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Protective Role of Executive Function Skills in High-Risk Environments

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Introduction

There is growing evidence in the study of resilience for the protective role of executive functions in the school success of children facing adversity. Executive function (EF), also termed cognitive control, describes goal-directed abilities to control thought, behavior, and emotions.[1] These skills can be seen in the ability to retain information in working memory, sustain or shift attention, inhibit automatic responses to perform an instructed or goal-directed action, and delay gratification.

EF skills develop rapidly in the preschool period[2] and are thought to provide a foundation for cognitive and behavioural school readiness.[3] In the classroom, EF skills may manifest as the ability to pay attention, follow instructions, wait one's turn, and remember rules. These skills broadly promote positive development in multiple domains, with recent research suggesting that young children's EF skills predict resilient school and peer functioning above and beyond intelligence level and are related to better mental health outcomes.[2,4,5,6,7]

These skills may be particularly important to promote adaptive functioning for children growing up in high-risk environments. However, the development of EF skills is vulnerable to exposure to trauma and chronic stress.[8] Children from various adverse backgrounds (e.g., homeless/highly mobile, poverty, early institutionalism, maltreatment, etc.) tend to perform worse on measures of executive function.[6,9,10,11] Taken together, these findings suggest a need to lower chronic stress exposure and target building executive function skills through intervention and prevention efforts with adversity-exposed children.

Subject

High-risk youth with more developed executive function skills show better cognitive and behavioural school readiness and performance.[3,12,13] These skills appear to enable children to navigate their constantly changing environment,[9,14] which may be especially key for children developing in environments characterized by harshness and unpredictability.[15]

However, recent research has shown that exposure high levels of adversity may undermine the development of some skills that support school readiness, including executive function.[6,7,9,10,11] These deficits may undermine children's abilities to succeed in academics and develop positive peer and teacher relationships.[12,16,17] This may have long-term implications for school success given that the achievement gap tends to persist and even widen throughout the school years.[18,19]

Given evidence that executive function skills are malleable to intervention and children who demonstrate poorer initial performance make greater gains,[20] efforts to improve high-risk children's transition to school have targeted building executive function skills prior to kindergarten.[4,21,22] Furthermore, research suggests that executive function skills are responsive to intervention across the school years.[20] It is also important to note that although children exposed to adversity tend to demonstrate lower EF skills on average, there is widespread heterogeneity, and many children manage to develop strong EF skills even in difficult circumstances.[23] Identifying and supporting existing sources of resilience, such as family and school support, that can bolster children's EF skills in high-risk environments is also essential.[24]

Problems

Studying the protective role of executive function presents several challenges. Until recently, there were few measures capable of fully capturing executive function abilities for children who are younger than four or are experiencing delays in the development of these skills. Since

exposure to chronic early life stress has been linked with impaired executive function skills in some children,[8] it is critical to be able to measure a wide range in functioning to fully capture the variability in these skills. The NIH Toolbox Cognition Battery now contains two tasks with developmental extension (Dext) versions that effectively lower the floor of the standard tasks and have demonstrated concurrent, short-term, and longer-term validity.[5,13] Additionally, the Minnesota Executive Function Scale (MEFS) is an adaptive, tablet-based EF assessment that can be used with children as young as two years old.[25] Expanding the use of EF tasks that are developmentally appropriate for young children will aid in the advancement of our understanding of the protective role of these skills in early childhood.

Current interventions to improve executive function skills employ a variety of methods including training, classroom curriculum, physical activity, and mindfulness.[20,22] Though these programs suggest executive function skills are malleable, they also show varied success in skill improvements.[22,23,26,27,28,29] Programs that utilize computer-based training show promise in promoting short-term gains in targeted aspects of executive function skills; however, improvements are specific to the domain trained (e.g., working memory) and do not seem to expand to other areas of executive function more generally.[20,30] A recent meta-analysis suggests that although it is possible to foster short-term gains in children's EF skills, many of these effects may be relatively transient.[31] Approaches that involve *implicit* training of executive function, such as mindfulness training and biofeedback-enhanced regulation training, seem to be more effective than *explicit* approaches such as practice with computerized or non-computerized EF tasks.[31]

Key Research Questions

Developmental studies designed to understand the protective role of executive function often address the following questions:

- What are the mechanisms through which executive function prepares children for school success?
- What helps foster executive function skills in young children experiencing delays?
- What helps promote development of executive function skills in the context of adversity?

