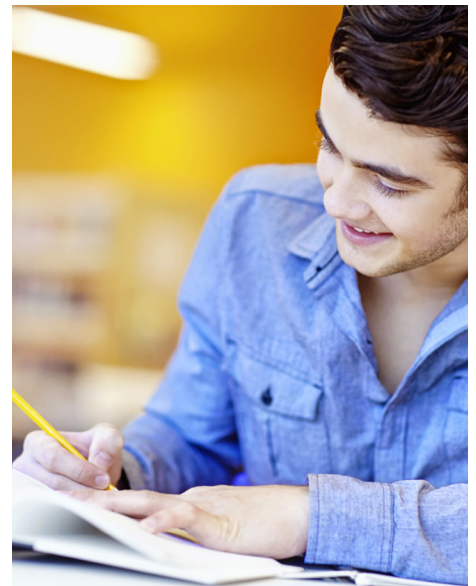


Enhancing and Practicing Executive Function Skills with Children from Infancy to Adolescence



Center on the Developing Child  HARVARD UNIVERSITY

Introduction

Executive function and self-regulation skills provide critical supports for learning and development. Just as an air traffic control system at a busy airport manages the arrivals and departures of many aircraft on multiple runways, executive function skills allow us to retain and work with information in our brains, focus our attention, filter distractions, and switch mental gears. There are three basic dimensions of these skills:

■ **Working memory** — The ability to hold information in mind and use it.

■ **Inhibitory control** — The ability to master thoughts and impulses so as to resist temptations, distractions, and habits, and to pause and think before acting.

■ **Cognitive flexibility** — The capacity to switch gears and adjust to changing demands, priorities, or perspectives.

These skills help us remember the information we need to complete a task, filter distractions, resist inappropriate or non-productive impulses, and sustain attention during a particular activity. We use them to set goals and plan ways to meet them, assess our progress along the way, and adjust the plan if necessary, while managing frustration so we don't act on it.

Although we aren't born with executive function skills, we are born with the potential to develop them. The process is a slow one that begins in infancy, continues into early adulthood, and is shaped by our experiences. Children build their skills through engagement in meaningful social interactions and enjoyable activities that draw on self-regulatory skills at increasingly demanding levels.

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For more resources on executive function from the Center on the Developing Child, please go to: developingchild.harvard.edu

In infancy, interactions with adults help babies focus attention, build working memory, and manage reactions to stimulating experiences. Through creative play, games, and schoolwork, children practice integrating their attention, working memory, and self-control to support planning, flexible problem-solving, and sustained engagement. By high school, students are expected to organize their time (largely) independently, keep track of their assignments, and manage projects to completion.

As children develop these capacities, they need practice reflecting on their experiences, talking about what they are doing and why, monitoring their actions, considering possible next steps, and evaluating the effectiveness of their decisions. Adults play a critical role in supporting, or “scaffolding,” the development of these skills, first by helping children complete challenging tasks, and then by gradually stepping back to let children manage the process independently—and learn from their mistakes—as they are ready and able to do so.

The activities that follow have been identified as age-appropriate ways to strengthen various components of executive function. Although scientific studies have not yet proven the effectiveness of all these suggestions, their presence here reflects the judgment of experts in the field about activities that allow children to practice their executive function skills. Practice leads to improvement. These activities are not the only ones that may help; rather, they represent a sample of the many things children enjoy that can support healthy development.

Finally, please note that when websites and products are referenced in these activity suggestions, it is because they are helpful resources or examples. Their inclusion does not imply endorsement, nor does it imply that they are the only, or necessarily the best, resources.

Executive Function Activities for 6- to 18-month-olds

These activities encourage infants to focus attention, use working memory, and practice basic self-control skills. During this stage of development, infants are actively developing their core executive function and self-regulation (EF/SR) skills. Supportive, responsive interactions with adults are the foundation for the healthy development of these skills. However, particular activities can strengthen key components of EF/SR.

In using these activities, adults should attend to the infant's interests and select activities that are enjoyable, while also allowing the infant to determine how long to play.



Lap games for younger infants

Generations of families have engaged babies in games while holding them in the lap. Different games practice different skills, but all are predictable and include some basic rules that guide adult and child behavior. Repetition helps infants remember and manage their own behavior to fit the game's rules.

■ **Peekaboo** — Hide-and-find games like this exercise working memory, because they challenge the baby to remember who is hiding, and they also practice basic self-control skills as, in some variations, the baby waits for the adult

to reveal him or herself. In other versions, the baby controls the timing of the reveal; this provides important practice regulating the tension around an expected surprise.

■ **Trot, Trot to Boston; This is the Way the Farmer Rides; Pat-a-Cake** — Predictable rhymes that end with a stimulating yet expected surprise are well-loved. Infants exercise working memory as they develop familiarity with the rhyme and practice anticipating a surprise, inhibiting their anticipatory reactions while managing high levels of stimulation.

Hiding games

Hiding games are a great way to challenge working memory.

■ **Hide a toy under a cloth** and encourage the infant to look for it. Once infants can find the toy quickly, hide it, show the child that you have moved it, and encourage the child to find it. Make more moves to increase the challenge. As the child remembers what was there and mentally tracks the move, he or she exercises working memory.

■ **Older infants may enjoy hiding themselves** and listening to you search loudly for them while they track your location mentally.

■ **You can also hide an object** without showing an older infant where it is and then allow the infant to search for it. He or she will practice keeping track of searched locations.

■ **Another challenging version** of these games involves putting a set of cups on a turntable (or “lazy Susan”), hiding an object under a cup, then spinning the turntable. Hiding more than one object can also increase the challenge.

