Chapter One

A MULTIDIMENSIONAL MODEL OF EXECUTIVE FUNCTIONS

INTRODUCTION

This introductory chapter offers a multidimensional definition of executive functions and a discussion of several topics related to executive functions development and use. These discussions are important for developing a common understanding of the authors' theoretical perspective on the multidimensional construct of executive functions and the assessment concepts and methods that are discussed in detail in the remainder of this book.

WHAT ARE EXECUTIVE FUNCTIONS?

Although the term *executive functions* has been in use for several decades now, there is great variation in how the construct has been defined (Jurado & Roselli, 2007). Rapid Reference 1.1 lists elements of executive functions definitions offered by various authors in the fields of cognitive psychology, neuropsychology, neuroscience, human development, and education. The diversity of definitions presents a challenge for authors attempting to write a book on the assessment of executive functions. Effective assessment of a psychological construct hinges on effective operational definition of the construct to be assessed (Anastasi & Urbina, 2009; Kline, 2000; McDonald, 1999; Nunnaly & Bernstein, 1994). How then does one accomplish the feat of operational definition when such diversity of opinion exists about exactly what it is that is to be measured?

To resolve the predicament arising from a plethora of definitions, the authors of this book chose to provide a widely inclusive multidimensional definition in the form of a comprehensive theoretical model of executive functions specifying how they are manifested in daily functioning. To be effectively comprehensive in nature and to form an overarching framework for the assessment of executive functions, the theoretical model needed to incorporate as many as possible of the salient elements of the various definitions listed in Rapid Reference 1.1.

Rapid Reference 1.1

Definitions/Elements of Executive Functions From the Professional Literature

Definitions of Executive Functions and/or Cognitive Constructs Subsumed in Definitions	Source	Holarchical Multidimensional Model Component
Shifting, updating, inhibition	Miyake, Friedman, Emerson, Witzki, and Howerter (2000)	Self-Regulation (Shift, Monitor, Correct, Inhibit)
Task analysis, strategy selection, and strategy monitoring	Borkowski and Burke (1996)	Self-Regulation (Analyze, Gauge, Decide, Monitor, Correct)
Control processes involving initiating, sustaining, inhibiting, stopping, shifting, anticipating, planning, efficiency and productivity; emotional as well as cognitive	Denckla (1996)	Self-Regulation (Initiate, Sustain, Inhibit, Stop, Interrupt, Shift, Anticipate, Plan, Execute) Domains of Functioning (Cognition, Emotion)
"The ability to maintain an appropriate problem-solving set for attainment of a future goal." (p. 201)	Welsh and Pennington (1988)	Self-Determination Self-Regulation (Sustain)
"The executive functions are a collection of processes that are responsible for guiding, directing, and managing cognitive, emotional, and behavioral functions, particularly during active, novel problem solving." (p. 1)	Gioia, Isquith, Guy, and Kenworthy (1996)	Domains of Functioning (Cognition, Emotion, Action) Self-Determination Self-Regulation (Generate, Monitor)
"The executive functions can be conceptualized as having four components: (1) volition; (2) planning; (3) purposive action; and (4) effective performance. Each involves a distinctive set of activity-related behaviors. All are necessary for appropriate, socially responsible, and effectively self-serving adult conduct." (p. 611)	Lezak, Howieson, Lorring, Hannay, and Fischer (2004)	Self-Generation Self-Determination Self-Regulation (Initiate, Energize, Plan, Execute, Monitor, Correct)
The central executive coordinates the processing of information by the phonological loop and the visualspatial sketchpad.	Baddeley and Hitch (1974)	Self-Regulation (Hold, Manipulate, Store)

Definitions of Executive Functions and/or Cognitive Constructs Subsumed in Definitions	Source	Holarchical Multidimensional Model Component
Supervisory attentional system	Norman and Shallice (1985)	Self-Regulation (Focus/Select, Sustain)
Attentional control; cognitive flexibility; goal setting	Anderson, Northam, Hendy, and Wrenall (2001)	Self-Regulation (Focus/Select, Sustain, Flexible) Self-Determination
Flexibility of thinking; inhibition; problem-solving; planning; impulse control; concept formation; abstract thinking; creativity	Delis, Kaplan, and Kramer (2001)	Self-Regulation (Flexible, Inhibit, Generate, Associate, Plan, Modulate)
Novel problem-solving; modification of behavior in light of new information; generation of strategies; sequencing complex actions	Elliot (2003)	Self-Regulation (Generate, Monitor, Correct, Modulate, Sequence, Execute)
Purposefully coordinating and organizing behaviors; reflecting on and analyzing the success of generated strategies	Banich (2004)	Self-Regulation (Organize, Analyze, Evaluate/Compare, Monitor) Self-Analysis
Self-regulation; set maintenance; selective inhibition of verbal and nonverbal responding; cognitive flexibility; planning; prioritizing; organizing time and space; output efficiency	Harris et al. (1995)	Self-Regulation (Sustain, Inhibit, Flexible, Plan, Evaluate/Compare, Analyze, Organize, Sense Time, Estimate Time, Execute, Monitor, Correct, Pace)
Selecting, monitoring, task analyzing, and revising strategies; planning, reflecting on plans; decision-making	Borkowski and Muthukrishna (1992)	Self-Regulation (Focus/Select, Monitor, Analyze, Gauge, Evaluate/Compare, Correct, Decide) Self Analysis
"Executive functions are defined as psychological processes that have the purpose of: Controlling implementation of activation-inhibition response sequences … That is guided by diverse neural representations (verbal rules, biological needs, somatic states, emotions, goals, mental models) …	Eslinger (1996)	Self-Regulation (Initiate, Energize, Inhibit, Balance) Self-Determination Domains of Functioning (Cognition, Emotion) Arenas of Involvement (Intrapersonal, Interpersonal, Environment, Academic/Symbol System)

(*continued*)

Definitions of Executive Functions and/or Cognitive Constructs Subsumed in Definitions	Source	Holarchical Multidimensional Model Component
For the purpose of meeting a balance of immediate, situational, short-term, and long-term future goals … That span physical-environmental, cognitive, behavioral, emotional, and social spheres." (p. 381)		
"More generally, approaching the prefrontal cortex with the assumption of heterogeneity of function and viewing it as a region subserving multiple and differently localized processes appears to be a beneficial approach toward identifying neurally plausible component processes of complex cognition. In particular, the regional distinction proposed here suggests that self referential or introspectively oriented mental activity may be qualitatively different from externally oriented mental activity concentrated on externally generated information. In view of the types of functional distinctions that have been proposed to hold within the human prefrontal cortex, it appears that different prefrontal subregions are best distinguished by viewing them as the components of a hierarchically organized system. Consequently, the general principle according to which the prefrontal cortex is organized may be not so much that of regional dissociations as that of a hierarchical organization." (p. 183)	Christoff and Gabrieli (2000)	Multiple EFs, Differential Internal (Intrapersonal) vs. External (Interpersonal, Environment, Academic/ Symbol System) expression of EFs Levels of Executive Control (viewed hierarchically rather than holarchically)
"The "executive functions" broadly encompass a set of cognitive skills that are responsible for the planning, initiation, sequencing, and monitoring of complex goal-directed behavior. Although a coherent framework of executive control has yet to be developed, two central themes are emerging. The first theme associates ECF with specific higher cognitive functions such as insight, will, abstraction, and judgment, which are mostly dependent on the frontal lobes.	Royall et al. (2002)	Self-Regulation (Planning, Initiation, Sequencing, Monitoring) EF levels (Self-Determination vs. Self-Regulation)

Definitions of Executive Functions and/or Cognitive Constructs Subsumed in Definitions	Source	Holarchical Multidimensional Model Component
This view implies that, like memory or language, the executive *cognitive* functions are acquired skills that can be directly measured. ECF impairment results in the loss of these capacities. The second theme emphasizes the cybernetic (from the Greek *kybernetes*, meaning "pilot") aspects of executive function. Executive functions *control* the execution of complex activities. This view implies first that ECF interacts with nonexecutive processes, and second that ECF impairment is made visible only via the disorganized operations of nonexecutive domains. The cybernetic view of frontal function is not necessarily incompatible with the older emphasis on higher cognitive abilities, but it does bring a new emphasis on the dynamic interactions between frontal control systems and the processes they interact with." (p. 378)		
"Many of the models of brain functioning have a hierarchical component to them, and we have postulated such a model for self-awareness. . . . This model has several properties: (1) There are four operational levels; arousal-attention; perceptual-motor; executive mediation; self-awareness. (2) Each operational level feeds forward to higher levels, providing a tentative digest of the analyses and associations within that level. (3) Each operational level also feeds backward to lower levels to modulate, bias, constrain or facilitate the analyses and operations that will occur. (4) Direct contact with the external environment is restricted to the perceptual-motor level. (5) The two highest levels are instantiated in frontal lobes. The executive mediation level is predominantly localized to ventrolateral and dorsolateral frontal regions. It incorporates action, planning, inhibitions, and facilitation of parietotemporal association cortices and working memory capacities.	Stuss and Alexander (2000)	Multi-Level Model of Executive Control Self-Activation Self-Regulation (Perceptual-Motor Level) Self-Awareness Discussion of mechanisms of EF interaction with domains of functioning

Definitions of Executive Functions and/or Cognitive Constructs Subsumed in Definitions	Source	Holarchical Multidimensional Model Component
Open and closed neural loops through basal ganglia and cerebellum provide neural space for unfolding complex plans and for learning frequently used plans. (6) Self-awareness emerges from convergence of emotional states and memory—not simply explicit remote memory of experiences or explicit semantic knowledge—but memory of abstract mental states that allow construction of expectancy and thus memory for the future. Human consciousness is an unstable template of experience and emotion." (p. 295)		
"With respect to memory retrieval, strategic searches of either semantic or episodic memory place heavy demands on selecting, maintaining, updating, and rerouting information processing. It is likely that different prefrontal regions control different aspects of memory. Thus, control of semantic representations will likely involve prefrontal regions that are different from those involved in control of episodic representations." (p. 218)	Shimamura (2002)	Self-Regulation (Retrieve)
The superior part of the dorsolateral prefrontal cortex plays a role in voluntary control of visual processing.	Rafal (2002)	Self-Regulation (Perceive)
During the first 2–3 months of life, development of connections between the prefrontal cortex and the occulomotor system and the occipital lobes enables infants to begin to be able to choose where to look and what to look at.	Eliot (1999)	Self-Regulation (Perceive)
"It now seems possible that there is an escape from the regress that formerly seemed infinite. As recently as a generation ago, processes of control had to be thought of as *homunculi*, because man was the only known model of an executive agent. Today, the stored-program computer has provided us with an alternative possibility, in the form of the *executive routine*. This is a concept that may be of considerable use to psychology.	Neisser (1967)	Self-Determination Self-Regulation (Analyze, Generate, Associate, Store, Retrieve, Compare/Evaluate, Decide)

