Executive Functions: A General Overview

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The term Executive Functions refers to a diverse group of cognitive processes that act in a coordinated way to direct perception, emotion, thought and action. While the mainstream literature refers to executive functions as the "CEO" of the brain, studies of brain functioning suggest that executive functions are not a unitary trait, but a set of multiple cognitive capacities that act in a coordinated way. Executive functions are responsible for a person's ability to engage in purposeful, organized, strategic, self-regulated, goal-directed behavior. As a collection of directive processes, Executive Functions cue the use of other cognitive capacities including reasoning, language, visual and spatial, and memory capacities. Executive Functions are involved with, but are not necessarily limited to, cueing and directing of all of the following:

- Inhibiting reflexive, impulsive responding;
- Stopping, or interrupting, and returning to, an ongoing activity;
- Directing and focusing attentional processes, screening out interference and distractions, and sustaining attention
- Cueing the initiation of effort and judgments about the amount of effort required to complete a task, and the sustaining of a sufficient amount of effort to effectively complete the task
- Demonstrating flexibility to consider the need for changes and the capacity for shifting of cognitive resources to focus on new demands or to respond to new conditions or new information
- Directing the efficient use of, and alternation between, pattern and detail processing (Knowing when to focus on the "big picture" and when to concentrate on the details, and when to switch between the two).
- Monitoring and regulating speed of information processing; finding the right combination of speed and accuracy for optimal performance of an activity
- Monitoring and correcting task performance for accuracy and efficiency
- Overseeing the selection of verbal-nonverbal and abstract-concrete information processing mechanisms
- Directing motor output, altering performance based on feedback
- Directing the efficient use of fluid reasoning resources
- Directing the use of working memory resources – that is, directing the ability to hold and mentally manipulate information
- Directing the efficient and fluent production of language when highly specific production demands are made
- Directing the integration of multiple abilities to produce oral or written responses or products that reflect the level of capacity of the component abilities involved
- Directing the efficient placement of information in long-term storage
- Directing the retrieval of information from long-term storage
- Regulating social behavior
- Regulating emotional control
- Enabling self-observation and self-analysis
- Making use of hindsight and foresight in the direction of current processing
- Enabling the capacity to "take the perspective of the other" in order to infer how someone

is perceiving, thinking, or feeling at a given point in time

In this frame of reference, executive functions are only directive processes; they give commands to engage. Executive functions are not the mental processes we use to perceive, feel, think and act, but rather are the processes that direct or cue the engagement and use of the mental processes that we use to perceive, feel, think and act. Because these processes are distinct from cognitive abilities, but interact with them in a way that results in efficient and effective performance and production, difficulties with executive functioning may explain why many bright children—with strong cognitive capacities—may fail to consistently demonstrate their knowledge or have difficulty following rules for behavior or regulating their emotions, even though they may be able to explain the rules or expectations for appropriate behaviors and emotional responses. It is helpful to think of executive functions as a set of independent but coordinated processes rather than a single trait. There is no guarantee that if one executive capacity is well-developed, all of them will be well-developed. Any person can have strengths and/or weaknesses in any one or more of the different executive functions at any given point in time. Assessment requires a multidimensional approach to identify the specific constellation of executive function strengths and weaknesses for any given child or adult.

A comprehensive model of executive functions involves multiple levels of executive cueing of perceiving, feeling, thinking, and acting. At the lowest level, cues are provided for Self-activation, that is, giving the command to wake up and engage a state of consciousness. Once awake, a person's Self-Regulation executive functions are involved in basic self-control of our perceptions, emotions, thoughts, and behaviors. While there is not yet consensus relative to the specific number of self-regulation executive functions, we propose 31 distinct self-regulation capacities: perceive, energize, initiate, focus/select, modulate, inhibit, gauge, sustain, interrupt/stop, shift, flexible, anticipate, plan, organize, generate, associate, analyze, compare/evaluate, choose/decide, balance, hold, manipulate, store, retrieve, pace, sense time, estimate time, sequence, execute, monitor, and correct.