Imitation or copying games

Infants love to copy adults. When they imitate, they have to keep track of your actions, remember them, wait their turn, and then recall what you did. In doing so, they practice attention, working memory, and self-control.

■ **These games have a variety of forms**, from taking turns making simple gestures (e.g., waving) to organizing toys in certain ways and asking children to copy you (e.g., placing toy

animals in a barnyard) or building simple buildings by putting one block on top of another and perhaps knocking them down to rebuild.

■ **As infants' skills improve**, make the patterns they copy more complicated.

■ **Adults can also demonstrate** ways to play with toys, like making a toy horse gallop or rocking a baby doll. This introduces the concept of using toys as symbols for real objects.

Simple role play

Older children in this age range enjoy doing the tasks they see you do.

■ **Take turns with any activity** that interests the child, such as sweeping the floor, picking up toys, dusting, etc. These games introduce the basics of imaginary play and practice working memory, self-control, and selective attention, because the toddler must hold the

activity in mind to complete it while avoiding distractions and inhibiting the impulse to do other things.

■ **Children can remember and play out** more complicated roles as they get older. They will also begin to initiate activities. Providing the necessary materials (e.g., a broom, a toy box, a dustcloth) can help children enjoy and sustain this type of play.

Fingerplays

Songs or chants with simple hand motions are a lot of fun for infants, and develop self-control and working memory as well as language. Infants can learn to copy the movements to a song and, with practice, will remember the sequence. *Eensy Weensy Spider*; *Where is Thumbkin?*; and *Open, Shut Them* are examples, but these fingerplays can be found in many languages and cultures.



Conversations

Simply talking with an infant is a wonderful way to build attention, working memory, and self-control.

■ **With younger infants**, start by following the infant's attention and naming aloud the things holding his or her attention. The infant will likely maintain his or her attention a little longer, practicing actively focusing and sustaining attention.

■ **As infants get older**, pointing out and

talking about interesting objects or events can help them learn to focus their attention on something the adult has identified. As babies learn language, they also develop their memory of what is said, eventually mapping words to objects and actions.

■ **Conversations in any language** besides English are also helpful. It has been found that bilingual children of many ages have better executive function skills than monolingual children, so experience using an additional language is an important skill.

Resources

Songs and games

- www.piercecountylibrary.org/files/library/wigglegsticklesall.pdf
- www.turben.com/media-library/8702756_infanttoddlerplaybook.pdf
- www.zerotothree.org/child-development/grandparents/play-o-12-mths-final.pdf

Executive Function Activities for 18- to 36-month-olds

During this stage of development, children are rapidly expanding their language skills. Language plays an important role in the development of executive function and self-regulation (EF/SR), as it helps children identify their thoughts and actions, reflect on them, and make plans that they hold in mind and use. Language also helps children understand and follow increasingly complex rules—both those that regulate behavior and those that apply to simple games. Additionally, bilingualism is associated with better EF/SR, so parents who are fluent in more than one language should use those languages with their children.



Active games

At this age, toddlers are actively developing many important physical skills, and they love physical challenges. The following activities require toddlers to focus and sustain their attention on a goal, inhibit unnecessary and ineffective actions, and try things in new ways if a first attempt fails. They may not always succeed, but the practice is very important. This is a learning process. Many of these activities will require frequent reminders from adult organizers, and they may not last very long!

- **Provide many materials and opportunities** to try new skills, such as throwing and catching balls, walking a balance beam, running up and down an incline, jumping, etc. Set up simple rules to follow for added working memory and inhibition challenges—for example, take turns running to a “finish line” and back.

- **Older toddlers can enjoy simple imitation games**, such as *Follow the Leader*, or song games like *Punchinella* or *Follow, Follow* (“Follow, follow, follow [child’s name], follow, follow, follow [child’s name]”—all children imitate [child]). These are great tests of working memory as well as attention and inhibition.

- **Games that require active inhibition** can be fun, too, like *freeze dance (musical statues)*, although don’t expect children to “freeze” without a few reminders. Also effective are

song games that require children to start and stop, or slow down and speed up, such as *Jack in the Box*; *Popcorn*; *Ring Around the Rosie*; or *Motorboat, Motorboat*.

- **Song games with many movements** are also fun. Examples include *The Hokey Pokey*; *Teddy Bear*; *I’m a Little Teapot*; or *Head, Shoulders, Knees, and Toes*. These require children to attend to the song’s words and hold them in working memory, using the song to guide their actions.

- **Fingerplays, or songs and rhymes with hand gestures** to match, continue to be popular with children this age, similarly challenging children’s attention, working memory, and inhibitory control.



Conversation and storytelling

As children develop more spoken language skills, they can begin to engage actively in conversation with adults and tell simple stories.

■ **Simply watching and narrating their play** can be a great way to help very young children understand how language can describe their actions. As children get older, questions can be added, such as “What will you do next?” or “I see you want to put the ball inside the jar. Is there another way to do that?” These comments help children pause to reflect on what they are trying to do, how what they have tried has worked, and how to plan their next move.

■ **Telling stories about shared events** can be a great way to reflect on these experiences. The

experience must be held in working memory while the child considers the order in which things happened, why things happened the way they did, and what the experience meant. These stories can also be written or drawn into simple books and revisited.

■ **Talking about feelings** is also important, either by labeling children’s feelings as they are noticed (“It looks like you are really angry right now”) or by telling the story of a time a child became upset. By giving children language to reflect on their feelings, these conversations can support the development of emotional regulation, which is essential for engaging executive function.

