PASS: A Cognitive Processing Based Theory of Intelligence

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Planning, Attention, Simultaneous, Successive (PASS) Theory

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Introduction

Practitioners and test authors have become increasingly conscious of the need for theory based intelligence tests (Lidz, 1991). There is also an increasing recognition that psychological processes should be measured especially in order to make better diagnostic and instructional decisions (Naglieri & Otero, 2010). The Planning, Attention, Simultaneous, and Successive cognitive processing (PASS) theory of intelligence as measured by the Cognitive Assessment System (CAS; Naglieri & Das, 1997a) fulfill that need.

The development of processing based intelligence tests was initiated by the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983). Alan and Nadeen Kaufman published the first well-developed measure of intelligence conceptualized and developed with an emphasis on cognitive processing rather than traditional general ability. The second intelligence test to be specifically developed using a neuropsychological perspective on ability was the CAS (Naglieri & Das, 1997a)(see Naglieri & Otero, 2011). These tests marked a change from the traditional verbal/nonverbal organizational approach used since the Army Mental Testing program described by Yoakum and Yerkes (1920) nearly 100 years ago. The K-ABC and CAS brought about an evolution in the field of intelligence testing by emphasizing (a) that a *test* of intelligence should be based on a *theory* of intelligence and (b) the test should measure basic psychological processes defined by the intellectual demands of the test not the content of the questions (e.g., verbal or nonverbal). This raises two important issues: what is a theory and what is a cognitive process?

IQ tests have been devoid of a theoretical foundation since they were first introduced more than 100 years ago (Naglieri & Kaufman, 2008). In recent years, considerable efforts have been made to reconceptualize already published tests within some theoretical framework. For example, both the Stanford-Binet (Roid, 2003) and the Differential Abilities Scales – Second Edition (Elliott, 2006) have been linked to the Cattell-Horn-Carroll view of intelligence. Luria’s neuropsychological theory provided the foundation of the PASS theory used for the CAS and the KABC-II is built on both theoretical models of Luria’s theory and the CHC model. Clearly, in recent times test authors are making efforts to either build tests on a theory of intelligence or attach a theory to a test. In either case, the field of IQ testing has evolved considerably in the past 30 years.

A cognitive process is described by Naglieri (2011) as a “foundational, neuropsychologically identified ability that provides the means by which an individual functions in this world (p. 147)”. He goes on to clarify that cognitive processes underlie all mental and physical activity and the application of cognitive processes allows for the acquisition of all types of knowledge and skills. However, it is very important to recognize that knowledge and skills are not examples of basic psychological processes but, instead, the result of the application of these processing abilities. It is also important to recognize that cognitive processes should be defined on the basis of a coherent theory that has been proposed, operationalized, tested and shown to have reliability, validity. Thus, the goal of this chapter is to describe a theory of intelligence grounded in cognitive and neuropsychological psychology and its validity.

# Origins of the PASS Theory

The Planning, Attention, Simultaneous, and Successive (PASS; Naglieri & Das, 1997a) theory is rooted in the work of A. R. Luria (1966, 1973a, 1973b, 1980) on the functional aspects of brain structures. J.P. Das and I used Luria’s work as a blueprint for defining the important components of human intelligence (Das, Naglieri, & Kirby, 1994; Naglieri & Das, 1997) because we strongly believe that a test of intelligence should be based on a theory of intelligence, and a theory of intelligence should be based on an understanding of basic psychological processes. Our efforts represent the first time that a specific ­researched neuropsychological theory was used to reconceptualize the concept of human intelligence and provide a specific tool to measure that theory.

Luria theorized that human cognitive functions can be conceptualized within a framework of three separate but related “functional units” that provide four basic psychological processes. The three brain systems are referred to as *functional units* because the neuropsychological mechanisms work in separate but interrelated systems. Luria (1973b) stated that “each form of conscious activity is always a complex functional system and takes place through the combined working of all three brain units, each of which makes its own contribution” (p. 99). The four processes form a “working constellation” (Luria, 1966, p. 70) of cognitive activity. A person may, therefore, perform the same task with different contributions of the PASS processes, along with the application of the child’s knowledge and skills.