Additional levels of executive control involve Self-Realization and Self-Determination. These executive functions direct a person's engagement with activities related to gaining an understanding of personal strengths and weaknesses and how a person's behavior affects others, and developing a personal set of goals and long-term plans that motivate and drive behavior. Beyond these levels of self-control, an individual can engage in directive processes that attempt to engage the self in an active exploration of self-generation questions (Why do I do the things I do? What really motivates my choice of self-goals? What is the meaning of life?), and possibly a transcending of the self to explore realms beyond self-generation to contemplation of the meaning of all existence and an ultimate source of consciousness (Trans-self Integration).

Most clinical work in school settings with children focuses on dealing with Self Regulation aspects of executive control. As children enter adolescence, Self Regulation issues remain an important focus, but Self Determination and Self Realization issues begin to play a more prominent role in development. Self Generation and Trans-self Integration issues, if they emerge at all, tend to be addressed later in adulthood.

Domains of Functioning

It is important to realize that executive control can vary greatly depending on the domain of functioning that is being cued and directed by executive functions. A person can have strengths or weaknesses in regulation of any one or more of the four domains of ***perception, emotion, thought,*** or ***action***. For example, a person can have effective control of perceptions, emotions, and thoughts, but not be able to effectively use one of more executive functions in attempts to cue and direct actions. Another person might find it difficult to control emotions as

well as actions but have little or no difficulty regulating perception and thoughts. The effectiveness of executive functions also can vary greatly within each of these four domains. For example, a person might have well-developed direction of gross motor capacities when playing sports but not fine motor capacities when holding a pencil and attempting to print letters and words. In the domain of thought, a person might be much better at cueing the use of reasoning with language than cueing the use of reasoning with nonverbal visual materials. In the domain of emotion, a person might have much greater control over the expression of joy or disgust than the expression of anger or sadness.

Arenas of Involvement for Executive Functions

In addition to the domains of functioning, executive function capacities can vary in effectiveness depending on the context in which they are being used. We call these varied contexts Arenas of Involvement and propose four distinct arenas within which the use of executive function capacities can vary greatly:

- ***Intrapersonal Arena*** – this is the arena where self-awareness and self-control directive processes are turned inward; these enable the ability to control one's own perceptions, emotions, thoughts and actions in relation to the self; i.e., self-discipline; they are involved in avoiding addictions and other self-destructive habits and behavior patterns, setting and maintaining personal goals and regulating purposeful behavior.
- ***Interpersonal Arena*** – this is the arena in which executive functions govern perception, emotion, cognition, and action in social interactions; where self-awareness and self-control directive processes are turned outward towards other human beings; they are involved in controlling one's actions in relation to others, in taking the perspective of others, in generating a theory of mind that enables a person to understand, infer, and predict the motivations, needs, and desires of others, and in weighing the benefits of cooperative behavior over self-serving behavior.
- ***Environment Arena*** – this is the arena in which executive functions direct and monitor perception, emotion, thought, and actions in relation to both the naturally-occurring and the man-made physical world; these processes direct perception, emotion, cognition, and action in relation to the environment and engagement of the environment, including behavior toward other animals and living organisms and inanimate materials; interactions with machines and other man-made devices; this arena includes directing perceptions, emotions, thoughts and actions to avoid "accidents" by anticipating the impact and consequences of one's own actions towards, and in, the physical environment.
- ***Symbol System Arena*** – this is the arena in which executive functions direct and monitor interactions with/manipulations of human-made symbol systems (reading, writing, mathematics, computer use); directing perception, emotion, cognition and action involving culturally derived symbol systems; mediating learning and producing through interaction with information media such as words, numbers, figures, diagrams, schematics, programming codes and other "languages." Executive function direction in this arena can be highly specific as in other arenas. For example, it is possible to experience executive function difficulties with directing written expression but not with directing reading for comprehension.