Matching/sorting games

Children this age are able to play simple matching and sorting games, which require children to understand the rule that organizes the activity (sorting by shape, color, size, etc.), hold the rule in mind, and follow it.

■ **Ask children to play a sorting game** in which you take turns sorting objects by size, shape, or color.

■ **Engage older toddlers in a silly sorting game**, such as putting small shapes in a big bucket and big shapes in a small bucket.

Children tend to put like with like, so a change is challenging, requiring them to inhibit the expected action and engage their selective attention and working memory.

■ **As they get older, toddlers also start to enjoy simple puzzles**, which require attention to shapes and colors. Adults can ask children to think about what shape or color they need, where they might put a certain piece, or where they might put the piece if it doesn’t fit, thereby exercising the child’s reflection and planning skills.

Imaginary play

Toddlers are beginning to develop the capacity for simple imaginary play. Often, toddlers imitate adult actions using objects that they have available (such as sweeping with a broom or pretending to cook with a pot). When they reach this age, these actions are not simply imitative, but can be sustained and show signs of simple imaginary play plots. For example, after “cooking” in the pot, the child will put the pot on the table and pretend to eat.

■ **Ask children questions** about what they are doing. Narrate the things you see happening.

■ **Play along with the child**, and let the child direct the play. Give the child a chance to tell you what role you should play and how you should do it. Regulating the behavior of others is an important way that children develop their own self-regulation skills.

■ **Provide a variety** of familiar household objects, toys, and clothing items to encourage children’s imaginary play.

Resources

Music

■ fun.familyeducation.com/toddler/music/37371.html

Other activities

■ www.zerotothree.org/child-development/grandparents/play-12-24-final.pdf

■ www.zerotothree.org/child-development/grandparents/play-24-36-final.pdf

Pretend play suggestions

■ www.mindinthemaking.org/wp-content/uploads/2014/10/PFL-playing-with-household-items.pdf

Executive Function Activities for 3- to 5-year-olds

Children's executive function and self-regulation skills grow at a fast pace during this period, so it is important to adapt activities to match the skills of each child. Younger children need a lot of support in learning rules and structures, while older children can be more independent. Ultimately, the goal is to shift children away from relying on adult regulation, so when the child seems ready, try to reduce the support you provide.



Imaginary play

During intentional imaginary play, children develop rules to guide their actions in playing roles. They also hold complex ideas in mind and shape their actions to follow these rules, inhibiting impulses or actions that don't fit the "role." Players often take ideas from their own lives, such as going to the doctor's office. They might act "sick," be examined by the doctor, and receive a shot. The "doctor" talks and acts like a doctor (calm and reassuring), the "sick child" talks and acts like a sick child (sad and scared), and the child in the role of "parent" talks and acts like a concerned parent (worried and caring). While younger children tend to play alone or in parallel, children in this age range are learning to play cooperatively and often regulate each other's behavior—an important step in developing self-regulation.

Ways to support high-level imaginary play:

■ **Read books, go on field trips, and use videos** to make sure that children know enough about the scenario and roles to support pretend play.

■ **Provide a varied set of props and toys** to encourage this type of play. Younger pre-schoolers may need more realistic props to get the play started (e.g., toy medical kits), while

older children can re-purpose other things to turn them into play props (e.g., paper towel tube that is used as a cast for a "broken arm"). Reusing familiar objects in a new way also practices cognitive flexibility.

■ **Allow children to make their own play props.** Children must determine what is needed, hold this information in mind, and then follow through without getting distracted. They also exercise selective attention, working memory, and planning. If the original plans don't work out, children need to adjust their ideas and try again, challenging their cognitive flexibility.

■ **Play plans can be a good way to organize play,** as shown by one early education program designed to build self-regulation, Tools of the Mind. Children decide who they are going to be and what they are going to do before they start playing, and then draw their plan on paper. Planning means that children think first and then act, thus practicing inhibitory control. Planning play in a group also encourages children to plan together, hold these plans in mind, and apply them during the activity. It encourages social problem solving, as well as oral language.

Storytelling

Children love to tell stories. Their early stories tend to be a series of events, each one related to the one before, but lacking any larger structure. With practice, children develop more complex and organized plots. As the complexity of the storytelling grows, children practice holding and manipulating information in working memory.

Ways to support children's storytelling:

■ **Encourage children to tell you stories,** and write them down to read with the child. Children can also make pictures and create their own books. Revisiting the story, either by reviewing pictures or words, supports more intentional organization and greater elaboration.

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■ **Tell group stories.** One child starts the story, and each person in the group adds something to it. Children need to pay attention to each other, reflect on possible plot twists, and tailor their additions to fit the plot, thereby challenging their attention, working memory, and self-control.

■ **Have children act out stories** they have written. The story provides a structure that guides

children's actions and requires them to attend to the story and follow it, while inhibiting their impulse to create a new plot.

■ **Bilingual families can tell stories in their home language.** Research indicates that bilingualism can benefit a variety of executive function skills in children of all ages, so fostering fluency in a second language is valuable.

Movement challenges: songs and games

The demands of songs and movement games support executive function because children have to move to a specific rhythm and synchronize words to actions and the music. All of these tasks contribute to inhibitory control and working memory. It is important that these songs and games become increasingly complex to interest and challenge children as they develop more self-regulation skills.

■ **Provide many opportunities** for children to test themselves physically through access to materials such as climbing structures, balance beams, seesaws, etc. Setting challenges for children—such as obstacle courses and games that encourage complex motions (skipping, balancing, etc.)—can also be fun. When children are trying new and difficult activities, they need to focus attention, monitor and adjust their actions, and persist to achieve a goal.