Definitions of Executive Functions and/or Cognitive Constructs Subsumed in Definitions	Source	Holarchical Multidimensional Model Component
. . . In other situations, however, the choice between register A and register B may depend on a complicated set of conditions, which must be evaluated by a separate subroutine called 'the executive.' Common practice is to make all subroutines end by transferring control to the executive, which then decides what to do next in each case. One might well say that the executive 'uses' the other routines, which are 'subordinate' to it. Some programs may even have a hierarchical structure, in which *routine*s at one level can call those which are 'lower' and are themselves called by others which are 'higher.' However, the regress of control is not infinite: there is a 'highest,' or executive routine which is not used by anything else. Note that the executive is in no way a *programmulus*, or miniature of the entire program. It does not carry out the tests or the searches or the constructions which are the tasks or the subroutines, and it does not include the stored information which the subroutines use. Indeed, the executive may take only a small fraction of the computing time and space allotted to the program as a whole, and it need not contain any very sophisticated processes. Although there is a real sense in which it 'uses' the rest of the program and the stored information, this creates no philosophical difficulties; it is not using itself. (As a matter of fact, some programs do have so-called recursive subroutines which use themselves). . . . . . . the use of a concept borrowed from computer programming does not imply that existing 'computer models' are satisfactory from a psychological point of view. In general, they are not. One of their most serious inadequacies becomes particularly apparent in the present context. The executive routine of a computer program must be established by the programmer		

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Definitions of Executive Functions and/or Cognitive Constructs Subsumed in Definitions	Source	Holarchical Multidimensional Model Component
from the beginning. Although artificially intelligent programs can easily 'learn' (modify themselves as a result of experience), none so far can make major developmental changes in its own executive routine. In man, however, such functions as 'turning round on one's own schemata' and 'searching through memory' are themselves acquired through experience. We do not know much about this learning, but it poses no new problem in principle, if we already assume the human memory stores information about processes rather than about contents. Mental activities can be learned; perhaps they are the only things that are ever learned.'' (pp. 295–296)		

DEFINING EXECUTIVE FUNCTIONS AS A MULTIDIMENSIONAL CONSTRUCT

Consistent with the common thread throughout the defining literature, the term executive functions can be viewed as an overarching developmental cognitive neuropsychological construct that is used to represent a set of neural mechanisms that are responsible for cueing, directing, and coordinating multiple aspects of perception, emotion, cognition, and action (Gioia, Isquith, Guy, & Kenworthy, 1996; McCloskey, Perkins, & Van Divner, 2009; Stuss & Alexander, 2000).

The operational definition of executive functions that guides the discussion of the assessment practices in this book is based on six interconnected concepts (McCloskey et al., 2009):

1. Executive functions are multiple in nature; they do not represent a single, unitary trait;
2. Executive functions are directive in nature, that is, they are mental constructs that are responsible for cueing and directing the use of other mental constructs;
3. Executive functions cue and direct mental functioning differentially within four broad construct domains: perception, emotion, cognition, and action;

4. Executive functions use can vary greatly across four arenas of involvement: intrapersonal, interpersonal, environment, and symbol system use;
5. Executive functions begin development very early in childhood and continue to develop at least into the third decade of life and most likely throughout the life span, and
6. The use of executive functions is reflected in the activation of neural networks within various areas of the frontal lobes.

Although the term *executive functions* is becoming more readily recognized by professionals and laypersons, the general metaphorical comparison of executive functions to the CEO of the brain or the conductor of the brain's orchestra (Brown, 2006; Gioia, Isquith, & Guy, 2001; Goldberg, 2001; Wasserstein & Lynn, 2001) represents an oversimplification of the concept that can lead to inadequate assessment efforts and a reduction in the construct's clinical utility. In order to understand and effectively assess executive functions, it is important not to think of executive functions as a unitary mental construct. Indeed, Martha Denckla's (1996) warning not to turn executive functions into the neuropsychologists' "*g*" (i.e., a singular, all-encompassing construct) is axiomatic to developing a clinically viable perspective on defining and assessing executive functions. Rapid Reference 1.2 provides more detailed discussion of executive functions as a set of interrelated directive capacities. As discussed in Rapid Reference 1.2, executive functions are best viewed as constituting a collection of "co-conductors" or section leaders, each responsible for a separate aspect of the overall production of the orchestra while working—ideally—in a highly coordinated manner with fellow co-conductors to ensure the desired outcomes.

DON'T FORGET

This book's discussion of executive function assessment is based on six interconnected concepts:

1. Executive functions do not represent a single, unitary trait;
2. Executive functions cue and direct the use of other mental constructs;
3. Executive functions cue, direct, and coordinate aspects of perception, cognition, emotion, and action;
4. Executive function use varies in different arenas of involvement: symbol system, interpersonal, intrapersonal, and environmental;
5. Executive functions develop over an individual's lifespan, with most significant development likely in the first 30 years of life; and
6. Executive function use is reflected in the activation of areas of the frontal lobes.

Rapid Reference 1.2

The Co-Conductor Concept of Executive Functions

As the term implies, executive functions is a concept that applies to multiple cognitive constructs rather than a single, unitary construct. Some discussions of executive functions, however, such as Goldberg's (2001) reference to executive functions as "the 'S' (for smart) factor," might unintentionally lead one to think of executive functions as a unitary, global mental capacity. Goldberg along with others (Brown, 2006; Gioia, Isquith, & Guy, 2001; Goldberg, 2001; Wasserstein & Lynn, 2001) get snared in the executive functions as a "g" conceptual trap by using the popular orchestra conductor metaphor as an analogy for the relationship between executive functions and the various other mental constructs they direct (see Figure RR1.2A). The orchestra conductor metaphor gives the (usually unintended) impression that the term executive functions defines a singular capacity for cognitive control that is responsible for directing all thought and behavior. Much closer to the current neurocognitive conceptions of executive functions (Berninger & Richards, 2002; Delis et al., 2001; Kaplan 1988; McCloskey et al., 2009; Stuss & Alexander, 2000) is the metaphor of executive functions as a collection of numerous "co-conductors" or "section leaders" each with a highly specific directive role in the overall performance of the orchestra, but each working—ideally—in a highly collaborative manner with all of the other co-conductors, as shown in Figure RR1.2B.

Stuss and Alexander (2000) addressed the problem presented by the orchestra metaphor, stating: "We emphasize that there are specific processes related to different brain regions within the frontal lobes. There is no frontal homunculus, no unitary executive function. Rather, there are distinct processes that do converge on a general concept of control functions. The idea

Figure RR1.2A Visual diagram representing executive functions as the singular conductor of the brain's orchestra (i.e., executive functions as "g").

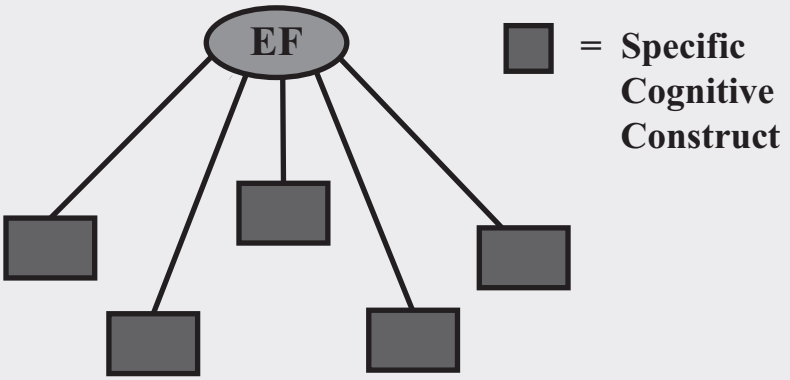
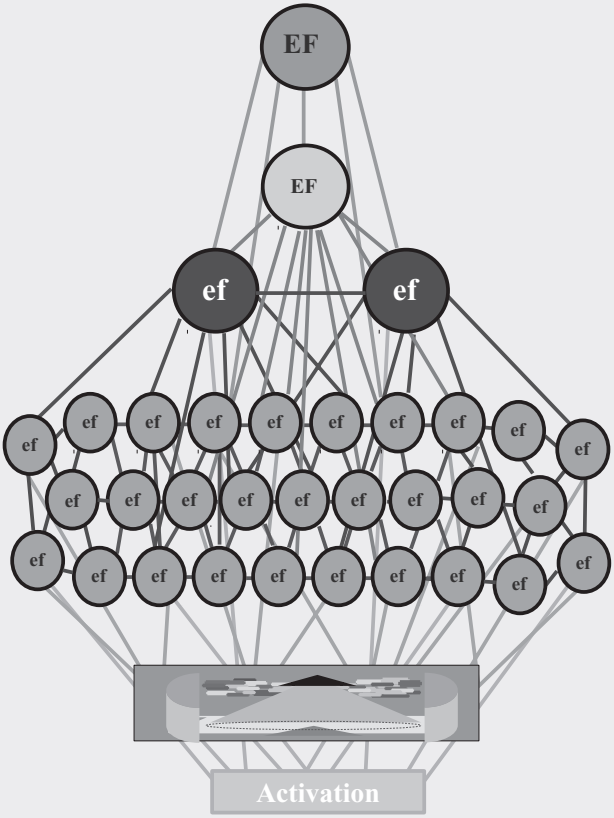


Figure RR1.2B Visual diagram representing executive functions as multiple co-conductors of the brain's orchestra.



of a supervisory system is very applicable, if the emphasis is on a system constructed of multiple parts. From a clinical viewpoint, the position that there is no homunculus suggests that there is not a single frontal lobe syndrome with point-to-point correspondence to a homunculus. While a generally consistent frontal lobe syndrome can be found in some patients, this syndrome label describes patients with extensive damage to the frontal lobes often late after injury" (p. 291).

Consistent with the assertions of Stuss and Alexander and other brain researchers (Christoff & Gabrieli, 2000; Denckla, 1996; Pennington, 1997; Posner & Rothbart, 2007; Royall et al., 2002), executive functions are most aptly

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characterized as a set of multiple mental constructs that appear to be responsible for cueing, directing, and coordinating multiple aspects of perception, emotion, cognition, and action (Gioia, Isquith, Guy, & Kenworthy, 1996; McCloskey et al., 2009). From this perspective, executive functions are seen only as directive processes. They issue or relay commands that engage other mental constructs to carry out those commands; they do not carry out the commands themselves. Executive functions are not the mental mechanisms we use to perceive, feel, think, and act. Instead, they are the mental mechanisms that direct or cue the engagement and use of other mental mechanisms that are used to perceive, feel, think, and act.

As a collection of directive capacities, executive functions cue and coordinate the use of other mental constructs such as reasoning, language, and visuospatial representation within the context of memory time frames. Figure RR1.2C depicts how a selected subset of five independent but interrelated self-regulation executive functions can be involved in an integrated manner to cue and direct the use of a single mental capacity such as the cognitive subdomain of reasoning with verbal information. Expanding on the concept illustrated in Figure RR1.2C, the diagram in Figure RR1.2D depicts interconnections between multiple self-regulation level executive functions (to be discussed later in this chapter) and four general domains of functioning. The single connections from each self-regulation level executive function to each domain of functioning, and even the multiple interconnections of every executive function with every other executive function, really represent an oversimplification of the neural interconnectivity involved. Rather, there are

Figure RR1.2C Neural network diagram illustrating connections between five self-regulation executive functions and one specific ability within the cognitive domain of functioning.