Executive functions difficulties for a given person may be evident in any or all of the arenas. It is possible to have executive functions problems in only one of the arenas and be able to direct perception, cognition, emotion, and motor functions very effectively in the other arenas. More often, however, persons with executive function difficulties demonstrate problems in two

or more of the arenas. Control of domains of function can vary within Arenas of Involvement; a person might have difficulties with specific executive functions in directing emotions in the intrapersonal arena (difficulties in directing how they feel about themselves), but not in the interpersonal arena (no difficulties in directing feelings about others).

Development of Executive Functions

Self-regulation executive functions are developing from the first years of life on throughout a person's entire lifetime. Large developmental shifts are noticeable, especially around adolescence. Because Executive Functions are developmental in nature, natural maturational delays and lags can be observed. Intra-individually, all executive functions do not develop evenly. For any given individual, one executive function can be more or less developed than any other executive function at any given point in time. Inter-individually, there is also great variation relative to chronological age. At the same age, different individuals will naturally vary considerably in their level of development of various executive functions. Cultural change points (e.g., educational transitions to Preschool, Kindergarten, 1st grade, junior high school, senior high school, college, graduate school, and workplace entry) can serve to highlight executive function developmental delays or significant deficiencies because, as the environment requires greater use execution functions, individuals may not have developed yet those requisite levels of executive functions control that are being demanded. Executive Function-based clinical syndromes, such as ADHD, demonstrate clear patterns of delayed developmental progression. Some researchers estimate developmental delays accompanying ADHD of about 30% associated with various Executive Functions such as the capacity to cue inhibition of impulsive reaction, modulating reactions, and focusing and sustaining attention.

Executive Functions and School

Although executive functions are used to guide cognitive processing involved in new learning, many new learning situations are structured in ways that reduce the need for strong executive function involvement. In contrast to the learning situation, demonstrating what has been learned usually requires significant involvement of executive functions to cue and direct production. Because executive control is heavily involved in demonstrating learning, executive functions difficulties usually manifest as "Producing Disabilities" much more so than "Learning Disabilities."

Internal Command versus External Demand

An important aspect of executive function engagement that is critical for understanding variations in everyday use of these capacities relates to the locus of intentionality for executive function involvement. The need for engagement of executive functions can stem from a person's own internal desires, drives, aspirations, plans, and proclivities, namely by *internal command*. On the other hand, if summoned by sources outside of the person, executive functions can be engaged through *external demand*. Executive functions use that arises from internal command utilizes specific neural networks routed through portions of the frontal lobes as well as other specific areas of the brain. These networks are distinct from, but not necessarily independent of, the neural networks of the frontal lobes and additional areas of the brain that must be activated when a person attempts to engage executive control in response to an external demand. Executive functions engagement by internal command is generally much easier to achieve because it flows naturally from the persons' own prevailing internal states. Engagement of executive functions in situations of external demand, however, requires much more mental effort and much greater capacity for self-control.

Many parents and teachers of children who demonstrate executive functions difficulties are often baffled by the seeming paradox of the child who functions so effectively when engrossed in activities of their own choosing, yet who seems woefully inept when requested to perform the simplest of household chores or classroom assignments. Parents and teachers who view these disparities often cannot help but think that the child's "sudden" incapacities are a matter of conscious choice – a convenient sham to avoid the hard work and effort that is being required of them. In actuality, most of these observed inadequacies are not a matter of conscious choice, but instead are the result of undeveloped, underutilized, or ineffectively engaged executive functions.

Executive Functions are not synonymous with traditional conceptions of intelligence

The extent to which executive functions can be considered as "synonymous" with intelligence depends on the definition of intelligence that is being offered. Extremely broad definitions of intelligence include executive functions along with just about everything else that constitutes efficient thought and action. Narrower definitions of intelligence often allude to the concept of executive functions, but subsume it under the heading of problem-solving. In fact, most of the research in cognitive psychology that deals with executive control processes refers to these mental functions under the heading of problem-solving and reasoning. Regardless of the definition of intelligence (with the exception of the concept of emotional intelligence), the role of executive functions in cueing and directing emotional processes is often overlooked.