■ **Encourage attention control through quieter activities** that require children to reduce stimu-

lation and focus attention—such as using a balance beam or yoga poses that include slow breathing.

■ **Play some music** and have children dance really fast, then really slowly. *Freeze dance* is also fun, and it can be made more difficult by asking children to freeze in particular positions. (Tools of the Mind uses stick-figure pictures to direct children.) When the music stops, children must inhibit action and shift their attention to the picture to imitate the shape depicted.

■ **Songs that repeat and add on** to earlier sections (either through words or motions) are a great challenge to working memory, such as the motions to *She'll Be Coming 'Round the Mountain*, the words to *Bought Me a Cat*, and backward-counting songs, such as *Five Green and Speckled Frogs* and songs repeating a long list (the *Alphabet Song*).

■ **Traditional song games**, like *Circle 'Round the Zero* are also fun. Complex actions, including finding partners, must be accomplished without becoming distracted.

Quiet games and other activities

■ **Matching and sorting activities** are still fun, but now children can be asked to sort by different rules, promoting cognitive flexibility. Children can first sort or match by one rule (such as by color), and then immediately switch to a new rule (such as by shape). For a more challenging version, play a matching game, but change the rule for each pair. *Quirkle* and *S'Match* are commercially available games that challenge cognitive flexibility in this way. Or play a bingo or lotto game, in which children have to mark a card with the opposite of what is called out

by the leader (e.g., for “day,” putting a chip on a nighttime picture). Children have to inhibit the tendency to mark the picture that matches, while also remembering the game's rule.

■ **Increasingly complicated puzzles** can engage children this age, exercising their visual working memory and planning skills.

■ **Cooking is also a lot of fun** for young children. They practice inhibition when waiting for instructions, working memory while holding complicated directions in mind, and focused attention when measuring and counting.

Resources

Pretend play suggestions

■ www.mindinthemaking.org/wp-content/uploads/2014/10/PFL-4-year-old-independent-play.pdf

Montessori activities – Walking on the line

■ www.infomontessori.com/practical-life/control-of-movement-walking-on-the-line.htm

Songs

■ kids.niehs.nih.gov/games/songs/childrens/index.htm

Executive Function Activities for 5- to 7-year-olds

Games can exercise children's executive function and self-regulation skills—and allow them to practice these skills—in different ways. At this age, children start to enjoy games that have rules, but do so with widely varying levels of interest and skill. Since an important aspect of developing these skills is having a constant challenge, it's important to choose games that are demanding but not too hard for each child. As the child players become familiar with these games, try to decrease the adult role as soon as possible; the challenge is greater for children if they remember and enforce the rules independently. Just be prepared with some techniques for negotiating conflict. Flipping a coin or drawing a straw are some methods used by Tools of the Mind, an early education program designed to build self-regulation.



Card games and board games

■ **Games that require players to remember** the location of particular cards are great at exercising working memory. At the simplest level, there are games such as *Concentration*, in which children uncover cards and have to remember the location of matches. At a more complicated level are games that require tracking types of playing cards as well as remembering their locations, including *Go Fish*, *Old Maid*, *Happy Families*, and *I Doubt It*.

■ **Games in which the child can match** playing cards, either by suit or number, are also good at practicing cognitive flexibility. Examples include *Crazy Eights*, *Uno*, and *Spoons*. *Blink* and *SET* are newer card games in which cards can be matched on more than two dimensions.

■ **Games that require fast responses** and monitoring are also great for challenging attention and inhibition. *Snap* and *Slapjack* are card games that fall into this category. *Perfection* draws on similar skills.

■ **Any board game that involves some strategy** provides important opportunities to make and hold a plan in mind for several moves ahead, consider the varying rules that govern different pieces, and adjust strategy in response to opponents' moves. Through strategizing, a child's working memory, inhibitory control, and flexibility have to work together to support plan-based, effective play. *Sorry!*, *Battleship*, *Parcheesi*, *mancala*, *checkers*, and *Chinese checkers* are some of the many examples of these types of games for children this age.

Physical activities/games

■ **Games that require attention** and quick responses help children practice attention and inhibition. They include *freeze dance* (musical statues); *musical chairs*; *Red Light, Green Light*; or *Duck, Duck, Goose* for younger children. Some of these games also require the person

who is "It" to mentally track others' movements, challenging working memory as well; these games include *Mother May I?* and *What Time Is It, Mr. Fox?* Others require selective responses and test inhibition, such as the *Magic Word Game*, in which children wait for a "magic word" to start an action.

continued

■ **Fast-moving ball games**, such as *four square*, *dodgeball*, and *tetherball*, require constant monitoring, rule following, quick decision-making, and self-control.

■ ***Simon Says* is another great game** for attention, inhibition, and cognitive flexibility, as the child has to track which rule to apply and switch actions, as appropriate. Other versions are the Australian *Do This, Do That* or the variation, *Do As I Say (Not As I Do)*.

■ **Children are now old enough** to enjoy structured physical activities, such as organized sports. Games that require coordination and provide aerobic exercise, such as soccer, have been shown to support better attention skills. Physical activities that combine mindfulness and movement, such as yoga and Tae Kwon Do, also help children develop their ability to focus attention and control actions.

Movement/song games

■ **Copy games**, in which the person imitating has to hold in mind the model's actions, draw on working memory. *Punchinella* is one example, with the model watching during the second verse ("I can do it, too"). Call-and-response songs provide a similar auditory challenge, like *Boom Chicka Boom* and *I Met a Bear*.