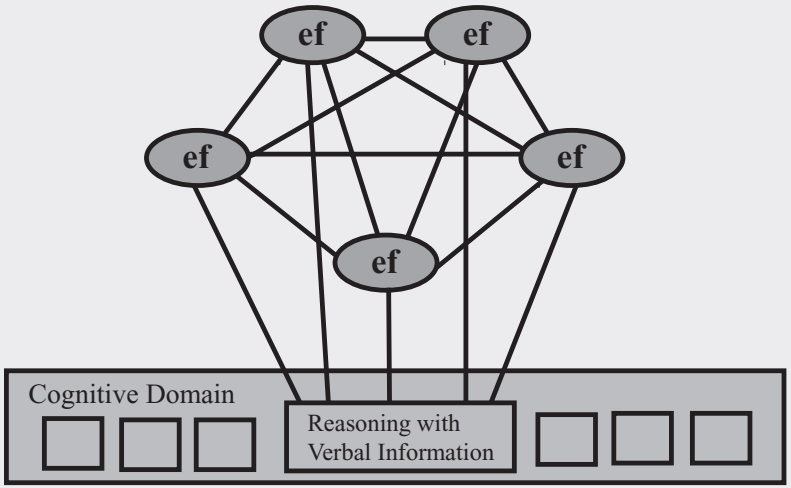
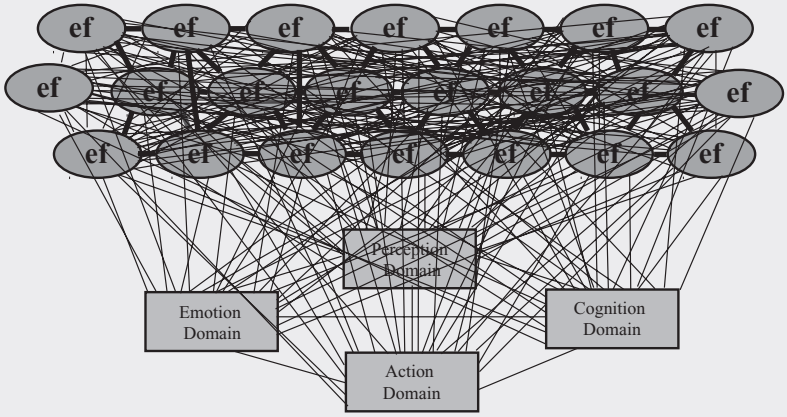
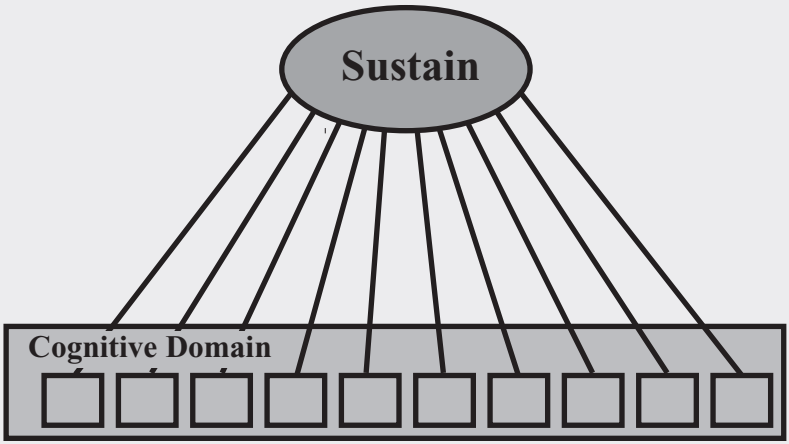


Figure RR1.2D Neural network diagram illustrating connections between multiple self-regulation executive functions and four separate domains of functioning. Each single line includes multiple additional connections to subdomains within each domain.



multiple connective neural pathways between each executive function and each of the various subdomains within each of the four very general domains of functioning shown in the diagram as well as multiple pathways between each executive function depending on which executive functions and which subdomains of functioning are being engaged at a given point in time. Figure RR1.2E visually

Figure RR1.2E Neural network diagram illustrating connections between one self-regulation executive function and 10 separate cognitive constructs within the cognitive domain of functioning.



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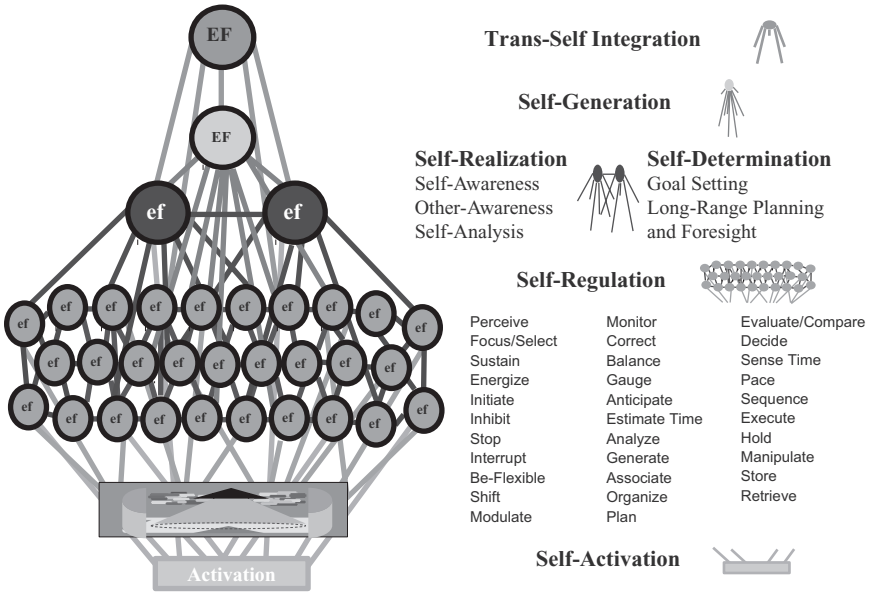
depicts the concept of the differentiated direction of multiple cognitive subdomains by a single self-regulation executive function. To begin to approximate the likely number of unique connections within the Cognitive Domain, one need envision connections from each of at least 32 self-regulation level executive functions to at least each of the 10 subdomains listed in Figure RR1.2E, and then multiply that number of connections by the four arenas of involvement. The resulting 1,280 connections would be the extreme lower bound estimate for the actual number of connections, with room for many more distinctions of additional self-regulation level executive functions and additional cognitive subdomains.

The concept of independent but coordinated processing is important in understanding how executive functions direct and affect perception, emotion, thought, and action. Because executive functions manifest through multiple neural control circuits, there is no guarantee that if a child exhibits one well-developed executive function neural circuit, all executive functions circuits will be well-developed in that child. Similarly, even though a child might have many well-developed executive functions, the interconnections between some of these executive functions might not be as well-developed as others, resulting in less coordinated direction and control when one interrelated circuit is activated, but not when a different interrelated circuit is activated. While certain clinical disorders may show specific, typical patterns of executive function weaknesses or deficiencies, any person can exhibit strengths and/or weaknesses in any one or more of the different executive functions at any given point in time. Assessment of executive functions, therefore, requires a multidimensional approach to identify the specific constellation of executive functions strengths and weaknesses for a given child. The level of specificity of strengths and weaknesses possible through assessment, however, will never fully reflect the client's actual pattern of neural connectivity, but it can highlight the most important executive function strengths and weaknesses in a manner that makes it possible to develop a plan for further development and improvement.

The comprehensive multidimensional model of executive functions used as a framework for assessment as described in this book has been presented in detail in other sources (McCloskey, 2004; McCloskey et al., 2009). This holarchical, developmental model offers a set of interrelated concepts to describe the nature of executive functions. The executive function components of the model are shown in Figure 1.1. Rapid Reference 1.3 presents the conceptual underpinnings of the model. Rapid Reference 1.4 describes 32 self-regulation level executive functions that form the core of the model and that are a major focus of executive functions assessment.

Figure 1.1 A Holoarchical Model of Executive Functions Specifying Tiers of Self-Control and Executive Functions within Tiers



Rapid Reference 1.3

A Comprehensive Model of Executive Functions

The Holarchical Model of Executive Functions is based on an integration of the following concepts:

- Five Tiers of Executive Function Control
- 32 Separate Self-Regulation Executive Functions within the Self-Regulation Level
- Four Broad Domain of Functioning with Multiple Subdomains within each
- Four Arenas of Involvement

Five Tiers of Executive Function Control

Self-Activation

The *self-activation* tier represents the neural processes involved in the awakening or "ramping up" of executive functions after sleep or other prolonged nonconscious states (Balkin et al., 2002). During the self-activation process, a

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less than optimal state of perceiving, feeling, thinking and acting is experienced; this suboptimal state is referred to as sleep inertia. This state of sleep inertia typically resolves shortly after awakening (i.e., approximately 5 to 20 minutes). As sleep inertia fades, access to upper level self-control processes becomes possible. The self-activation level represents the gateway to self-control at the other levels.

Self-Regulation

As the self-activation process unfolds, a person has increasing degrees of access to the self regulation-tier of executive functions. The *self-regulation* tier is comprised of multiple executive functions responsible for cueing, directing, and coordinating moment-to-moment functioning within the various subdomains of the four broad domains of Perception, Emotion, Thought, and Action. Self-regulation executive functions are responsible for the aspects of self-control that enable a person to direct daily functioning. The model of executive functions presented here identifies 32 self-regulation executive functions that can be used individually and in varying combinations to direct and cue perception, emotion, cognition, and action most of the time. Rapid Reference 1.4 provides a brief description of the 32 self-regulation executive functions specified in the model.

The 32 self-regulation executive functions described in Rapid Reference 1.4 are distinct from one another and are not uniform in their degree of control capacity, that is a child's effectiveness with each of these self-regulation level executive functions can vary greatly. For example, a person might be very effective at using the *Focus/Select* cue to direct attention to a stimulus, but be very ineffective in the use of the *Sustain* cue when it would be advantageous to maintain attention to the stimulus for an extended period of time.

Self-Realization and Self-Determination

At the third tier of this model, self-control processes extend beyond the basic self-regulation executive functions that govern day-to-day functioning. Executive functions at this tier are engaged in directing the development of a consistent self-image and goals and plans that extend beyond the immediate moment. The two subdomains distinguished at this level—self-realization and self-determination—are described next.

Self-Realization. Being able to direct, cue, and coordinate the use of self-regulation executive functions does not require a person to be consciously aware of what they are doing or how they are doing it. It is possible to nonconsciously make use of executive functions to self-regulate perceptions, feelings, thoughts, and actions without engaging in any conscious form of self-realization. The activation of separate neural circuits routed through specific portions of the frontal lobes is necessary for a person to be aware of themselves in a reflective manner. Such self-reflective processes enable a person to become aware of their

nonconscious use, or disuse, of lower tier self-regulation executive functions and to take conscious control of these lower tier executive functions (Johnson et al., 2002; Morin, 2004). Frequent and sustained use of these self-realization neural pathways leads to greater self-awareness and greater capacity for conscious control of the 32 self-regulation level executive functions that are typically accessed nonconsciously.

