bulletin*, *144*(11), 1147. doi:10.1037/bul0000160

Kassai, R., Futo, J., Demetrovics, Z., & Takacs, Z. K. (2019). A meta-analysis of the experimental evidence on the near-and far-transfer effects among children's executive function skills. *Psychological Bulletin*, *145*(2), 165. doi:10.1037/bul0000180

Kirkham, N. Z., Cruess, L., & Diamond, A. (2003). Helping children apply their knowledge to their behavior on a dimension ‐ switching task. *Developmental Science*, *6*(5), 449–467. doi:10.1111/1467-7687.00300

Kloo, D., & Perner, J. (2003). Training transfer between card sorting and false belief understanding: Helping children apply conflicting descriptions. *Child Development*, *74*(6), 1823–1839. doi:10.1046/j.1467-8624.2003.00640.x

Lillard, A. S., Lerner, M. D., Hopkins, E. J., Dore, R. A., Smith, E. D., & Palmquist, C. M. (2013). The impact of pretend play on children's development: A review of the evidence. *Psychological Bulletin*, *139*(1), 1. doi:10.1037/a0029321

Marcovitch, S., & Zelazo, P. D. (1999). The A ‐ not ‐ B error: Results from a logistic meta ‐ analysis. *Child Development*, *70*(6), 1297–1313. doi:10.1111/1467-8624.00095

Medrano, J., & Prather, R. W. (2023). Rethinking executive functions in mathematical cognition. *Journal of Cognition and Development*, 1–16. doi:10.1080/15248372.2023.2172414

Milner, B. (1963). Effects of different brain lesions on card sorting: The role of the frontal lobes. *Archives of Neurology*, *9*(1), 90–100. doi:10.1001/archneur.1963.00460070100010

Miller-Cotto, D., Smith, L. V., Wang, A. H., & Ribner, A. D. (2022). Changing the conversation: A culturally responsive perspective on executive functions, minoritized children and their families. *Infant and Child Development*, *31*(1), e2286.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. doi:10.1006/cogp.1999.0734

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., … Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693–2698. doi:10.1073/pnas.1010076108

Morton, J. B., & Munakata, Y. (2002). Active versus latent representations: A neural network model of perseveration, dissociation, and decalage. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology*, *40*(3), 255–265. doi:10.1002/dev.10033

Müller, U., & Kerns, K. (2015). The development of executive function. In L. Liben & U. Müller (Vol. Eds.), R. M. Lerner (Series Ed.), *Handbook of child psychology and developmental science, Vol. 2: Cognitive processes* (7th ed., pp. 571–623). New York: Wiley.

Munakata, Y. (1998). Infant perseveration and implications for object permanence theories: A PDP model of the AB task. *Developmental Science*, *1*(2), 161–184. doi:10.1111/1467-7687.00021

Niebaum, J. C., & Munakata, Y. (2022). Why doesn't executive function training improve academic achievement? Rethinking individual differences, relevance, and engagement from a contextual framework. *Journal of Cognition and Development*, 1–19. doi:10.1080/15248372.2022.2160723

Obradović, J., Finch, J. E., Portilla, X. A., Rasheed, M. A., Tirado ‐ strayer, N., & Yousafzai, A. K. (2019). Early executive functioning in a global context: Developmental continuity and family protective factors. *Developmental Science*, *22*(5), e12795. doi:10.1111/desc.12795

Raver, C. C., Blair, C., & Willoughby, M. (2013). Poverty as a predictor of 4-year-olds' executive function: New perspectives on models of differential susceptibility. *Developmental Psychology*, *49*(2), 292. doi:10.1037/a0028343

Richland, L. E., & Burchinal, M. R. (2013). Early executive function predicts reasoning development. *Psychological Science*, *24*(1), 87–92. doi:10.1177/0956797612450883

Robson, D. A., Allen, M. S., & Howard, S. J. (2020). Self-regulation in childhood as a predictor of future outcomes: A meta-analytic review. *Psychological Bulletin*, *146*(4), 324. doi:10.1037/bul0000227

Rosen, M. L., Hagen, M. P., Lurie, L. A., Miles, Z. E., Sheridan, M. A., Meltzoff, A. N., & McLaughlin, K. A. (2020). Cognitive stimulation as a mechanism linking socioeconomic status

with executive function: A longitudinal investigation. *Child Development*, *91*(4), e762–779. doi:10.1111/cdev.13315

Rogoff, B., Coppens, A. D., Alcalá, L., Aceves-Azuara, I., Ruvalcaba, O., López, A., & Dayton, A. (2017). Noticing learners strengths through cultural research. *Perspectives on Psychological Science*, *12*(5), 876–888.

Spiegel, J. A., Goodrich, J. M., Morris, B. M., Osborne, C. M., & Lonigan, C. J. (2021). Relations between executive functions and academic outcomes in elementary school children: A meta-analysis. *Psychological Bulletin*, *147*(4), 329. doi:10.1037/bul0000322

Takacs, Z. K., & Kassai, R. (2019). The efficacy of different interventions to foster children's executive function skills: A series of meta-analyses. *Psychological Bulletin*, *145*(7), 653. doi:10.1037/bul0000195

Wiebe, S. A., Espy, K. A., & Charak, D. (2008). Using confirmatory factor analysis to understand executive control in preschool children: I. Latent structure. *Developmental Psychology*, *44*(2), 575. doi:10.1037/0012-1649.44.2.575

Zaitchik, D., Iqbal, Y., & Carey, S. (2014). The effect of executive function on biological reasoning in young children: An individual differences study. *Child Development*, *85*(1), 160–175. doi:10.1111/cdev.12145

Zelazo, P. D. (2006). The Dimensional Change Card Sort (DCCS): A method of assessing executive function in children. *Nature Protocols*, *1*(1), 297–301. doi:10.1038/nprot.2006.46

Zelazo, P. D. (2020). Executive function and psychopathology: A neurodevelopmental perspective. *Annual Review of Clinical Psychology*, *16*(1), 431–454. doi:10.1146/annurev-clinpsy-072319-024242

Zelazo, P. D., & Carlson, S. M. (2020). The neurodevelopment of executive function skills: Implications for academic achievement gaps. *Psychology & Neuroscience*, *13*(3), 273–298. doi:10.1037/pne0000208

Zelazo, P. D., & Carlson, S. M. (2022). Reconciling the context-dependency and domain-generality of executive function skills from a developmental systems perspective. *Journal of Cognition and Development*, 1–19. doi:10.1080/15248372.2022.2156515

Zelazo, P. D., Forston, J. L., Masten, A. S., & Carlson, S. M. (2018). Mindfulness plus reflection training: Effects on executive function in early childhood. *Frontiers in Psychology*, *9*, 208. doi:10.3389/fpsyg.2018.00208

Zelazo, P. D., Frye, D., & Rapus, T. (1996). An age-related dissociation between knowing rules and using them. *Cognitive Development*, *11*(1), 37–63. doi:10.1016/S0885-2014(96)90027-1

Zelazo, P. D., Müller, U., Frye, D., Marcovitch, S., Argitis, G., Boseovski, J., & Carlson, S. M. (2003). Personality and development in childhood: A person-centered approach. *Monographs of the Society for Research in Child Development*, *68*(1), i–151.