■ **Songs that repeat** and add on to earlier sections (either through words or motions) also challenge working memory, like the motions to *She'll Be Coming 'Round the Mountain*, or the words to *Bought Me a Cat*. The classic memory

games of *Packing for a Picnic* or *Packing a Suitcase for Grandma's* fall in this category, too. Older children can enjoy the added challenge of alphabetizing the list.

■ **Singing in rounds** is a challenge for older children that requires use of working memory and inhibition. *Row, Row, Row Your Boat* is a simple round to start with, but there are many with greater complexity.

■ **Complicated clapping rhythms** also practice working memory, inhibition, and cognitive flexibility, and have been popular with generations of children in many cultures. *Miss Mary Mack* and *Down Down Baby* are familiar examples.

Quiet activities requiring strategy and reflection

■ **Children become increasingly independent** at this age, and puzzle and brain teaser books that include mazes, simple word finds, matching games, etc., exercise attention and problem-solving skills (requiring working memory and cognitive flexibility).

■ **Logic and reasoning games**, in which rules about what is possible need to be applied to solve puzzles, start to become interesting and provide great working memory and cognitive flexibility challenges. ThinkFun, a game and puzzle company, provides some appealing and age-appropriate versions with *Traffic Jam* and *Chocolate Fix*, while *Mastermind* is another

old favorite that now has a simpler version for younger children. Educational online game sites provide many similar activities as well.

■ **Guessing games** are also popular and require players to use working memory and flexible thinking to hold in mind previous responses while they develop and discard potential theories. Some examples are *20 Questions* or *Guess My Rule* (often played with blocks of different colors, sizes, and shapes, so that children try to guess which attribute, or set of attributes, defines the rule for the set).

■ ***I Spy* and the books derived from this game** require children to think about categorization and use selective attention in searching for the correct type of object.

Resources

Online games

- www.coolmath.com
- pbskids.org/lab/games

Game rules

- www.pagat.com
- en.wikipedia.org/wiki/List_of_traditional_children%27s_games

Fun songs

- www.scoutsongs.com

ThinkFun

- www.thinkfun.com

Tools of the Mind

- www.toolsofthemind.org

Helping your child manage social play

- mindinthemaking.org/wp-content/uploads/2015/03/PFL-stubborn-play-schoolage.pdf

Executive Function Activities for 7- to 12-year-olds

These games provide challenges and practice for executive function and self-regulation skills among school-age children. For children in this age range, it is important to steadily increase the complexity of games and activities.

Card games and board games

■ **Card games in which children have to track** playing cards exercise working memory and promote mental flexibility in the service of planning and strategy. *Hearts*, *spades*, and *bridge* are popular examples.

■ **Games that require monitoring and fast responses** are great for challenging attention and quick decision-making in children at this age. *Spit*, for example, requires attending to your own play as well as your opponents' progress.

■ **For younger children, card games requiring matching** by either suit or number continue to test cognitive flexibility. *Rummy* games, including *gin rummy*, are popular examples. Games with more complicated sets of options, such as *poker* and *mahjong*, may challenge older children.

■ **Any game involving strategy** provides important practice with holding complicated moves in mind, planning many moves ahead, and then adjusting plans—both in response to imagined outcomes and the moves of opponents. With practice, children can develop real skill at classic games of strategy like *Go* or *chess*, while challenging working memory and cognitive flexibility. Many more modern strategy games exist as well. Mensa, the high IQ society, holds



a yearly competition testing new games, and provides an interesting list of favorites.

■ **Children this age also enjoy more complex games** involving fantasy play, which require holding in working memory complicated information about places visited in imaginary worlds, rules about how characters and materials can be used, and strategy in attaining self-determined goals. *Minecraft* is a popular computer game of this sort, while *Dungeons & Dragons* is a longtime card-based favorite.

Physical activities/games

■ **Organized sports** become very popular for many children during this period. Developing skill at these games practices children's ability to hold complicated rules and strategies in mind, monitor their own and others' actions, make quick decisions and respond flexibly to play. There is also evidence that high levels of physical activity, particularly activity that requires coordination, like soccer, can improve all aspects of executive function.

■ **Various jump rope games** also become popular among children of this age. Children can become very skilled at *jump rope*, *double Dutch*, *Chinese jump rope*, and other such challenges. Developing skill in these games requires focused practice, as well as the attention control and working memory to recall the words of the chant while attending to the motions.

■ **Games that require constant monitoring** of the environment and fast reaction times also challenge selective attention, monitoring, and

continued

inhibition. For younger children, hiding/tag games, particularly those played in the dark, like *flashlight tag* and *Ghost in the Graveyard*, are fun. Older children may enjoy games like *laser tag* and *paintball*. Many video games also provide practice of these skills, but can include

violent content, so care should be taken in selecting appropriate options and setting reasonable time limits. Common Sense Media, a non-partisan media information organization, provides useful reviews of popular games.

Music, singing, and dance

■ **Learning to play a musical instrument** can test selective attention and self-monitoring. In addition to the physical skill required, this activity challenges working memory to hold the music in mind. There is also some evidence that the practice of two-handed coordination supports better executive function.

■ **Whether or not children learn an instrument, participating in music classes** or community events can still require them to follow rhythmic patterns, particularly when improvisation is involved (e.g., clapping or drumming). This can challenge their coordination of working memory, attention, cognitive flexibility, and inhibition.