Frequent engagement of self-awareness executive functions supports the emergence of a capacity for self-analysis. Self-analysis involves self-reflection, that is, considering one's perceptions, emotions, thoughts, and actions, and making judgments about the adequacy or inadequacy of one's functioning in these domains. Such self-reflection and judgment creates an idea of "who I am, and how adequate I am"; that is, a sense of self as defined by one's recollections of one's perceptions, emotions, thoughts, and actions. Such an increased awareness of self is distinct from, and can dissociate from, one's capacity for becoming aware of how others react to one's actions that presumably reflect one's perceptions, emotions, and thoughts. Self-reflection that takes into account other persons' perspectives one's actions can add multiple dimensions to the generation of an image that defines "who I am." The self-analysis executive functions accessed at this tier enable one to develop a sense of personal strengths and weaknesses and realize how they impact one's daily functioning and the functioning of others. Self-analysis executive functions also form the basis for an individual's theory of mind that enables one to understand, anticipate, and empathize with other individuals' perceptions, feelings, thoughts, and actions and to infer that other individuals are engaging in, or have the potential to engage in, the same type of self-analysis.

Self-Determination. Although day-to-day self-regulation executive functions can be consciously engaged, developing a broader sense of self-determination that extends beyond the immediate moment requires the engagement of specific neural circuits involving portions of the frontal lobes that enable goal setting and long-term planning (Luria, 1980). Effective use of these circuits makes it possible for a person to set goals and formulate plans that extend far beyond the capacity of the lower tier self-regulation executive function of Plan that cues the use of short-term planning routines lasting only a few minutes or less.

It is important to recognize that no self-determined goal or self-desired outcome is necessary for effective use of lower-tier self-regulation executive functions, including the Plan function. Consequently, it is possible for a person to engage self-regulation executive functions effectively on a day-to-day basis, responding only to fleeting inner urges or external demands imposed in the immediate moment without ever engaging higher-tier self-determination executive functions. Consistent with the holarchical conception of the model, however, the converse is also quite possible; that is, a person can engage the higher-tier self-determination executive functions to generate long-term goals and

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formulate elaborate plans, but have little in the way of lower-tier self-regulation executive functions to direct day-to-day perception, feeling, thought, and action in a manner consistent with the long-term goals and far-reaching plans generated at the higher tier.

Although self-determination executive functions can be greatly enhanced by the effective use of lower tier self-regulation executive functions, it is not necessary to have developed all 32 self-regulation executive functions to a high degree in order to successfully execute a self-determined plan or achieve a self-determined goal. The better developed a person's self-determination executive functions the more likely it is that they will find ways to make the most of the self-regulation executive functions they might possess—whether great or few. Even in the case of exceptional self-determination executive functions however, it is possible that a person can exhibit so many severe self-regulation executive function deficits as to make it highly unlikely that the person will achieve the goals they envision or carry out the long-term plans that they are capable of devising unless the lower-tier self-regulation executive functions are strengthened through maturation or intervention or the self-regulation executive functions of others are enlisted to aid in the process. Conversely, a person can demonstrate a near complete lack of desire to generate personal goals or plans, instead following the goals and plans set out for them by others and doing so in a manner that leads to great success through the effective daily application of lower-tier self-regulation executive functions.

Self-Generation

The tiers discussed to this point have addressed how we can self-regulate perceptions, feelings, thoughts, and actions in our daily lives and how we can develop capacities for extending control beyond the immediate moment through self-reflection, foresight, goal-setting, and planning. At some point in life, however, a person may begin to pose questions about the nature of existence and the meaning of life. The urge to pose such questions represents the emergence of the next tier of executive function control referred to in this model as the Self-Generation capacity. The pursuit of the answers to Self-Generation questions can lead to the development of a personal philosophy of life, or the development of a set of self-guiding principles that significantly influence aspects of self-realization, self-determined long-term goals and plans, and the daily self-regulation of perceptions, feelings, thoughts, and actions, increasing personal coherence and producing a greater depth of meaning and purpose. At this tier, it is possible to more fully realize the directive power of thought and the effects that directed intentions can have on all aspects of a person's life. Research has shown that posing self-generative questions and contemplating ethical dilemmas co-occur with the activation of neural circuits heavily dependent on specific areas of the frontal lobes (Greene, Nystrom, Engell, Darley, & Cohen, 2004; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Newberg, Alavi, Baime,

Mozley, & d'Aquili, 1997; Newberg, Alavi, Baime, Pourdehnad, Santanna, & d'Aquili, 2001; Newberg, d'Aquili, & Rause, 2001; Vaitl et al., 2005).

Like all other self-control executive functions in a holarchical model, Self-Generation executive functions can emerge independently of the other executive functions and can be utilized to some degree regardless of the degree of development within the other tiers. It is possible for a person to spend a great deal of time generating and reflecting on a highly refined philosophy of life intended to guide daily functioning, but at the same time be unable to effectively guide daily self-regulation in a manner that enables the realization of long-term goals or the production of consistent behavior patterns that are in keeping with the person's overarching philosophy of life. Alternatively, a person might be greatly invested in understanding the meaning of life or determining ethical principles for guiding behavior in general but be lacking in awareness of how their own perceptions, feelings, thoughts, and actions affect others. Although activation at the Self-Generation tier might be viewed as an important advancement in personal development, some individuals coherently direct their lives with a high level of self-awareness, achieving their personal goals through the use of well developed self-regulation executive functions while never questioning the meaning of what they are experiencing, that is, never activating neural circuits that are involved in the engagement of Self-Generation executive functions.

Trans-Self-Integration

Beyond the posing of questions about the meaning or purpose of life and existence and the generation of higher levels of intention for self-direction lies the capacity to direct one toward contemplation of the interconnected nature of things. The desire to seek out experiences that would enable a person to transcend the limits of human perception and the sense of an individual self to experience a sense of "oneness" with everything is referred to in this model as Trans-Self-Integration. These efforts to experience "ultimate truth" or the "reality beyond reality" often lead to what some mystic traditions refer to as unity consciousness. Engagement of Trans-Self-Integration represents a desire to transcend all lower tiers of executive control; to see past the sense of self that is so central in the engagement of Self-Generation, Self-Realization, Self-Determination, and daily Self-Regulation.

As in the case of Self-Generation, there are compelling reasons for including Trans-Self-Integration in a comprehensive model of executive functions. Neuroscience research has indicated that the ability to experience the phenomenological state of egolessness or unity consciousness is directly linked to neural circuits that are heavily dependent on heightened activation of areas of the frontal cortex accompanied by reduced activation of parietal lobe functions responsible for one's discrete sense of time and spatial location (Benson, Malhotra, Goldman, Jacobs, & Hopkins, 1990; Herzog et. al., 1990; Newberg, d'Aquili, & Rause, 2001; Newberg et al. 1997; Newberg et al. 2001). As with Self-Generation executive

(*continued*)

functions, engagement of Trans-Self-Integration executive functions can have a tremendous impact on how a person uses all lower-tier executive functions, serving as an ultimate source of intentional direction for many, or possibly all, aspects of the person's life.

Four Domains of Functioning Each With Multiple Subdomains

The model diagram in Figure 1.1 shows four separate boxes for Perception, Emotion, Thought, and Action. The distinction of four domains is meant to highlight the fact that self-regulation, in the context of these domains, is not necessarily uniform, but rather can be highly dissociable. As noted in Rapid Reference 1.1, it is equally important to recognize that the extent of control exerted by a specific self-regulation executive function can vary greatly for each of the multiple subdomains within each of the four domains. A person may be able to exert effective executive function control in many of the subdomains of one domain but in very few of the subdomains of another domain. The result is a profile of self-regulation executive functions that varies individually by domain (and subdomain) of functioning. For example, a person might be very effective in cueing the inhibition of most aspects of perception, emotion, and thought, but be much less effective in cueing the inhibition of most aspects of action. Through appropriate use of executive functions assessment methods, it should be possible to generate a profile indicating the degree of effectiveness of use of each of the 32 self-regulation executive functions within each of the four domains (and within multiple subdomains) of perception, emotion, cognition, and action.

Four Arenas of Involvement

Although the concept of variation of executive functions use by domains of function helps to clarify the varied nature of many executive function difficulties, it cannot explain all of the variation that is observed in the daily use of self-regulation executive functions. An additional concept identified here as Arenas of Involvement represents a critical dimension for a fuller understanding of the range of variability in engagement of self-regulation executive functions.

Arenas of Involvement reflect the behaviorally observable fact that executive function use can vary greatly depending on whether individuals are attempting to direct themselves in relation to their own internal states (i.e., self-regulation within the Intrapersonal Arena); to direct themselves in relation to others (i.e., self-regulation within the Interpersonal Arena); to direct themselves in relation to the environment around them (i.e., self-regulation in the Environment Arena); or to direct themselves in relation to engagement of culturally derived symbol systems that are used to process and share information, especially in academic pursuits (i.e., self-regulation in the Symbol System Arena). Brief descriptions of the nature of executive function involvement in each arena are provided next.

The intrapersonal arena. The intrapersonal arena refers to when a person is using self-regulation executive functions to cue and direct perceptions, feelings, thoughts, and actions in relation to oneself, that is, how a person perceives him- or herself, feels or thinks about him- or herself, and acts toward him- or herself. Effective use of executive functions in the intrapersonal arena drives the daily engagement of purposeful, positive behavior, a positive sense of self, self-control, and self-discipline and enables a person to avoid self-destructive habits and patterns of perception, emotion, thought, and action that can reduce the quality of life.

The interpersonal arena. The interpersonal arena refers to when a person is using executive functions to cue and direct perceptions, feelings, thoughts, and actions in relation to the perceptions, feelings, thoughts, and actions of other persons. Effective engagement of executive functions in this arena enables a person to interact appropriately with others as circumstances dictate; to appreciate and deal with the perspectives of others; to generate a theory of mind that enables a person to understand, infer, and predict the motivations, needs, and desires of others; and to find ways to balance the needs of the self with the needs of others.

The environment arena. The environment arena refers to when a person is using self-regulation executive functions to cue and direct perceptions, feelings, thoughts, and actions in relation to the environment around them. Effective engagement of executive functions in this arena enables a person to interact with natural and man-made environs while anticipating the impact and consequences of one's own actions in, and on, the physical environment.

