

Building the Brain's "Air Traffic Control" System: How Early Experiences Shape the Development of Executive Function. Working Paper 11. Center on the Developing Child Harvard University.

WE PREPARE DINNER WHILE SIMULTANEOUSLY HELPING OUR CHILDREN WITH THEIR HOMEWORK and making notes about appointments we need to schedule for the week. We focus on our jobs when we need to and our families when they need us. We remember the phone number that our neighbor just gave us so we can write it down as soon as we find a pen. We take a deep breath, rather than honk, if the car in front of us fails to move immediately when the light turns green. As adults, our capacities to multitask, to display self-control, to follow multiple-step directions even when interrupted, and to stay focused on what we are doing despite ever-present distractions are what undergird the deliberate, intentional, goal-directed behavior that is required for daily life and success at work. And while there are cognitive limits to anyone's ability to multi-task effectively, we need and rely on these basic skills in all areas of our lives. Without them, we could not solve complicated problems and make decisions, persist at tedious but important tasks, make plans and adjust them when necessary, recognize and correct mistakes, control our impulsive behavior, or set goals and monitor our progress toward meeting them. Children need to develop these skills, too, in order to meet the many challenges they will face on the road to becoming productive, contributing members of their communities.

We are not born with the skills that enable us to control impulses, make plans and stay focused. We are born with the potential to develop these capacities-or not- depending on our experiences during infancy, throughout childhood, and into adolescence.

EF skills develop through practice and are strengthened by the experiences through which they are applied and honed.

“Providing the support that children need to build EF Skills at home, in child care and preschool programs, and in other settings they experience regularly is one of society’s most important responsibilities.”

Being able to focus, hold and work with information in mind, filter distractions, and switch gears is like having an air traffic control system at a busy airport to manage arrivals and departures of dozens of planes on multiple runways.

In the brain, this air traffic control mechanism is called Executive Function.

EF refers to a group of skills that helps us focus on multiple streams of information at the same time, monitor errors, make decisions in light of available information, revise plans as necessary, and resist the urge to let frustration lead to hasty actions.

Acquiring the early building blocks of EF skills is one of the most important and challenging tasks of the early childhood years, and the opportunity to build further on these rudimentary capacities is critical to healthy development throughout middle childhood and adolescence.

Young children depend on their emerging EF skills to help them as they learn to read and write, remember the steps in performing an arithmetic problem, take part in class discussions or work projects, and enter into and sustain play with other children.

It is this set of skills that enable children to plan and act in a way that makes them good students, classroom citizens and friends.

Children who do not have opportunities to use and strengthen these skills, and, therefore to become proficient- or children who lack the capacity for proficiency because of disabilities or, for that matter, adults who lose it due to brain injury or old age- have a very hard time managing the routine tasks of daily life.

For young children, adults set up the framework (i.e., establishing routine, providing cues, breaking big tasks into smaller chunks) that helps children use the EF skills they are developing to the best of their abilities. These techniques are called “scaffolding.”

Elementary teachers identify problems with paying attention, managing emotions, completing tasks, and communicating wants and needs verbally as major determinants of whether a child is ready to succeed in the school setting.

In many ways, coming to school with a solid base of these foundational EF skills is more important than whether children know their letters and numbers.

- 1. Executive function skills are crucial building blocks for the early development of both cognitive and social capacities.**
- 2. Both normative differences in the nature and pace of individual developmental trajectories and the impacts of significant adversity will affect how the development of EF will unfold in any given child**
- 3. Several interventions focused on supporting the development of specific EF skills have demonstrated at least short-term effectiveness, with evidence also emerging that they may have impacts on other aspects of learning as well.**

Children (even just one or two) who are not controlling impulses, waiting turns, stay focused on work task, and remember instructions will bring chaos to any classroom faster than just about anything else.

This can impact the overall climate of the class and lead to teacher burnout and exasperation.

WHAT ARE EXECUTIVE FUNCTIONS?

WORKING MEMORY is the capacity to hold and manipulate information in our heads over short periods of time. It provides a mental surface on which we can place important information so that it is ready to use in the course of our everyday lives. It enables us to remember a phone number long enough to dial it, to return to our place in a magazine article before a friend interrupted us, and to recall whether we had added the salt to what we were cooking before we had to help our child find a missing shoe. It enables children to remember and connect information from one paragraph to the next, to perform an arithmetic problem with several steps, to keep track of the moves and make a logical next step in a game of checkers, and to follow multiple-step instructions without reminders (“go to your cubbies, put away your storybooks, bring back your arithmetic books, and open them to page 30”). It also helps children with social interactions, such as planning and acting out a skit, taking turns in group activities, or easily rejoining a game after stepping away to get a drink of water.