■ **Singing in parts and rounds**, as is done in children's singing groups, is also a fun challenge, requiring a similar coordination of working memory, monitoring, and selective attention. As children's musical skills grow,



adults can present them with steadily increasing challenges.

■ **Dancing**, too, provides many opportunities to develop attention, self-monitoring, and working memory, as dancers must hold choreography in mind while coordinating their movements with the music.

Brain teasers

Puzzles that require information to be held and manipulated in working memory can be terrific challenges.

■ **Crossword puzzles** are available for all skill levels and draw on manipulation of letters and words in working memory as well as cognitive flexibility.

■ **Sudoku** provides a similar challenge but

works with numbers and equations rather than letters and words.

■ **Classic spatial puzzles** like *Rubik's Cube* require children to be mentally flexible and consider spatial information in devising potential solutions.

■ **Cogmed and Lumosity** provide computer game puzzles and challenges that are designed to exercise working memory and attention.

Resources

Common Sense Media

- www.common sense media.org
- www.common sense media.org/game-reviews

List of winning games from American Mensa's Mind Games competitions

- mind games.us.mensa.org/about/winning-games/

Other programs

- www.cogmed.com
- www.lumosity.com

Tips for using video games

- www.mindinthemaking.org/wp-content/uploads/2014/10/PFL-learning-and-videogames.pdf

Executive Function Activities for Adolescents

During adolescence, executive function skills are not yet at adult levels, but the demands placed on these skills often are. Teenagers need to communicate effectively in multiple contexts, manage their own school and extracurricular assignments, and successfully complete more abstract and complicated projects. Here are some suggestions for helping teens practice better self-regulation throughout the daily challenges they face.

Goal setting, planning and monitoring

Self-regulation is necessary in any goal-directed activity. Identifying goals, planning, monitoring progress, and adjusting behavior are important skills to practice.

■ **To focus the planning process**, encourage teens to identify something specific that they want to accomplish. Most important is that the goals are meaningful to the teen and not established by others. For some teens, planning the college application process may be self-motivating, but for others, planning a social event may be more important. Start with something fairly simple and achievable, such as getting a driver's license or saving money to buy a computer, before moving on to longer-term goals like buying a car or applying to colleges.

■ **Help teens develop plans** for steps to reach these goals. They should identify short- and long-term goals and think about what has to be done to achieve them. For example: If teens want their team to win the sports championship, what skills do they need to learn? How might they practice them? Identify some problems that might arise, and encourage the teen to plan ahead for them.



■ **Taking on large social issues**, such as homelessness, domestic violence, or bullying can be both appealing and overwhelming to teens. *DoSomething.org* and *Volunteer-Match.org* can help identify concrete actions.

■ **Remind adolescents to periodically monitor their behavior** and consider whether they are doing the things they planned and whether these plans are achieving the goals they identified. “Is this part of the plan? If not, why am I doing it? Has something changed?” Monitoring in this way can identify counter-productive habitual and impulsive actions and maintain focused attention and conscious control.

Tools for self-monitoring

■ **Self-talk is a powerful way** to bring thoughts and actions into consciousness. Examples include having teenagers talk themselves through the steps of a difficult activity or periodically pausing for a mental play-by-play narrative of what is happening. When occasions

arise that provoke strong negative emotions or feelings of failure, self-talk can help adolescents identify potentially problematic thinking and behavior patterns.

■ **Encourage self-talk that focuses on growth.** Help teens recognize that an experience—particularly a failure—can offer lessons, and need

continued

not be interpreted as a final judgment on one's abilities. For example, when a sports team loses a game, help a discouraged team member to consider what went wrong and what he or she might do to improve next time—rather than simply deciding the team lacks any skills. The same thinking can be helpful for school assignments. Carol S. Dweck, a professor at Stanford University who researches mindsets, has developed a website with more suggestions.

■ **Help adolescents be mindful of interruptions** (particularly from electronic communication such as email and cell phones). Multitasking may feel good, but there is strong evidence that it saps attention and impedes performance. If two (or more) tasks are competing for attention, discuss ways to prioritize and sequence.

■ **Understanding the motivations of others** can be challenging, particularly when people are driven by different perspectives. Encourage teens to identify their hypotheses about others' motivations and then consider alternatives. "Why do you think she bumped into you? Can you think of another explanation?" Teens who are not used to this kind of thinking may need you to model the process: "Could it be that she didn't see you?"

■ **Writing a personal journal** can foster self-reflection by providing teens a means with which to explore thoughts, feelings, actions, beliefs, and decisions. There are many ways to approach journaling, but all encourage self-awareness, reflection, and planning (see websites at end of this section).

Activities

There are many activities that teens may enjoy that draw on a range of self-regulation skills. The key is a focus on continual improvement and increasing challenge. Some examples follow, below:

■ **Sports** — The focused attention and skill development inherent in competitive sports draw on the ability to monitor one's own and others' actions, make quick decisions, and respond flexibly to play. Ongoing, challenging aerobic activity can also improve executive function.

■ **Yoga and meditation** — Activities that support a state of mindfulness, or a nonjudgmental awareness of moment-to-moment experiences, may help teens develop sustained attention, reduce stress, and promote less reactive, more reflective decision-making and behavior.

■ **Music** — Working memory, selective attention, cognitive flexibility, and inhibition are challenged while developing skills in playing a musical instrument, singing, or dancing—particularly when dealing with complicated pieces that involve multiple parts, sophisticated rhythms, and improvisation.

■ **Theater** — A performance is carefully choreographed and requires all participants, on stage and backstage, to remember their jobs, attend to their timing, and manage their behavior. For actors, learning the lines and actions of a role draw heavily on attention and working memory.