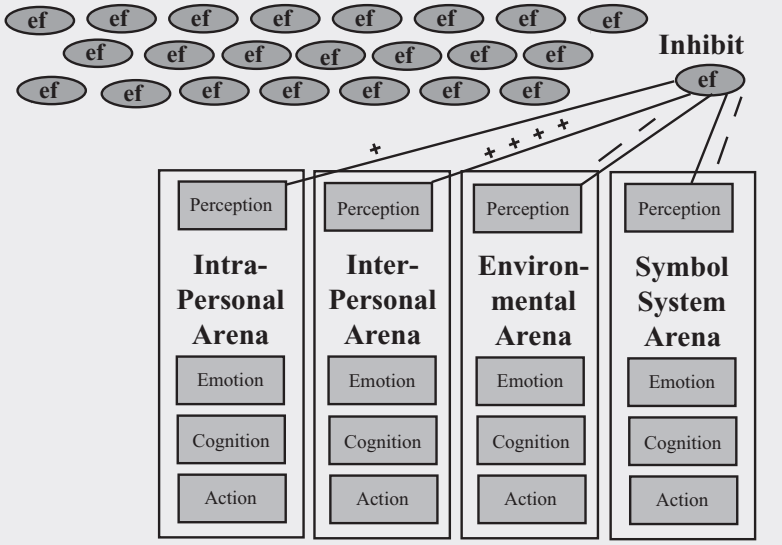
The academic (symbol system) arena. The symbol system arena refers to when a person uses self-regulation executive functions to cue and direct perceptions, feelings, thoughts, and actions in relation to the processing of information involving the use of humanmade symbol systems. Effective engagement of executive functions in this arena enables a person to cue and direct the processes of reading, writing, and speaking one or more languages, and the use of mathematics, science, and other formal systems of thought and knowledge. Many persons who exhibit learning disabilities also demonstrate executive function difficulties in the symbol system arena, but the terms learning disability and executive function difficulty should not be thought of as synonymous. As will be discussed later in more detail, executive function difficulties can impact the efficiency of new learning, but they are much more likely to impact attempts to demonstrate what has been learned.

As is the case within domains of functioning, executive functions use within arenas of involvement is dissociable; a person may experience executive function difficulties in one or more of the arenas while demonstrating very effective use of executive functions in one of more of the other arenas. Each of the 32 self-regulation executive functions is fully modular; each self-regulation

(*continued*)

executive function can have a varying level of effective use for each domain (and subdomain) of functioning and within each arena of involvement. For example, a person might effectively use one or more self-regulation executive functions to direct perception and cognition within the Interpersonal Arena while at the same time being very poor with the use of other self-regulation executive functions to direct perception and cognition within that same arena. Figure RR1.3 illustrates a fuller picture of the dissociable nature of executive functions, showing a possible combination of strengths and weaknesses for a single self-regulation capacity (Inhibit) within a single domain of functioning (Emotion) across the four arenas of involvement. The diagram shows a person that is able to cue the modulation of emotion very effectively when dealing with others and adequately when dealing with feelings about him- or herself, but who has great difficulty directing the modulation of emotions relative to academic work (e.g., feelings of frustration with reading, writing, and math), as well as with situations that arise in the environment (e.g., feelings of anger about bad traffic conditions).

Figure RR1.3 Examples of variations in cueing capacity strength for the Inhibit self-regulation executive function for the perception domain of functioning within the four arenas of involvement.



The model builds on conceptual and empirical work from multiple disciplines in an attempt to integrate research in neuroscience (Frakowiak et al., 1997; Nelson & Luciana, 2001; Stuss & Knight, 2002) with various psychological theories and perspectives (Assagioli, 1976; Barkley, 1997, 2005; Berninger, 1994; Berninger & Richards, 2002; Damasio, 1994; Denckla, 1996; Freeman, 2000; Maslow, 1968, 1970; Miller, 2001; Minsky, 1985; Neisser, 1967; Posner & Raichle, 1994; Posner & Rothbart, 2007; Stuss & Alexander, 2000; Wilber, 1977, 1979, 1995, 2000). The model is offered as a way to conceptualize and organize the interplay of the multiple executive functions that involve the use of neural networks routed through the frontal lobes. As shown in Figure 1.6, the executive functions within the model are structured into five holarchically organized tiers representing different levels of specificity of executive functions capacity. The holarchical model enables clinicians to appreciate the overlapping, multidimensional nature of executive functions development and the problems associated with developmental lags at one or more levels. The development of executive functions will be discussed briefly in the next section of this chapter. Readers interested in learning more about the model of executive functions described in Rapid Reference 1.3 are encouraged to read *Assessment and Intervention for Executive Function Difficulties* (McCloskey et al., 2009).

Rapid Reference 1.4

Brief Descriptions of the 32 Self-Regulation Executive Functions of the Holarchical Model of Executive Functions

ATTENTION CLUSTER

PERCEIVE/AWARE

Cueing the taking in of information from the external environment (e.g., seeing, hearing, touching), cueing awareness of the need to tune it to thoughts and/or feelings, body position in space and body movements.

FOCUS/SELECT

Cueing attention to the most relevant specifics of a given environment, situation, or content while downgrading or ignoring the less relevant elements.

SUSTAIN

Cueing sustained engagement of the processes involved in perceiving, feeling, thinking, or acting for as long as a situation requires.

(*continued*)

ENGAGEMENT CLUSTER

INITIATE

Cueing the initiation of perceiving, feeling, thinking, or acting as needed.

ENERGIZE

Cueing the application of energy and effort into perceiving, feeling, thinking, and acting.

INHIBIT

Cueing resistance to sudden urges to perceive, feel, think, or act.

STOP

Cueing the immediate cessation of perceiving, feeling, thinking, or acting.

INTERRUPT

Cueing the brief interruption of perceiving, feeling, thinking, or acting.

FLEXIBLE

Cueing the realization and acceptance of the need to change perceptions, feelings, thoughts or actions based on the situation at hand.

SHIFT

Cueing the transition from one perception, feeling, thought, or action to another.

OPTIMIZATION CLUSTER

MODULATE

Cueing changes in the amount and intensity of mental energy invested in perceiving, feeling, thinking, and acting. For example, effectively adjusting voice volume, activity level, and reactions to sights and sounds.

MONITOR

Cueing the use of routines to check on the accuracy of perceptions, emotions, thoughts, or actions.

CORRECT

Cueing the correction of errors of perception, emotion, thought, or action based on feedback from internal or external sources.

BALANCE

Cueing the establishment of balance when perceiving, feeling, thinking or acting to enhance or improve experiencing, learning, or performing. Cueing the sensing of the trade-off between opposing processes or states (e.g., pattern vs. detail; speed vs. accuracy; humor vs. seriousness) in order to maintain a balance.

EVALUATION CLUSTER

GAUGE

Cues the "sizing up" of the demands of a task in order to know the perceptions, emotions, thoughts, or actions needed to effectively engage the task or situation.

ANTICIPATE/FORESEE

Cues the anticipation of conditions or events in the very near future, such as the consequences of one's own perceptions, feelings, thoughts, and/or actions.

ESTIMATE TIME

Cues the use of an internal time sense to determine how long something will take to complete, or how much time is still left in a specific period of time.

ANALYZE

Cues the examination of perceptions, feelings, thoughts, or actions to obtain a greater understanding of a problem or situation.

ASSOCIATE

Cues the activation of the resources needed to make the proper associations among perceptions, feelings, thoughts, and actions appropriate for the situation at hand.

GENERATE

Cues the activation of the resources needed to carry out novel problem-solving routines.

ORGANIZE

Cues the use of routines for sorting, sequencing, or otherwise arranging perceptions, feelings, thoughts, and/or actions, to enhance or improve the efficiency of experiencing, learning, or performing.

PLAN (Short Term)

Cues for the specification of a series of perception, feelings, thoughts, and/or actions that, if carried out, would be most likely to produce a desired outcome in the very near future (within minutes to within several hours).

EVALUATE/COMPARE

Cues the making of comparisons among, or the evaluation of the adequacy of, perceptions, feelings, thoughts, or actions.

CHOOSE/DECIDE

Cues for the making of a choice or the rendering of a decision.

EFFICIENCY CLUSTER

SENSE TIME

Cues for the monitoring of the passage of time (recognizes the need for having an internal sense of how long they have been perceiving, feeling, thinking, or acting).

PACE

Cues for the regulation of the rate at which perceptions, feelings, thoughts, and actions are experienced or performed.

(*continued*)

SEQUENCE

Cues for the ordering of a series of perceptions, feelings, thoughts, and/or actions, especially in cases where automated routines are being accessed or are initially being developed.

EXECUTE

Cues for the activation of well-known series of perceptions, feelings, thoughts, and/or actions, especially in cases where automated routines have been practiced and used frequently.

MEMORY CLUSTER

HOLD

Cues the holding onto of specific perceptions, feelings, thoughts, and actions for a brief period of time.

MANIPULATE

Cues for the manipulation of perceptions, feelings, thoughts, or actions as they are being held in mind.

STORE

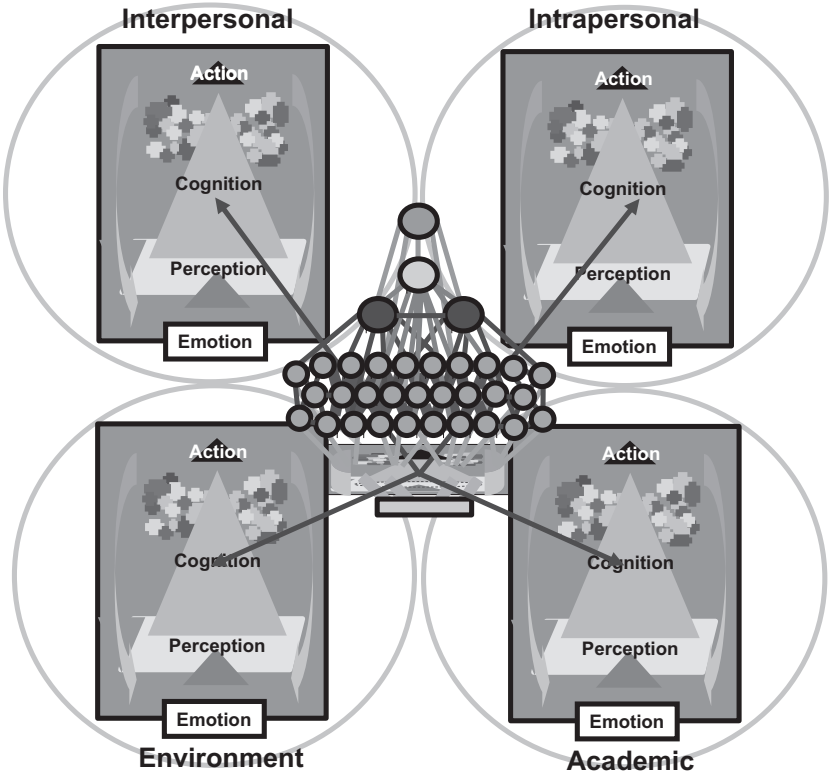
Cues the storing of specific perceptions, feelings, thoughts, and actions so that they can be retrieved as needed at a later time.

RETRIEVE

Cues for the retrieval of previously stored information about perceptions, feelings, thoughts, and actions.

The comprehensive model discussed here proposes a set of holoarchically organized executive function capacities that cue and direct functioning differentially for multiple subdomains within four general domains (Perception, Emotion, Thought and Action) as engaged differentially within four separate but coordinated Arenas of Involvement (Intrapersonal, Interpersonal, Environment and Symbol System). Figure 1.2 depicts executive function direction of the four domains of functioning within the four arenas of involvement. As will be discussed in later chapters, the distinctions of domains and subdomains of functioning, arenas of involvement, and self-regulation executive functions are critical to the development of a comprehensive approach to the assessment of executive functions. Rapid Reference 1.1 shows the relationship of various definitions or dimensions of executive functions to the various facets of the Holarchical Model of Executive Functions.