Although effective functioning is accomplished through the integration of all processes as demanded by the particular task, not every process is equally involved in every task. For example, tasks like math calculation may be dominated by a single process (e.g., planning), while tasks such as reading decoding may be strongly related to another process (e.g., successive). Effective ­functioning—­for example, processing of visual ­information—­also involves three hierarchical levels of the brain. Consistent with structural topography, these can be described in the following manner. First, there is the *projection area*, where the modality characteristic of the information is important. Above the projection area is the *association area*, where information loses part of its association with a particular modality. Above the association area is the *overlapping zone*, where information is no longer modality specific. This enables information to be integrated from various senses and processed at a higher level. Thus modality is most important at the level of initial reception, and less important at the level where information is integrated.

### Description of the Three Functional Units

The function of the first unit provides reg­ulation of cortical arousal and attention; the second codes information using simultaneous and successive processes; and the third provides for strategy development, strategy use, self-monitoring, and control of cognitive activities.

According to Luria, the first of these three functional units of the brain, the ­attention–­arousal system, is located primarily in the brainstem, the diencephalon, and the medial regions of the cortex (Luria, 1973b). This unit provides the brain with the appropriate level of arousal or cortical tone, as well as ­directive and selective attention (Luria, 1973b). When many stimuli are presented to a person who is then required to pay attention to only one stimulus, the inhibition of responding to other (often more salient) stimuli and the focus of attention to the target stimulus, depends on the first functional unit. Luria stated that optimal conditions of arousal are needed before the more complex forms of attention, involving “selective recognition of a particular stimulus and inhibition of responses to irrelevant stimuli” (1973b, p. 271), can occur. Moreover, only when individuals are sufficiently aroused and their attention is adequately focused can they utilize processes in the second and third functional units.

The second functional unit is associated with the occipital, parietal, and temporal lobes posterior to the central sulcus of the brain. This unit is responsible for receiving, processing, and retaining information the person obtains from the external world. This unit involves simultaneous processing and successive processes. Simultaneous processing involves integrating stimuli into groups so that the interrelationships among the components are understood. For example, in order to produce a diagram correctly when given the instruction “Draw a triangle above a square that is to the left of a circle under a cross,” the relationships among the different shapes must be correctly comprehended. Whereas simultaneous processing involves working with stimuli that are interrelated, successive processing involves information that is linearly organized and integrated into a ­chain-­like progression. For example, successive processing is involved in the production of sequences of sounds used to make words, decoding of unfamiliar words, production of syntactic aspects of language, and speech articulation. Following a sequence such as the order of operations in a math problem is another example of successive processing. In contrast, simultaneous processing involves integration of separate elements into groups.

The third functional unit is associated with the prefrontal areas of the frontal lobes of the brain (Luria, 1980). Luria stated that “the frontal lobes synthesize the information about the outside world . . . and are the means whereby the behavior of the organism is regulated in conformity with the effect produced by its actions” (1980, p. 263). This unit provides for the programming, regulation, and verification of behavior, and is responsible for behaviors such as asking questions, solving problems, and self-monitoring (Luria, 1973b). Other responsibilities of the third functional unit include the regulation of voluntary activity, conscious impulse control, and various linguistic skills such as spontaneous conversation. The third functional unit provides for the most complex aspects of human behavior, including personality and consciousness (Das, 1980).

### Functional Units: Influences and Issues

Luria’s organization of the brain into functional units accounts for cultural influences on higher cognition as well as biological factors. He stated that “perception and memorizing, gnosis and praxis, speech and thinking, writing, reading and arithmetic, cannot be regarded as isolated or even indivisible ‘faculties’ ” (Luria, 1973b, p. 29). That is, we cannot, as phrenologists attempted to do, identify a “writing” spot in the brain; instead, we must consider the concept of units of the brain that provide a function. Luria (1973b) described the advantage of this approach:

It is accordingly our fundamental task not to “localize” higher human psychological processes in limited areas of the cortex, but to ascertain by careful analysis which groups of concertedly working zones of the brain are responsible for the performance of complex mental activity; when contributions made by each of these zones to the complex functional system; and how the relationship between these concertedly working parts of the brain in the performance of complex mental activity changes in the various stages of its development. (p. 34)

Activities such as reading and writing can be analyzed and linked as constellations of activities to specific working zones of the brain that support them (Luria, 1979, p. 141). Because the brain operates as an integrated functional system, however, even a small disturbance in an area can cause disorganization in the entire functional system (Das & Varnhagen, 1986).