Unlike theoretical definitions of intelligence, however, operational definitions of intelligence that are used to develop assessments of the psychological construct of intelligence usually do not include the use of executive functions as a distinct content domain and do not attempt to assess the role of executive functions per se as a part of test performance even though executive functions are often involved in many ways in the performance of the tasks that are used to assess intelligence. The manner in which most tests are constructed (explicit directions, teaching items, examiner cueing of attention and performance), however, usually reduces the impact of the examinee's executive functions on performance of tasks thought to assess intelligence. Even with the reduction in executive functions demands in many tests, intelligence test scores sometimes do not accurately reflect a child's capacity for the use of executive functions. As a result, the following observations typically hold true:

- Correlations between most of the "purest" executive functions measures and measures of general intelligence tend to be very low (.20's, and .30's; i.e., a 4% to 9% overlap between measures of intelligence and measures of executive functions). This is especially true when a concerted effort has been made to minimize the overlap between the two types of measures.
- In cognitive neuropsychological parlance, executive functions can display a "double dissociation" from the specific cognitive abilities that are typically assessed on intelligence tests, such as reasoning with verbal information or reasoning with nonverbal visual material. This means that it is possible to identify individuals who are strong in executive functions, but weak in reasoning in a particular area, and vice versa (some individuals have relatively weak reasoning capacity but have strong executive functions related to cueing and directing the little reasoning capacity that is available, while other individuals have relatively strong reasoning capacity but relatively weak executive functions related to cueing and directing that reasoning capacity).
- The distinction between executive functions that direct mental processes and the mental processes such as reasoning, visual perception and discrimination, language, memory, attention, and motor acts that are being directed by executive functions, is critical for a clear understanding of the broader picture of a child's cognitive strengths and

weaknesses. An understanding of the directive nature of executive functions can add considerable explanatory power to the clinical picture of a child with learning and/or "performing" difficulties who appears to have a number of cognitive strengths but is unable to use them effectively to produce the desired academic outcomes.

The relationship of reasoning and executive functions is an area of great debate. Some researchers espouse the idea that reasoning and executive functions are the same cognitive capacity. Others view executive functions as separate from reasoning. We hold the latter belief, primarily based on empirical evidence of performance on measures that primarily assess reasoning abilities and measures that primarily assess executive function control of reasoning abilities. Many individuals can effectively perform specific reasoning tasks that do not require a great deal of executive function control to complete, but are unable to complete simple reasoning tasks that do require a great deal of executive function control to complete.

Executive Functions and Language Processing

A related topic of much debate is the role of language in executive functions and other mental capacities such as working memory. Some researchers, philosophers, and clinicians believe that language plays a central role in all aspects of the development and use of executive functions and working memory, implying or specifically stating that executive functions and working memory processes are not even possible without the generation and manipulation of internal language (self-talk). Others argue that language is not central to all aspects of executive functions or working memory and that only certain aspects of higher levels of consciousness are likely to be constrained by language.

Readers should keep in mind, however, that the argument against the idea that language is central to the development and use of executive function and working memory processes is not a denial of the role that language can play in the control of self-regulation processes. Many clinical approaches have demonstrated how effective "self-talk" and language-driven executive functions control can be in modifying executive function cueing and directing of perceptions, emotions, thoughts and actions. Ross Greene's work with explosive children effectively uses language to help the child develop a vocabulary for self-expression and problem-solving. A therapeutic format with self-talk playing a central role has been used by Jeffrey Schwartz to effectively treat obsessive-compulsive disorder. Reuven Feuerstein's mediated learning approach keys off of verbal descriptions of control processes and how to think about thinking. Language is an effective cognitive tool that can be co-opted to improve the use of deficient or delayed executive functions. Indeed, it would seem that language is the most effective tool we have for re-programming our own brains and minds. The fact that language can be used in this way, however, does not mean that language is the basis for all effective executive functions use or that executive functions use at any of the levels cannot be carried out successfully without language processes being engaged.