Figure 1.2 Executive Function Direction of Domains of Function Within Arenas of Involvement

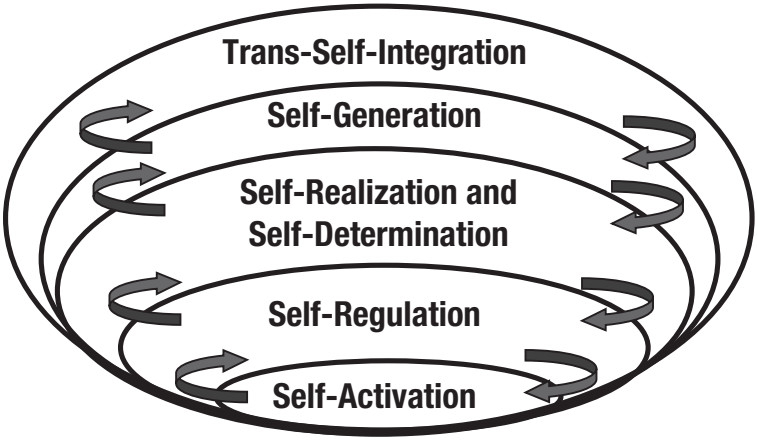


DEVELOPMENT OF EXECUTIVE FUNCTIONS

Information related to the development of executive functions is summarized in Rapid Reference 1.5. The tier structure shown in Figure 1.1 is not meant to represent a hierarchical tier-to-tier progression of cognitive neuropsychological development where one level is completed before advancement to the next level is possible. Rather, the model of executive functions presented here is conceived as a developmental holarchy similar to that described by Koestler (1964) and Wilber (1995) and depicted in Figure 1.3.

In such a holarchical model, development unfolds in a fluid, dynamic manner; no rigid constraints are placed on movement between the tiers. Development thus progresses from lower tiers to higher tiers without the requirement of full development of all of the executive functions of a lower tier before progression to

Figure 1.3 Holarchically Nested Levels of Developing Executive Functions



a higher tier. Additionally, development at lower tiers can continue at the same time as growth is occurring at higher tiers.

Within this holarchical model of executive functions, a person can be developing executive functions at multiple tiers at one time and can be moving forward with the development of upper tier executive functions despite the presence of substantial deficiencies in development of one or more executive functions at a lower tier. For example, development of a sense of self and an awareness of what a person can and cannot do can be enhanced greatly by the effective use of self-regulation executive functions, but the emergence or refinement of such higher level growth is not necessarily dependent on strong development of any or all of the 32 specified self-regulation executive functions; it is possible for a person to be very deficient in the use of one or more self-regulation executive functions while being painfully self-aware of these deficiencies due to advancement of growth in self-awareness capacities.

It is important to note however, that deficiencies with some self-regulation capacities are more likely than others to make it much more difficult, but not impossible, to develop self-awareness and/or to engage in self-reflection, goal generation, and long-term planning. For example, a person who is exceptionally poor at inhibiting impulsive perceiving, feeling, thinking, or acting, and who cannot sustain attention to perceptions, feelings, thoughts, or actions for more than a few seconds is likely to find it extremely difficult to engage in prolonged periods of self-reflection or self-analysis.

The wide variations in the development of executive functions among children of the same age noted in Rapid Reference 1.5 are very similar in nature to the wide variations in the physical development of children that are so apparent to adult observers. Among a group of same-age children, many will be very similar in general physical appearance. Some of the children, however, will stand out as appearing much younger looking, or much older looking, than their same-age peers. Although not observable outwardly, a similar range of variability also is present in terms of these same-age children's development of executive functions. It is also critical to recognize that physical development and executive functions development are not necessarily progressing in tandem. As a result, the youngest looking child may well have the best-developed executive functions of the entire same-age group, while the oldest looking child might have the least developed executive functions. For each child, various aspects of physical and mental development, including the multiple executive functions, follow their own separate growth trajectories.

Rapid Reference 1.5

Executive Functions Development

- Executive functions develop holarchically, not hierarchically.
- Executive functions development follows a timeline that is similar but not identical for all individuals.
- The development of some aspects of executive functions (self-activation, self-regulation) are ongoing from birth; others emerge later in childhood and show dramatic increases in levels of activation during the early adolescent years (self-realization, self-determination) and some may not emerge until adulthood or not at all (self-generation, trans-self-integration).
- Each of the 32 self-regulation executive functions has a unique, but interrelated, trajectory of development.
- Growth of each executive function may not be a steady, incremental trajectory; growth spurts and growth plateaus are likely to occur at various times in the process.
- Wide variations in the development of executive functions will be present within same-age cohorts.
- Although developmental gains vary greatly across persons and may be small for some individuals, executive functions typically show year-to-year growth.

(*continued*)

- Development of executive functions does not progress in a smooth continuous upward trajectory reflecting increased frequency and quality of use. Rather, developmental spurts during which frequency and quality of use are noticeably improved are followed by periods of lower frequency and poorer quality of use. Gradually over time, the shifts between use and disuse occur more rapidly and are much less pronounced until the point where frequency and quality of use is the typical state, with "glitches" or disruptions of this efficient state occurring relatively infrequently or emerging during periods of fatigue or stress.
- Development of executive functions varies intra-individually as well as inter-individually. For any given person, an ipsative as well as a normative profile of executive function strengths and weaknesses can be identified.

The fact that variations in the development of executive functions are neither physically apparent nor easy to observe seems to produce in many adult observers a bias against the appreciation of the significant impact of these developmental variations on a child's capacity to learn and produce as expected, especially within school settings. Students the same age who vary widely in physical development are not expected to perform comparably in gym class (e.g., lift the same amount of weight as or wrestle any peer regardless of size and weight) in order to earn a passing grade. The accommodations made for obvious differences in rates of physical development when judging the adequacy of performance in physical education however, typically are not afforded for the less obvious differences in development of executive functions when judging the adequacy of performance in cognitively based educational activities. To earn passing grades in academic areas, all same-age students are expected to display the same degree of development of multiple executive functions bundled together under vague, poorly defined labels such as self-responsibility or self-discipline.

The perceptual barrier that obscures the recognition of variation in the development of executive functions is usually accompanied by the equally detrimental belief that physical development is out of the direct control of any child, but mental development, especially that of executive functions, is well within the direct control of all children. Children who do not demonstrate the appropriate degree of self-responsibility are simply choosing to do so. Such assumed willful disobedience usually is attributed to poor parenting, poor schooling, the decline of societal values, a lack of internal motivation, laziness, apathy, questionable character, or various combinations of these sources.

Often in school settings, and even in many homes, the inability to recognize natural developmental variations results in very rigid expectations for the demonstration of executive functions. The negative consequences applied to a child not measuring up to the expected standards can be severe, unreasonable, and often uncompromising in nature. Appreciation of the natural variations in maturation of executive functions is crucial for ensuring appropriate educational experiences for those children who are demonstrating nothing more than natural maturational delays in the development of these capacities. The fact that mental maturational lags cannot be identified as easily as physical maturational lags does not excuse away the need to identify them and to act in accordance with that knowledge.

It is important to note that educational systems in the United States and many other countries follow a rigid chronologically aged-based structure. Children enter preschool, kindergarten, first grade, middle school, high school, and post-secondary institutions at predetermined chronological ages. Each transition from one level to the next within this system demands a greater degree of development of executive functions for success. The restricted age range for each of these transitions guarantees that some children will not be prepared to handle the executive functions challenges of the more demanding newer environment. These children are at-risk for failure to adapt quickly enough to the newly imposed conditions for no other reason than a lack of maturity of the necessary executive functions. For some of these children, the gap closes soon enough to enable them to recover from a rocky start and acclimate to the greater demands for increased executive functions use. For others, the developmental lag is much greater and growth is much slower, resulting in adjustment difficulties that may persist throughout the entire time spent at that level. Given that a child's rate of development can change over time, some students experience a delay in readiness at one or more transitions while effectively navigating others.

In the case of some developmental syndromes such as ADHD, research findings indicate roughly a 30% chronological delay in the development of various areas of the frontal cortex (Krain & Castellanos, 2006; Rubia, Smith, Brammer, & Taylor, 2007; Shaw et al. 2006; Shaw et al. 2007). These chronological findings align quite well with a model of executive functions wherein a 6-year-old child with ADHD is able to utilize specific self-regulation executive functions such as the Focus/Select, Sustain, Inhibit, and Modulate cues about as well as the average 4-year-old. Provided these developmental delays persist over time, this same child now at age 12 will utilize these executive functions about as well as the average 8-year-old. At age 18, this child will utilize these executive functions about as well as the average 12-year-old. It is not difficult for clinicians to realize the effects that such delays in maturation are likely to have on a child's educational experiences,

especially in the performance of tasks involving those vaguely defined qualities typically referred to as self-responsibility and self-discipline. As our thinking about that same 18-year-old extends to his or her ability to navigate the roads and highways as a driver with the Focus, Inhibit, and Sustain executive functions of a 12-year-old, it also is not difficult for clinicians and parents to understand the effects of these deficits in potentially life-threatening ways. Understanding the maturational delay aspect of the self-regulation problems exhibited by children can help clinicians appropriately conceptualize the nature of a child's difficulties and formulate appropriate interventions that reflect the need for great patience when faced with the slow progress that children experiencing these developmental delays are apt to demonstrate.

LOCUS OF INTENTIONALITY

How is it that some children who exhibit effective use of executive functions when engrossed in an activity of their own choosing can look so woefully inept when requested by others to perform that same activity? This seeming paradox befuddles parents, teachers, and the children who demonstrate these kinds of on-demand executive functions difficulties. Those who view these disparities often cannot help but think that these "sudden" incapacities are a matter of conscious choice—a convenient sham to avoid the hard work and effort that is needed from them. In actuality, a large majority of these observed inadequacies are not a matter of conscious choice, but instead are the result of undeveloped, underutilized, or ineffectively engaged executive functions.