Recent Research Results

Research consistently indicates that children with more developed executive function skills prior to kindergarten experience greater school success.[6,7] For academic achievement, these skills may scaffold language and mathematic success.[12] In fact, in a low-income sample of children, researchers have found that executive function skills prior to kindergarten predict growth in both numeracy and literacy skills across the kindergarten year and into third grade.[12,13] In addition to providing a cognitive foundation for learning, executive function skills may also support academic success by promoting appropriate classroom behavior.[3] Many kindergarten teachers report that it is more important for children to control themselves in the classroom, follow directions, and not be disruptive than it is to know the alphabet or how to count to 20.[3] Furthermore, executive function skills may promote the development of positive teacher and peer relationships.[32,33] Studies suggest that there is overlap between the development of executive function and Theory of Mind (ToM), which is the ability to identify that others' desires and knowledge differ from one's own. These skills are associated with lower levels of aggression, better problem-solving skills, and positive social skills.[34,35]

Recent research suggests that the nature of adversity experienced may be relevant to understanding the development of children's EF in high-risk contexts. For example, cognitive skills appear to be particularly impacted for children exposed to deprivation, such as institutional rearing or neglect, as opposed to children exposed to threat, such as child abuse or violence exposure.[36] Further, the recently articulated "hidden talents" approach advocates for a strengths-based perspective that acknowledges the development of stress-adapted skills in adversity-exposed children.[37] For example, children raised in unpredictable home environments appear to demonstrate enhanced task switching abilities, particularly under stress.[37] Additionally, children exposed to violence and poverty performed worse than their non-adversity exposed peers on EF tasks using traditional abstract stimuli, but performed equally well when more ecologically valid stimuli were used.[38] This suggests that apparent EF "deficits" may be ameliorated when children are more familiar with task stimuli. Finally, recent work has demonstrated that neighborhood resources also contribute to EF skills in preschool-aged children, over and above the effect of family resources.[39] This suggests that it may be important to consider the broader contexts where children spend time, which may present additional opportunities for interventions and policy efforts.

Research Gaps

First, much of the research on hidden talents in adversity-exposed youth has been conducted with older school-aged children and adolescents.[37] More work is needed to understand how adversity impacts the development of EF in early childhood, when domains of EF such as working memory and inhibitory control appear to be less differentiated.[40] Additionally, there is currently limited research on the effectiveness of interventions to sustain long-term gains in executive function skills with very high-risk children. It will be important to remember that intervention needs and responses of children with different experiences may differ. For children currently experiencing chronic stress (e.g., homeless/highly mobile), it is unclear whether it is feasible to target executive function skills without first reducing stress and building coping skills. Finally, researchers have begun to emphasize the role of upstream social factors, such as class- and race-based structural disadvantage, on the development of children's EF skills.[41] Efforts to mitigate structural inequality and support parents' access to resources that promote their children's development may be just as effective as directly targeting children's EF skills through intervention. Future research will be needed to learn how best to tailor interventions and policy efforts to account for the needs of adversity-exposed children.

Conclusions

Studies consistently suggest that exposure to trauma or chronic early life stress may impact the development of executive function skills.[6,7,9,10,11] These skills appear to provide the foundation for school readiness through cognition and behaviour.[3,5,12] Because early school success is so important for later school success, it is essential to identify sources of strength that can bolster early EF skills in adversity-exposed young children.[16,17,23,24]

For this reason, there has been increased attention to interventions that promote executive function. Although there is evidence that executive function is malleable,[18,42] few interventions have attempted to boost skills in children currently experiencing toxic levels of stress. Efforts to design interventions that promote executive function in these children may need to address current levels of stress exposure and simultaneously work to reduce these to gain maximum benefit.

Implications for Parents, Services and Policy

Research to date underscores the importance of executive function skills for school success, especially for children living in high-risk environments. Programs designed to boost executive

function have shown mild short-term gains across multiple levels, including school curriculum, computer-based training, and even physical activities, like martial arts.[20,43,44] Interventions that promote implicit skill gains such as teaching self-regulation strategies, self-distancing, and mindfulness may be particularly fruitful.[31,45] Additionally, parents can play a key role in fostering children's EF development. For example, autonomy-supportive parenting practices, such as providing children with choices, can promote children's EF and support their sense of self-efficacy, encouraging them to engage in more challenging tasks.[46] Furthermore, sensitive caregiving may promote EF skills by shielding children from some of the chaos they are experiencing.[47] As such, supporting parents may be an important way to indirectly bolster children's EF in high-risk contexts.[23] Executive function skills also have been successfully targeted through school-based curriculum in preschool and Head Start classrooms.[4,35] Experimental evidence suggests early childhood classrooms, like Head Start, can successfully build executive function skills by providing more self-regulatory support in a classroom (e.g., implementing clear rules and routines, redirecting or rewarding children's behaviour).[35] Increasing attention to executive function skills in early childhood programs and increasing accessibility of these programs for adversity-exposed children may reduce the achievement gap that is apparent before school begins and persists throughout the school years.

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