Executive Functions and Diagnostic Categories

While it would seem practical to have a specific diagnostic category with a name such as Executive Dysfunction or the like, the diagnostic puzzle related to executive functions cannot be put together quite that simply. In terms of existing clinical diagnostic categories, the connection between AD/HD and executive function difficulties is probably the most obvious. The *Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition, Text Revision* (DSM-IV-TR; American Psychiatric Association, 2000) definition of AD/HD includes reference to difficulties with both inhibition, modulation, and attention. Although individuals accurately diagnosed with AD/HD demonstrate difficulties with inhibiting and modulating perceptions,

emotions, thoughts and/or actions as well as focusing and sustaining attention, many of these individuals also demonstrate other self-regulation executive functions difficulties.

The obvious connection between AD/HD and executive functions difficulties has led some professionals to think of all individuals with executive functions difficulties as having AD/HD. This is clearly not the case. Rather, the ADHD diagnosis encompasses a core set of self-regulation difficulties common to all individuals accurately diagnosed with AD/HD (the self-regulation executive functions of inhibit, modulate, focus, and sustain) along with additional executive functions difficulties that vary greatly from person to person. This is one of the reasons why professional consensus on all aspects of AD/HD has been, and remains, difficult to achieve. There are many individuals, however, who do not have problems with cueing inhibition or modulation or with focusing and sustaining attention, but who have many difficulties with the use of other executive functions, and therefore do not meet the diagnostic criteria for AD/HD.

Terms such as *executive dysfunction* and *dysexecutive syndrome* are sometimes used to refer to individuals with executive functions difficulties, though these terms currently do not relate to any specific diagnostic schema that is widely agreed upon. For example, there is no DSM-IV-TR diagnostic category of Executive Dysfunction or Dysexecutive Function Syndrome, and at this point in time (2010) such a diagnostic category has not been listed as being considered for inclusion in the next edition of the DSM.

Although there could be some merit in the development of a separate diagnostic category or educational classification for executive functions difficulties, the greatest challenge to such an approach is the fact that the diagnostic criteria of most clinical conditions encompass difficulties with the use of one or more executive functions. In many ways, the DSM-IV-TR can be thought of as a *behavioral user's guide to all the things that can go wrong with the frontal lobes*. It is our opinion that simply including a new diagnostic category for executive functions difficulties in future revisions of the DSM will not sufficiently address the central role that executive functions difficulties play in most of the existing DSM diagnostic categories. The new edition of the DSM, therefore, would have greater clinical utility if it were to incorporate a new axis that could be used to identify specific executive functions difficulties experienced by an individual along with the various clinical diagnoses that might be assigned. Following this line of reasoning, the pervasiveness of executive functions difficulties of one type or another associated with most of the mental disorders experienced by children and adults makes clear the need to carefully assess the nature of the executive functions difficulties of these children and adults so that appropriate interventions can be identified and implemented (In DSM parlance, a new Axis would be required to identify the level and degree of executive functions difficulties being experienced by the person in order to formulate an appropriate course of intervention).

Assessment of Executive Functions

Although assessment of executive functions is not yet a standard part of all psychoeducational assessments, a number of instruments have been developed over the last decade to assess the executive functions of children. We observed that almost all of these measures are standardized, norm-referenced individually-administered tests that share a common set of limiting characteristics: 1) they utilize only a formal direct approach to data collection from a single source – the child; 2) they focus assessment on executive functions direction of information processing capacities only within the domains of perception, cognition, and action; and 3) they focus only on directing the use of information processing capacities in relation to functioning in the symbol system arena.