Explanation for these seeming paradoxes can be found in the concept of *locus of intentionality. Locus of intentionality* as used here makes the important distinction between executive control engaged through *internal command* and executive control engaged as a result of *external demand* (Brown & Marsden, 1988; Freeman, 2000). *Internal command* refers to the engagement of executive functions that is triggered by a person's own internal desires, drives, aspirations, plans, and proclivities. *External demand*, on the other hand, refers to the engagement of executive functions in an effort to respond to external triggers, such as environmental conditions or the request of another person. The seeming paradox arises from the fact that executive control emanating from internal command is in concert with internal desires and motivational states that are active and influencing functioning whereas executive control necessitated by external demand requires a much more complex series of commands that may represent a large movement away from the prevailing internal state of the child. When responding to external demands for the use of executive functions, a person must first cue the

use of the Flexible cue to generate a willingness to consider the external request for altering the prevailing internal mental state along with the Interrupt or Stop cue to disengage any executive functions that are currently engaged in the direction of perceptions, feelings, thoughts, and actions based on prevailing internal commands. For persons already functioning under strong internally generated self-determination and self-generation guidance routines, the external demand might need to be evaluated against these existing upper-tier routines to reconcile or overcome any resistance to new demands due to possible conflicts of interest. After successful disengagement of internally commanded routines and successful cueing of a flexible stance to be open to the external demand, the person must cue the Gauge function to take stock of the situation and determine what perceptions, feelings, thoughts, or actions and related executive functions are needed in order to effectively respond to the external demand, and then cue and direct the use of the needed perceptions, feelings, thoughts, and actions in an effort to successfully comply with the external demand. All of these steps can be carried out either through conscious or nonconscious processing, but as is the case with most mental functioning, reactions to external demands typically occur nonconsciously. In other words, all the steps described above typically occur without a person consciously and deliberately thinking through them whether or not they want to respond to the external demand. Conscious direction of the transition from responding to internal commands to responding to external demands however is certainly possible. Difficulties arise when a person, nonconsciously or consciously, fails to shift from responding to internal commands to responding to external demands even in situations where it would be in their best interest to do so. This failure to shift locus of intentionality is often attributed to negative personal traits such as laziness, apathy, oppositional tendencies, or a passive aggressive stance. In actuality, the majority of such difficulties are rooted in an inability to effectively engage the neural networks needed to accomplish the shift.

Sports offer the best examples of the difficulties inherent in shifting executive function control from an internally commanded state to an externally demanded one. Examples of gifted athletes who fail to perform effectively in competition abound. Highly skilled, dedicated athletes spend a great deal of time training to perfect their skills in preparation for competition. In private, internally commanded practice sessions their performance is often flawless. Faced with the external demands of the competition unfolding on the playing field, however, these highly skilled athletes sometimes find it difficult to effectively engage executive functions under these externally demanded conditions in a manner that matches the precision of their internally commanded practice routines. Could it really be the case that all dedicated athletes who perform poorly during competition

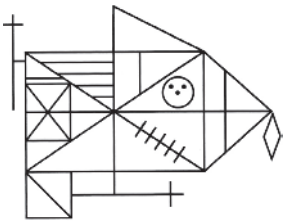
are simply choosing not to engage the executive functions needed to respond successfully? That they simply didn't want it enough? That they lacked the desire to win? That they weren't serious enough about their pursuit of excellence? After all, you've seen them perform much better than that many times before. How is it that when the demand and the stakes were so high, their performance was so poor? The examples of failure of top athletes in high stakes competition enables us to realize that even the most capable of individuals can have difficulty harnessing executive functions to direct and coordinate perceptions, feelings, thoughts, and actions under conditions of external demand. Handling external demands can be an onerous task even for those who have spent so much of their time attempting to perfect their executive control of specific perceptions, feelings, thoughts, and actions in order to respond effectively to varying conditions of external demand. Imagine what it must be like then for children who exhibit executive functions difficulties when they are faced with sudden external demands and the expectations for immediate compliance that often accompany them. All too often however, parents and teachers fail to appreciate the plight of the person who has not mastered the fine art of instant obedience and flawless execution.

Figure 1.4 offers an example of the sometimes stunning disparity that can exist between what a person is unable to accomplish in an externally-demanded situation and what they are able to accomplish when they are functioning in an internally commanded mental state. At the time of the evaluation when this 10-year-old child was asked to draw the Rey Complex Figure shown in Figure 1.4, he remarked that he liked to draw and that he considered himself to be a good artist. Unfortunately, also at the time of the evaluation this child was taking medication that had a detrimental effect on some executive functions, especially ones routed through the right frontal lobe. James was stunned with his inability to direct his drawing skills in his attempt to provide, on demand, an accurate copy of the design in front of him. Visibly shaken by his lack of production, James cried out in defense of his obviously subpar efforts: "But I *am* a good artist!" James' protest was certainly well-founded, as reflected in the free-hand sketch of a dragon shown in Figure 1.4 that was completed by James at a time when, in an internally commanded state, he "felt like drawing." In continued work with James, the challenges faced were: (a) helping him understand that the problem was a lack of executive function control of his well-developed drawing skills, not a lack of drawing skill, (b) showing him how the use of specific cognitive strategy routines could enable him to effectively apply his drawing skills; (c) teaching him how to generate and use cognitive strategy routines to complete drawing tasks; and (d) getting him to monitor situations so that he was able to recognize when to cue the use of the cognitive strategy routines that he had learned.

Figure 1.4 An example of the contrast in performance between externally demanded production and internally commanded production for a child with executive functions difficulties.

Production Based on External Demand

Model



Child's attempt to copy the model on request

Production Based on Internal Command: Child's freehand imaginative drawing at the time of his choosing

Patience, a nonjudgmental attitude, and a realization of the mental effort and frontal lobe maturation required to adapt to external demands can go a long way in helping individuals like James take a positive approach to efforts at developing greater on-demand executive function control of their mental faculties. And even under the best of conditions, consistent production might be a long, long time in coming. Conversely, attributing a child's lack of compliance with external demands to character flaws and negative personal traits or attitudes such as laziness, apathy, a sense of entitlement, or a desire to undermine authority will only serve to alienate the child, diminish any personal sense of connection, and often further reduce the likelihood of attempts at compliance with future externally imposed demands.

EXECUTIVE FUNCTIONS IN LEARNING AND PRODUCING

Learning can be viewed as a complex process involving the interplay of basic processes that take in sensory information and create mental representations, abilities, and skills that act on these mental representations, and lexicons that serve as storehouses of information that has been learned in the past. Learning also

requires the integration of multiple time frames of reference, initially registering incoming information in the immediate moment, moving into the past to retrieve previously learned information from lexicons, and holding on to information to manipulate it as time moves forward into the future. The 32 self-regulation executive functions play a critical role in the learning process as they are used to effectively direct and coordinate the interplay of the basic processes, abilities, skills, and lexicons and cue the proper accessing of the necessary time-related frames of reference. Individuals who are able to apply age appropriate self-regulation executive functions require a minimal amount of input from other sources in order to learn and effectively demonstrate what they have learned. These students exhibit effective use of executive functions and are able to engage in self-directed learning.

In contrast, individuals who exhibit executive function difficulties typically require much more input from external sources to assist them in the learning process. Ideally, this additional input helps them to overcome their executive functions difficulties so that they can make use of adequately developed processes, abilities, skills, and lexicons. For example, a person who has difficulty cueing the Focus/Select and Sustain functions is likely to benefit from teacher prompts that indicate on what or where to focus attention and prompts that cue for sustaining attention. When executive function difficulties are addressed effectively, a person can learn effectively.

It is critical to note, however, that addressing executive functions difficulties during instruction does not guarantee that students with executive functions difficulties will be able to demonstrate what they have learned when that learning is assessed. When executive function difficulties are present, inadequate production is likely to be demonstrated in the form of inadequate responses to questions during instruction, failed tests, or poorly done or incomplete assignments. If the individual learner has not been made aware of and taught how to overcome executive functions difficulties, these difficulties are likely to impact efforts at demonstrating what is learned even though learning did take place. Because learning is judged, not on the process of learning, but rather on the products of that learning, students who demonstrate executive functions difficulties can easily be mislabeled as having a learning disability when in fact, they have what could be called a *producing disability*. In other words, producing disabilities (or in their milder form, producing difficulties) are not the same thing as learning disabilities (or in their milder form learning difficulties). The distinction between learning and producing disabilities is critical to the accurate characterization of the nature of a student's problems. Learning disabilities involve the disruption of basic processes such that initial perceptions are not adequately prepared for mental representation (Berninger & Richards, 2002; McCloskey, 2009; McCloskey,

Whitaker, Murphy, & Rogers, 2012). In broader models such as those proposed in RTI (Fletcher, Lyon, Fuchs, & Barnes, 2007), learning disabilities can also be the result of disruption of abilities that act on and manipulate mental representations. When learning disabilities are exhibited, a person is much less capable of learning new skills and building skill-based lexicons. Although demonstration of what has been learned will be poor for these individuals, the source of their poor production is a learning disability not a producing disability.

One of the best examples of such a learning disability is developmental phonological dyslexia where an individual's deficiencies in the use of the basic auditory process of hearing sub-word sound units results in poor decoding skill development and poor overall reading achievement (Berninger & Richards, 2002; Shaywitz, 2003; Temple, 1997). When assessment of instruction is based on reading on grade or age level, students with phonologically based dyslexia are not likely to be able to demonstrate their learning. If these deficiencies are identified at an early age and the child is provided with appropriate remedial instruction, reading skills ultimately are much more likely to be at grade or age-appropriate levels. In the absence of any severe ability constraints or executive functions difficulties, the child identified as having a reading disability due to a phonological processing deficit is much more likely to perform adequately on assessments of new learning involving reading.

However, as noted earlier, the same is not likely to be true of a student who does not have a learning disability but who does have executive function difficulties. When assessment of what has been learned requires a degree of self-regulation beyond the person's existing capacities and no support is offered during the assessment, the individual is at risk of not being able to demonstrate what they have learned, that is, they are at risk for demonstrating a producing disability rather than a learning disability. The child with executive function difficulties, particularly those with self-regulation difficulties, will be able to learn effectively as long as those difficulties are being addressed effectively during instruction, during periods of study, and in the assessment of what has been learned. Many very good teachers and clinicians who are highly competent at ensuring that students are not overwhelmed by executive functions demands during the instructional process have a difficult time grasping the idea that if assessment is not guided in the same manner as instruction or if completion of the assessment inordinately requires the use of multiple executive functions, some students are not likely to demonstrate effectively what they have learned. Often those students with significant executive function difficulties will report that due to these demands, they could not determine how to demonstrate their knowledge of the information that they had learned. In fact, they may report that the assessment did not seem consistent with the instruction they received or with what they had learned. When students seek

help in trying to clarify assessment demands, resistance to such requests usually centers on the argument that assessment is not a fair and accurate estimate of what the student knows unless the student can perform without any form of assistance. The problem here is that this stance ignores the fact that unless some students are very effectively taught, not just the content of the lessons, but also how to overcome executive function difficulties during assessment, an accurate estimate of what these students know is unlikely.

Production difficulties often surface when a student is transitioning to the next level of schooling. Unexpected nose dives in academic production often occur during three specific education level transitions: from elementary to middle or junior high school; from middle or junior high school to senior high school; and from high school to a post-secondary setting such as a college or a technical school. There are many possible reasons for the greater academic impact of executive function difficulties during educational transitions. Abrupt shifts in teaching style; an increase in the number of teachers and teaching styles; increased complexity of learning and production demands, and increased expectations for self-direction of learning and producing all can have a negative impact on students who do not possess the executive functions needed to handle the changed conditions. When an educational transition occurs ahead of the development of the necessary executive functions, the student is underprepared for taking on the responsibilities of the new learning environment, and the result often is a lack of adequate production including failing grades or grades significantly below a child's putative cognitive abilities. The lack of adequate production can be bewildering to the parents and the students alike, especially if no difficulties had been noted prior to this latest transition. Parents will often question how a child who seems so bright is beginning to do so poorly.