■ **Strategy games and logic puzzles** — Classic games like *chess*, as well as computer-based training programs like *Cogmed* and *Lumosity*, exercise aspects of working memory, planning,



and attention. Mensa, the high IQ society, holds a yearly competition testing new games and has an interesting list of strategy games.

■ **Computer games** can also be valuable, as long as time limits are established and observed. Games that require constant monitoring of the environment and fast reaction times challenge selective attention, monitoring, and inhibition. Moving through complicated imaginary worlds, such as those found in many computer games, also challenges working memory. Common Sense Media, a non-partisan media information source, provides some good reviews of popular games.

Study skills

In school, adolescents are expected to be increasingly independent and organized in their work. These expectations can place a large load on all aspects of executive function. Basic organization skills can be very helpful in this regard. The list below can serve as a guide for teens to use.

■ **Break a project down** into manageable pieces.

■ **Identify reasonable plans** (with timelines) for completing each piece. Be sure that all steps have been explicitly identified and ensure that the completion of each step is recognized and celebrated.

■ **Self-monitor while working.** Set a timer to go off periodically as a reminder to check on whether one is paying attention and understanding. When you don't understand, what might be the problem? Are there words you don't know? Do you know what the directions are? Is there someone you can ask for help? Would looking back at your notes help? If you have stopped paying attention, what distracted you? What might you do to refocus? Identify key

times to self-monitor (e.g., before handing in an assignment, when leaving the house, etc.).

■ **Be aware of critical times for focused attention.** Multitasking impedes learning. Identify ways to reduce distractions (e.g., turn off electronics, find a quiet room).

■ **Use memory supports for organizing tasks.** Mnemonic devices can be powerful tools for remembering information. Developing the habit of writing things down also helps.

■ **Keep a calendar** of project deadlines and steps along the way.

■ **After completing an assignment,** reflect on what did and did not work well. Develop a list of things that have supported focused and sustained attention as well as good organization, memory and project completion. Think about ways to ensure that these supports are in place for other projects.

■ **Think about what was learned** from assignments that were not completed well. Was this due to a lack of information, a need to improve certain skills, bad time management, etc.? What would you do differently next time?

Resources

Journaling with teens – some supports

- extension.missouri.edu/p/GH6150
- www.cedu.niu.edu/~shumow/iit/doc/journal-writing.pdf

Carol S. Dweck's work on mindsets

- mindsetonline.com/changeyourmindset/firststeps/index.html

Common Sense Media

- www.common sense media.org
- www.common sense media.org/game-reviews

List of winning games from American Mensa's Mind Games competitions

- mindgames.us.mensa.org/about/winning-games/

Other programs

- www.cogmed.com
- www.lumosity.com

Stress management suggestions

- www.mindinthemaking.org/wp-content/uploads/2014/10/PFL-school-age-stress-management.pdf

References

- Barenberg, J., Berse, T., & Dutke, S. (2011). Executive functions in learning processes: Do they benefit from physical activity? *Educational Research Review*, 6(3), 208–222.
- Bavelier, D., & Davidson, R.J. (2013). Brain training: Games to do you good. *Nature*, 494(7438), 425–426.
- Best, J.R., & Miller, P.H. (2010). A developmental perspective on executive function. *Child Development*, 81(6), 1641–1660.
- Bialystok, E. (1999). Cognitive complexity and attentional control in the bilingual mind. *Child Development*, 70(3), 636–644.
- Bierman, K.L., Nix, R.L., Greenberg, M.T., Blair, C., & Domitrovich, C.E. (2008). Executive functions and school readiness intervention: Impact, moderation, and mediation in the Head Start REDI program. *Development and Psychopathology*, 20(3), 821–843.
- Blakemore, S.-J., & Choudhury, S. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry*, 47(3–4), 296–312.
- Bodrova, E., & Leong, D.J. (2007). *Tools of the Mind: The Vygotskian Approach to Early Childhood Education* (2nd Ed.). Upper Saddle River, NJ: Pearson.
- Bradshaw, C.P., Goldweber, A., Fishbein, D., & Greenberg, M.T. (2012). Infusing developmental neuroscience into school-based preventive interventions: Implications and future directions. *Journal of Adolescent Health*, 51(2 Suppl.), S41–47.
- Bunge, S.A., & Wright, S.B. (2007). Neurodevelopmental changes in working memory and cognitive control. *Current Opinion in Neurobiology*, 17(2), 243–250.
- Burke, C.A. (2010). Mindfulness-based approaches with children and adolescents: A preliminary review of current research in an emergent field. *Journal of Child and Family Studies*, 19(2), 133–144.
- Carlson, S.M., & Meltzoff, A.N. (2008). Bilingual experience and executive functioning in young children. *Developmental Science*, 11(2), 282–298.
- Casey, B.J., Getz, S., & Galvan, A. (2008). The adolescent brain. *Developmental Review*, 28(1), 62–77.
- Center on the Developing Child at Harvard University. (2011). *Building the Brain's "Air Traffic Control" System: How Early Experiences Shape the Development of Executive Function: Working Paper No. 11*. Retrieved from <http://developingchild.harvard.edu>.
- Chang, Y.-K., Tsai, Y.-J., Chen, T.-T., & Hung, T.-M. (2013). The impacts of coordinative exercise on executive function in kindergarten children: An ERP study. *Experimental Brain Research*, 225(2), 187–196.
- Cohen-Gilbert, J.E., & Thomas, K.M. (2013). Inhibitory control during emotional distraction across adolescence and early adulthood. *Child Development*, 84(6), 1954–1966.
- Crone, E.A. (2009). Executive functions in adolescence: Inferences from brain and behavior. *Developmental Science*, 12(6), 825–830.
- Davis, C.L., Tomporowski, P.D., McDowell, J.E., Austin, B.P., Miller, P.H., Yanasak, N.E., Allison, J.D., & Naglieri, J.A. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: A randomized, controlled trial. *Health Psychology*, 30(1), 91–98.
- Dawson, P., & Duare, R. (2010). *Executive Skills in Children and Adolescents: A Practical Guide to Assessment and Intervention* (2nd Ed.). New York: The Guilford Press.
- Diamond, A., Barnett, W.S., Thomas, J., & Munro, S. (2007). Preschool program improves cognitive control. *Science*, 318(5855), 1387–1388.
- Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, 333(6045), 959–964.
- Farrington, C.A., Roderick, M., Allensworth, E., Nagao, J., Keyes, T.S., Johnson, D.W., & Beechum, N.O. (2012). *Teaching Adolescents to Become Learners: The Role of Noncognitive Factors in Shaping School Performance: A Critical Literature Review*. Chicago: University of Chicago Consortium on Chicago School Research.
- Galinsky, E. (2010). *Mind in the Making: The Seven Essential Life Skills Every Child Needs*. New York: HarperStudio.
- Garon, N., Bryson, S.E., & Smith, I.M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, 134(1), 31–60.
- Green, C.S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, 423(6939), 534–537.
- Green, C.S., & Bavelier, D. (2006). Effect of action video games on the spatial distribution of visuospatial attention. *Journal of Experimental Psychology: Human Perception and Performance*, 32(6), 1465–1478.
- Greenberg, M.T., & Harris, A.R. (2012). Nurturing mindfulness in children and youth: Current state of research. *Child Development Perspectives*, 6(2), 161–166.
- Hughes, C. (2011). Changes and challenges in 20 years of research into the development of executive functions. *Infant and Child Development*, 20(3), 251–271.
- Johnson, J., & Reid, R. (2011). Overcoming executive function deficits with students with ADHD. *Theory Into Practice*, 50(1), 61–67.
- Kray, J., & Ferdinand, N.K. (2013). How to improve cognitive control in development during childhood: Potentials and limits of cognitive interventions. *Child Development Perspectives*, 7(2), 121–125.
- Mackey, A.P., Hill, S.S., Stone, S.I., & Bunge, S.A. (2011). Differential effects of reasoning and speed training in children. *Developmental Science*, 14(3), 582–590.