To correct for this narrow focus, the recommended approach to the assessment of executive functions is a multidimensional, multimethod one involving both formal and informal

techniques applied both directly with the child and indirectly with parents, teachers and others who know the child well. These techniques included, but are not limited to:

Direct Observation
- Standardized, individually-administered norm-referenced tests
- Qualitative process-oriented observation of cognitive processes during task performance.

Behavior Ratings
- Parent and Teacher Ratings of Child
- Adolescent and Adult Self-Rating Scales

Behavior Observations
Clinical Interviews
Anecdotal Records
Case History

Issues related to intervention

The ultimate goal of any intervention designed to address executive functions difficulties should be to increase the child's capacity for internally directed self-regulation. Intervention efforts depend on an understanding of three key concepts:

1) Executive functions difficulties are associated with sub-optimal brain function.
2) Brain function can be altered through intervention.
3) Interventions can activate the use of intact brain structures.

When attempting to develop an intervention plan for a child with executive functions difficulties, the following general guideline should help to increase the likelihood of successful implementation:

1. Provide the child with as rich an "executive functions environment" as possible; modeling of the effective use of executive functions by adults and others is critical for development.
2. Initially adopt the position that the executive function difficulties are the result of nonconscious disuse of existing executive functions that can be activated through intervention efforts.
3. Focus on making the child aware of the executive functions needed to achieve desired behavior goals and on teaching the child how and when to activate the needed executive functions with the ultimate goal being internalization of the self-regulation routines needed for effective functioning.
4. Develop and apply, as needed, interventions involving external control. Monitor the use of these interventions closely to determine when to begin the gradual or complete withdrawal of external control so that internal control can be engaged and demonstrated.
5. Maintain and model attitudes of hope, perseverance, and patience with intervention efforts.
6. Maintain, and foster in others, reasonable expectations for behavior change and sensible and reasonable consequences for unacceptable behavior.

A review of the general intervention literature suggests that strategies designed to address executive functions difficulties can be grouped according to an internally directed versus externally managed control dimension and include the following:

Intervention strategies for developing internal control.
- Increasing Awareness
- Modeling Appropriate Use of Executive Functions
- Teaching Specific Executive Functions as Skills Routines

Using Verbal Mediation
Using Verbal or Nonverbal Labeling
Teaching the Use of Internal Feedback
Establishing Self-Administered Rewards

Intervention strategies for maintaining external control.

Pharmacological treatment
Structuring the Environment
Structuring Time
Externalizing Cues for Effective Processing
Providing Feedback
Providing Rewards
Aligning External Demands with Internal Desires

Although there is a lack of evidence-based literature available specifically addressing executive function interventions per se, there exists a wealth of data from various professional fields related to effective interventions for dealing with children exhibiting executive function difficulties. Of particular note for increasing internal self regulation are a wide variety of intervention techniques based on the core principles of Cognitive Behavior Therapy. The literature base on the use of behavior management with children diagnosed with AD/HD is perhaps the best example of the efficacy of the use of external control strategies for managing executive function difficulties. Peg Dawson and Richard Guare have published a second edition of their workbook entitled *Executive skills in children and adolescents: A practical guide to assessment and intervention* (2010). This was the first intervention volume that specifically addressed executive functions difficulties as a class of unique mental functioning problems. Dawson and Guare have also published a guide for parents entitled *Smart but Scattered* (2009) and Cooper-Kahn and Dietzel have published a parent guide entitled *Late, Lost and Unprepared* (2008). Interest in classroom applications of the concept of executive functions is growing quickly; two recent publications in this area are: *Executive Function in the Classroom* (2010) by Christopher Kaufman and *Promoting Executive Function in the Classroom* (2010) by Lynn Meltzer. The ideas included in this handout are discussed in further detail in the book Assessment and Intervention for Executive Function Difficulties (2009) by McCloskey, Perkins & VanDivner. Readers interested in the more technical and theoretical aspects of this topic may wish to examine Elkhonon Goldberg's book entitled *The New Executive Brain: Frontal Lobes in a Complex World* (2009).