

Executive Functions

What are executive functions?

The term “Executive Functions” refers to the higher-level cognitive skills you use to control and coordinate your other cognitive abilities and behaviors. The term is a business metaphor, where the chief executive monitors all of the different departments so that the company can move forward as efficiently and effectively as possible. Who we are, how we organize our lives, how we plan and how we then execute those plans is largely guided by our executive system.

Types of executive functions

Executive functions can be divided into organizational and regulatory abilities. Organization includes gathering information and structuring it for evaluation. Regulation involves evaluating the available information and modulating your responses to the environment. Seeing a wonderful dessert in front of you may be tempting to devour, but your executive system might remind you that eating it would conflict with your inner goals, such as losing weight. That long range thinking and reasoning is typical of the executive system. One type of executive function is called prospective memory, the ability to project into the future and solve problems that are likely to arise.

- **Organization:** attention, planning, sequencing, problem solving, working memory, cognitive flexibility, abstract thinking, rule acquisition, selecting relevant sensory information
- **Regulation:** initiation of action, self-control, emotional regulation, monitoring internal and external stimuli, initiating and inhibiting context-specific behavior, moral reasoning, decision-making

Impaired executive functions

Because these skills integrate information at higher level across cognitive domains, damage to the executive system typically involves a cluster of deficiencies, not just one ability. The loss of that "administrative" control affects the ability to organize and regulate multiple types of information and, therefore, behaviors.

Damage to the executive system, often leads to:

- Socially inappropriate behavior
- Inability to apply consequences from past actions
- Difficulty with abstract concepts (the inability to make the leap from the symbolic to the real world)
- Difficulty in planning and initiation (getting started)
- Difficulty with verbal fluency
- Inability to multitask
- Difficulty processing, storing, and/or retrieving information
- Frequent “policing” by others to monitor the appropriateness of their actions
- Loss of fine motor skills like grabbing something with your thumb and forefinger more than gross motor skills like running and jumping
- Moody or “roller coaster” emotions
- Lack of concern toward people and animals
- Loss of interest in activities
- Unawareness or denial that their behavior is a problem
- Antisocial behavior associated with disinhibition
- Trouble planning for the future

In addition to frontotemporal dementia, executive function deficits are associated with a number of psychiatric and developmental disorders, including obsessive-compulsive disorder, Tourette's syndrome, depression, schizophrenia, attention-deficit/hyperactivity disorder, autism and addiction.

Executive functions are difficult to assess directly since they coordinate other cognitive skills. Damage to memory, language, visuospatial skills and other cognitive functions can impact how a person performs on tests of executive function. Executive skills are also grounded in real world

experience, which makes laboratory tests more difficult to create. The instruments used to assess executive behavior require mental agility, foresight, planning and freedom from distraction. Widely used tests include the Word Fluency Task, Stroop Test, Wisconsin Card Sorting Test, Trailmaking Test and Porteus Mazes.

The anatomy of executive functions

Executive deficits have been associated with damage to the most forward areas of the frontal lobes (located just above your eyes), as well as the cortical and subcortical structures that connect to the frontal lobes. The executive system involves the prefrontal cortex, basal ganglia and thalamus.

The frontal lobes are the last areas of the brain to fully develop. This area of the brain was evolutionarily late to appear and is much larger in human beings than in our closest non-human primate relatives. The frontal lobes typically account for about 40% of the human brain.

Impact of FTD

Behavioral variant frontotemporal Dementia (bvFTD)

Progressive shrinking of the tissue in the frontal and anterior temporal lobes of the brain defines bvFTD. The changes most commonly associated with bvFTD are a loss of social skills, loss of concern for the emotions of others, disinhibition and antisocial behaviors, poor moral reasoning, lack of initiation, inappropriate humor, trouble making plans and moderating food intake. Sometimes patients with bvFTD also develop addictive behaviors late in life or show diminished response to pain.

Semantic Dementia (SD)

SD results from progressive damage to parts of the anterior temporal lobes (the lobes of the brain near your ears). Though more commonly thought of as a language disorder, people with SD often show changes in executive function including inappropriate staring, loss of concern for the emotions of others, poor moral reasoning, lack of initiation, inappropriate humor, trouble making plans and moderating their diet.

Progressive Nonfluent Aphasia (PNFA)

Executive function changes are less common or less severe in progressive nonfluent aphasia (PNFA).