Marcovitch, S., Jacques, S., Boseovski, J.J., & Zelazo, P.D. (2008). Self-reflection and the cognitive control of behavior: Implications for learning. *Mind, Brain, and Education*, 2(3), 136–141.

Meltzer, L. (Ed.). (2007). *Executive Function in Education: From Theory to Practice*. New York: The Guilford Press.

National Scientific Council on the Developing Child. (2004). *Young Children Develop in an Environment of Relationships: Working Paper No. 1*. Retrieved from <http://developingchild.harvard.edu>.

Ophir, E., Nass, C., & Wagner, A.D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences of the United States of America*, 106(37), 15583–15587.

Prencipe, A., & Zelazo, P. D. (2005). Development of affective decision making for self and other: Evidence for the integration of first- and third-person perspectives. *Psychological Science*, 16(7), 501–506.

Richtel, M. (2010, June 7). Attached to technology and paying a price. *The New York Times*. Retrieved from <http://www.nytimes.com/2010/06/07/technology/07brain.html?pagewanted=1>.

Rosen, C. (2008). The Myth of Multitasking. *The New Atlantis*, Spring, 105–110.

Schunk, D.H., & Zimmerman, B.J. (Eds.). (2008). *Motivation and Self-Regulated Learning: Theory, Research, and Applications*. New York: Lawrence Erlbaum Associates.

Staiano, A.E., Abraham, A.A., & Calvert, S.L. (2012). Competitive versus cooperative exergame play for African American adolescents' executive function skills: Short-term effects in a long-term training intervention. *Developmental Psychology*, 48(2), 337–342.

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Sciences*, 9(2), 69–74.

Steinberg, L. (2007). Risk taking in adolescence: New perspectives from brain and behavioral science. *Current Directions in Psychological Science*, 16(2), 55–59.

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review*, 28(1), 78–106.

Steinberg, L. (2010). A behavioral scientist looks at the science of adolescent brain development. *Brain and Cognition*, 72(1), 160–164.

Tang, Y.-Y., Yang, L., Leve, L.D., & Harold, G.T. (2012). Improving executive function and its neurobiological mechanisms through a mindfulness-based intervention: Advances within the field of developmental neuroscience. *Child Development Perspectives*, 6(4), 361–366.

Taylor, S.J., Barker, L.A., Heavey, L., & McHale, S. (2013). The typical developmental trajectory of social and executive functions in late adolescence and early adulthood. *Developmental Psychology*, 49(7), 1253–1265.

Ursache, A., Blair, C., & Raver, C.C. (2012). The promotion of self-regulation as a means of enhancing school readiness and early achievement in children at risk for school failure. *Child Development Perspectives*, 6(2), 122–128.

Winsler, A., Ducenne, L., & Koury, A. (2011). Singing one's way to self-regulation: The role of early music and movement curricula and private speech. *Early Education and Development*, 22(2), 274–304.

Yurgelun-Todd, D. (2007). Emotional and cognitive changes during adolescence. *Current Opinion in Neurobiology*, 17(2), 251–257.

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