Because of the wide variation in rates of executive functions developmental however, the capacity for handling an increase in demands for self-regulation can vary greatly from one student to the next. For some students, as executive functions development progresses their capabilities come to be more in line with the demands of the educational setting and adjustments can be made to bring production more in line with expectations. Here the impact may be relatively minimal and parents and the student may characterize this process as the student needing a quarter of the year to adapt to the greater demands. Students experiencing more extreme developmental delays or medical conditions resulting in severe executive function deficits often are unable to produce work that is judged adequate by established standards, although many of these students have been able to learn new content and acquire academic skills. Whether the executive function difficulties are mild or severe, what these students have difficulty with is meeting the demands

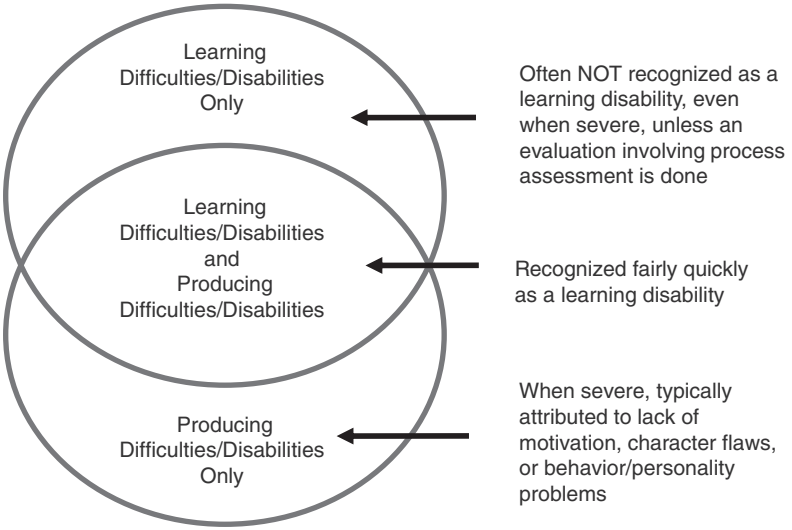
for production that demonstrates what they have learned. These students may struggle with one or more production formats such as recording their thoughts in writing, responding effectively to oral and/or written test questions, completing projects that are done within specified timelines and that contain all required elements or follow the required rubric, or remembering to do and/or hand in homework assignments, lab reports, or other required materials. The greater the number and severity of the executive function delays or deficits exhibited, the greater the problems from lack of production, the greater the risk of persistent failure in the school setting, and the greater the risk for a sense of demoralization of self.

If this were not bad enough, exacerbating the challenges faced by students with executive function difficulties is the lack of a sanctioned diagnostic classification for executive function difficulties. This lack of classification makes it difficult, if not impossible to obtain the educational services these students need to help them succeed in school. The distinction between learning and producing disabilities, or more generally between learning and producing difficulties, is an important one because it sheds light on why educational support services are, or are not, provided to children who are struggling in school. As mentioned earlier, it is certainly the case that a number of children demonstrate both learning problems due to processing deficits or ability constraints and production problems due to executive function difficulties.

The clinical experiences of the authors suggest that children who experience difficulties with both learning and producing are the most likely to be identified as learning disabled at a relatively young age. Figure 1.5 illustrates the three ways that learning and producing difficulties manifest. The center overlapping portion of both circles represents those students who have both learning and producing difficulties. Typically, the lack of adequate production is what initially draws teachers' attention to the difficulties of these students. When a comprehensive assessment is undertaken with these students, the learning difficulties are revealed (even though the producing difficulties may not be well documented or addressed in the assessment). The dual nature of the problems exhibited by these students makes it easy for both teachers and parents to see the need for instructional modifications and/or specialized services to help these students succeed in school.

Those at the upper and lower nonoverlapping portions of the diagram represent a somewhat less clear picture. The nonoverlapping portion of the top circle represents those students who demonstrate adequately developed executive functions for their age but are hampered by specific learning difficulties. In the case of a reading disability described earlier, a student who has well developed executive functions but poor subword sound processing leading to limited decoding skills may find alternative ways to move new words from the status of unfamiliar and undecodable

Figure 1.5 A General Model for Conceptualizing Learning and Producing Difficulties



to the status of familiar and recognized by sight. When these students are assessed, the extent of their word recognition store masks the fact that they cannot decode unfamiliar words. Students with well-developed executive functions can be quite inventive in the strategies they develop to compensate for a learning disability. Those with adequately developed executive functions sometimes are able to maintain adequate academic production throughout all levels of schooling. However, even for these students, at some point in the educational process, the production demands are likely to become too much to handle and problems will persist until they receive the assistance they need to manage their learning disabilities.

The fact that these students are able to produce adequately despite their learning disabilities makes it much less likely that their learning difficulties will be recognized by teachers or even parents, at least during the elementary school years and especially in an educational climate where learning disabilities are identified strictly with a "response to instruction" model. More often, the learning difficulties of these students surface in later school years when their executive functions begin to be overtaxed in their efforts to compensate for the effects of the learning disability. At this point in time, parents are often the first to see the struggles that the student is having in keeping up with coursework and to request assistance from school staff. School staff may be reticent in complying with parent requests at these later grades, especially if the student is earning passing grades

and especially if the student's previous educational record has not been suggestive of a disability. The problem here usually is that the school staff have not been observing the unusual compensatory strategies employed, the inordinate amount of time and effort required to complete school work, and the strain that these additional efforts are placing on the students at home. The burden is then on the parents to convince school staff that some kind of assistance is needed.

The nonoverlapping portion of the bottom circle represents those students for whom there is no ostensible evidence of learning disabilities per se, but who demonstrate inadequate production due to developmental delays or deficits in one or more executive functions. Similar to the students with both learning and producing difficulties, the inadequate production of these students results in closer scrutiny by school staff and parents. In the case of some of these students, written expression production difficulties are noted allowing them to be classified as learning disabled even though, had a thorough assessment been conducted, it would have been revealed that the lack of written production was not due to any basic process deficits or any lack of abilities that would constrain written production, that is, not really due to a learning disability, but rather due to a poor ability to cue and direct the coordination of all of the processes, abilities, skills, lexicons, and time frames needed for adequate production, that is, due to a producing disability. Although labeling a producing disability as a learning disability is inaccurate, it does provide an administratively sanctioned means for helping the student to improve his or her writing skills. For another subset of these students, competent assessment documenting their executive functions difficulties, especially those related to poor cueing of inhibition and modulation and poor cueing of the focusing and sustaining of attention, and the impact these have had on academic production, will lead to an appropriate classification of ADHD or ADD, making the student eligible for assistance through a 504 accommodation plan or under the special educational classification of "Other Health Impaired—ADHD/ADD."

Unfortunately, for an all too large percentage of these students, no specific learning difficulties are identified and ADHD is ruled out as the cause of their lack of production. In the absence of a diagnosed cause, the observed lack of production is attributed by staff and parents to a myriad of negative traits or character deficiencies such as laziness, apathy, unwillingness to take responsibility for their own actions, lack of motivation, overt hostility, or lack of respect for authority—what Denckla (2007) refers to as "adult name-calling." While attributing the difficulties of these students to such nefarious origins might ease the conscience of some parents and teachers or enable them to shift responsibility for dealing with the situation completely onto the poorly developed brain of the student, these attributions do not serve to solve the problems that have been created by the lack of production and

certainly do not provide any guidance to these students' developing brains as to how to solve their problems. Conversely, they often serve to exacerbate the situation, creating even more unwanted negative behavior and further demoralization, resulting in a larger rift between the student and those who hold expectations for production. Without appropriate identification of the source of the difficulties experienced by these students and proper assistance through interventions aimed at reducing executive functions demands and/or improving the student's ability to use executive functions, this group of students faces the greatest risk of failing in school.

SUMMARY

The discussion of the multidimensional construct of executive functions provided in this chapter is intended to serve as the theoretical foundation for the rationale underlying the assessment methods discussed in subsequent chapters of this book. At this point, it should be apparent to the reader that executive functions are a complex collection of directive capacities that vary greatly based on domains of functioning, arenas of involvement, and a number of contextual factors, all of which need to be taken into account to some degree when attempting to assess executive functions involvement in the direction of perception, emotion, thought, and action. The chapters that follow will offer clinicians a model for applying assessment techniques in a way that characterizes as accurately as possible a client's executive functions through the most effective means available. It is hoped that the information provided here and in the remaining chapters of this essentials guide will enable clinicians to more effectively identify the executive functions difficulties that often underlie students' lack of academic production and behavior problems and lead to effective intervention efforts.

TEST YOURSELF

1. **The holarchical model of executive functions described in this chapter is based on**
   (a) the gold standard definition of executive functions accepted by most researchers and clinicians.
   (b) the metaphorical concept of executive functions as director of the brain's orchestra.
   (c) a synthesis of multiple theoretical and research perspectives on executive functions.
   (d) a set of constructs derived primarily from factor analysis of large data sets.

2. The term *the executive* was first used to refer to human mental functioning by

(a) Alan Baddeley.
(b) Roberto Assagioli.
(c) Ulrich Neisser.
(d) Russell Barkley.

3. The holarchical model of executive functions is based in part on all of the following except

(a) Executive functions are multiple in nature; they do not represent a unitary trait.
(b) Executive functions cue, direct, and coordinate the use of other mental constructs.
(c) Executive functions use can vary across four broad construct domains.
(d) Executive functions use is invariant across four different arenas of involvement.

4. The holarchical model enables clinicians to appreciate the overlapping, multidimensional nature of executive functions development and the problems associated with developmental lags at one or more levels.

True or False

5. Unlike development in a hierarchical model, development in a holarchical model

(a) can progress to the next level before completion of development at a lower level.
(b) cannot progress to the next level before completion of development at a lower level.
(c) starts at the same point in early childhood for all levels of development.
(d) ends at the same point in late adolescence for all levels of development.

6. In the holarchical model presented in this chapter, all of the following are considered self-regulation executive functions except

(a) Speak.
(b) Shift.
(c) Monitor.
(d) Gauge.

7. Being able to attend to a video game for hours but being unable to attend to a lecture on history for more than a few minutes is an executive functions paradox that is referred to in this chapter as representing the difference between

(a) "can do" and "won't do."
(b) internal command and external demand.
(c) self-actualization and self-discipline.
(d) laziness and laissez-faire.

8. A student performed very poorly on a teacher-assigned persuasive essay but received high praise for an extremely well written letter to the school paper arguing for expansion of the school's intramural sports program. From the perspective of the executive functions framework presented in this chapter, this paradox is most likely the result of

(a) a lack of motivation for complying with assignments.
(b) significant written expression skills deficits.
(c) a lack of character and self-discipline.
(d) difficulties with external on-demand production.

9. The conceptual metaphor of the CEO of the brain

(a) is an oversimplification of the concept of self-control.
(b) effectively represents the concept of self-control.
(c) addresses the homunculus problem of self-control.
(d) explains the decision making processes of self-control.

10. The gradual process of gaining control of self-regulation executive functions after a period of sleep is referred to as

(a) Self-Determination.
(b) Self-Generation.
(c) Self-Activation.
(d) Self-Realization.

Answers: 1. c, 2. c, 3. d, 4. True, 5. a, 6. a, 7. b, 8. d, 9. a, 10. c