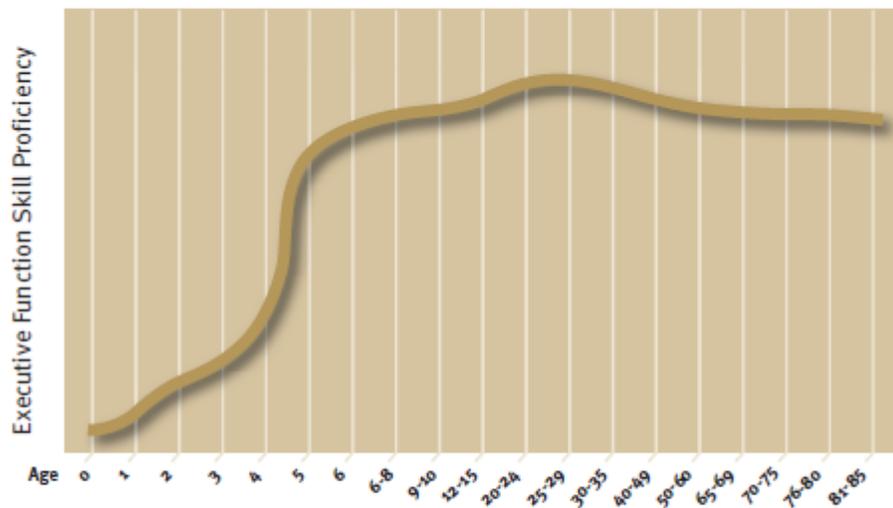
INHIBITORY CONTROL is the skill we use to master and filter our thoughts and impulses so we can resist temptations, distractions, and habits and to pause and think before we act. It makes possible selective, focused, and sustained attention, prioritization, and action. This capacity keeps us from acting as completely impulsive creatures who do whatever comes into our minds. It is the skill we call on to push aside daydreams about what we would rather be doing so we can focus on important tasks. It is the skill we rely on to help us “bite our tongue” and say something nice, and to control our emotions at the same time, even when we are angry, rushed, or frustrated. Children rely on this skill to wait until they are called on when they know the answer, to be good at games like “Simon Says” and “Red Light/Green Light,” to stop themselves from yelling at or hitting a child who has inadvertently bumped into them, and to ignore distractions and stay on task in school.

COGNITIVE OR MENTAL FLEXIBILITY is the capacity to nimbly switch gears and adjust to changed demands, priorities, or perspectives. It is what enables us to apply different rules in different settings. We might say one thing to a co-worker privately, but something quite different in the public context of a staff meeting. If a friend asks if we like her new haircut and we don't, we are able to flexibly shift to the social convention that governs not hurting people's feelings. Likewise, we teach our children about “outside voices” and “inside voices” and the different situations in which they should use each. As the author of *The Executive Brain*, Elkhonon Goldberg, notes, “The ability to stay on track is an asset, but being ‘dead in the track’ is not.”⁴ Stated differently, self-control and persistence are assets, rigidity is not. Cognitive flexibility enables us to catch mistakes and fix them, to revise ways of doing things in light of new information, to consider something from a fresh perspective, and to “think outside the box.” If the “church in two blocks” where we were told to turn right is actually a school, we adjust and turn anyway. If we are missing a recipe ingredient, we call a neighbor or make a substitution. Children deploy this skill to learn exceptions to rules of grammar, to approach a science experiment in different ways until they get it to work, or to try different strategies when they are working out a conflict with another child.

EF is distinct from (yet foundational to) school readiness and academic success.

Children’s EF skills provide the link between early school achievement and social, emotional, and moral development.

Executive Function Skills Build Throughout Childhood and Adolescence



A range of tests measuring different forms of executive function skills indicates that they begin to develop shortly after birth, with ages 3 to 5 providing a window of opportunity for dramatic growth in these skills. Growth continues throughout adolescence and early adulthood; proficiency begins to decline in later life.

Source: Weintraub et al. (In Press).⁴⁰

A young child's environment of relationships plays an important role in the development of executive capacities.

them on their own. Enhancing the development of executive functioning involves sensitive, responsive caregiving and individualized teaching in the context of situations that require making choices, opportunities for children to direct their own activities with decreasing adult supervision over time, effective support of early emotion regulation, promotion of sustained joint attention, and the availability of adults who are not under such pressure that they cannot make time for children to practice their skills.^{34,41,42,43,44,45}

Ordered and predictable environments foster the development of EF skills by offering children ample experiences that involve give-and-take interactions with others.

Adverse environments resulting from neglect, abuse, and/or exposure to violence can impair the development of EF skills as a result of the disruptive effects of toxic stress on the developing architecture of the brain.

Children who experience adversity at an early age are more likely to exhibit deficits in EF, suggesting that these capacities are vulnerable to disruption early in the developmental process.

WHAT RESEARCH TELLS US:

- **The healthy development of EF skills can be supported with specialized practice and training**
- **Focused preschool interventions can also protect and enhance EF**
 - **Programs aimed explicitly at fostering EF skills**
 - **Programs that train and support teachers in effective classroom management strategies supplemented with assistance from Mental Health consultants**
 - **Programs that train teachers to model and coach children as their social-emotional skills are developing (focus on prosocial behaviors, social problem-solving skills, ability to understand and express emotions constructively, and ability to control impulsive behavior and organize themselves to accomplish goals.**
- **Improvements in EF extend to young children's performance on measures of social skills and academic performance.**

MISCONCEPTIONS:

- **Contrary to popular belief, learning to control impulses, pay attention, and retain information actively in one's memory does not happen automatically as children mature, and young children who have problems with these skills will not necessarily outgrow them.**

- By 12 months of age, a child's experiences are helping lay the foundation for the ongoing development of EF skills. Adverse circumstances can disrupt this process.
- Contrary to popular belief, young children who do not stay on task, lose control of their emotions, or are easily distracted are not "BAD KIDS" who are being intentionally uncooperative and belligerent.
- Contrary to the theory that guides some early education programs that focus solely on teaching letters and numbers, explicit efforts to foster EF have positive influences on instilling early literacy and numeracy skills.

THE SCIENCE-POLICY GAP:

Education policies that emphasize literacy instruction alone are missing an important opportunity to increase their effectiveness by including attention to the development of EF skills.

The expulsion of young children from pre-k programs because of unmanageable behavior illustrates the need for greater availability of expertise and resources to improve the EF skills of vulnerable young children.

The lack of services that directly address sources of toxic stress during the earliest years of life indicates a disconnect between policies and the known vulnerability of many aspects of brain development (including EF skills) to the effects of early adversity and the need for preventative policies to reduce such lost opportunities.