Luria’s concept of dynamic functional units provides the foundation for PASS processes. These basic psychological processes are firmly based on biological correlates, yet develop within a sociocultural milieu. In other words, they are influenced in part by the cultural experiences of the person. Luria (1979) noted that “the child learns to organize his memory and to bring it under voluntary control through the use of the mental tools of his culture” (p. 83). Kolb, Gibb, and Robinson (2003) have also noted that although “the brain was once seen as a rather static organ, it is now clear that the organization of brain circuitry is constantly changing as a function of experience” (p. 1). Similarly, Stuss and Benson (1990) recognize this interplay and especially the use of speech as a regulatory function when they state:

The adult regulates the child’s behavior by command, inhibiting irrelevant responses. The child learns to speak, the spoken instruction shared between the child and adult are taken over by the child, who uses externally stated and often detailed instructions to guide his or her own behavior. By the age of 4 to 4½, a trend towards internal and contract speech (inner speech) gradually appears. The child begins to regulate and subordinate his behavior according to his/her speech. Speech, in addition to serving communication thought, becomes a major self-regulatory force, creating systems of connections for organizing active behavior inhibiting actions irrelevant to the task at hand. (p. 34)

Luria stressed the role of the frontal lobes in language, organization, and direction of behavior and speech as a cultural tool that furthers the development of the frontal lobes and self-regulation. Cultural experiences thus actually help to accelerate the utilization of planning and self-regulation, as well as the other cognitive processes.

Luria (1979) also points out that ab­straction and generalizations are themselves products of the cultural environment. Children learn, for example, to attend selectively to relevant objects through playful ­experiences and conversations with adults. Even simultaneous and successive processes are influenced by cultural experiences (e.g., learning songs, poems, rules of games, etc.). Naglieri (2003) has summarized the influence of social interaction on children’s use of plans and strategies, and the resulting changes in performance on classroom tasks.

The relationship between the third and first functional units is particularly strong. The first functional unit works in cooperation with, and is regulated by, higher systems of the cerebral cortex, which receive and process information from the external world and determine an individual’s dynamic activity (Luria, 1973b). In other words, this unit has a reciprocal relationship with the cortex. It influences the tone of the cortex and is itself influenced by the regulatory effects of the cortex. This is possible through the ascending and descending systems of the reticular formation, which transmit impulses from lower parts of the brain to the cortex and vice versa (Luria, 1973b). For the PASS theory, this means that attention and planning are necessarily strongly related, because attention is often under the conscious control of planning. That is, our planning of behavior dictates the allocation of our limited attentional resources. This also helps explain how these two components of the PASS theory can be related to the concept of executive function.

Although there is yet to be a consensus definition of the concept of executive function, most theorists agree that this is an ability that is necessary for purposeful behavior so that goals are achieved. The frontal lobes, especially the dorsolateral and the ventromedial regions, in combination with mid brain structures in the basal ganglia and the cerebellum are a key to efficient executive functioning. Tasks that measure this cognitive process should be relatively unfamiliar so that the examinee has to develop a way to solve the problem, self-monitoring and error correction, it could involve selective attention in settings where a highly learned response has to be inhibited, and using methods of working with information that needs to be remembered over a short period of time.  All these attributes are contained in the planning and attention constructs of PASS theory as measured by the CAS Planning and Attention scales.

### Three Functional Units and PASS Theory

Luria’s concept of the three functional units used as the basis of the PASS theory is ­diagrammatically shown in Figure 7.1. Although rendering a complex functional system in two-dimensional space has its limitations, the diagram illustrates some of the important characteristics of the PASS theory. First, an important component of the theory is the role of a person’s fund of information. Knowledge and skills are a part of each of the processes, because past experiences, learning, emotions, and motivations provide the background as well as the sources for the information to be processed. This information is received from external sources through their sense organs. The information may involve memory, or perception, or thinking (Das, Kirby & Jarman, 1975, 1979), but all will be analyzed according to the processing demand(s) of the task. When that sensory information is sent to the brain for analysis, central processes become active. However, internal cognitive information in the form of images, memory, and thoughts becomes part of the input as well. Thus the four processes operate within the context of an individual’s knowledge base and cannot operate outside the context of knowledge. “Cognitive processes rely on (and influence) the base of knowledge, which may be temporary (as in immediate memory) or more long term (that is, knowledge that is well learned)” (Naglieri & Das, 1997c, p. 145). Cognitive processing also influences knowledge acquisition, and learning can influence cognitive processing. Both are also influenced by membership in particular social and cultural milieus (Das & Abbott, 1995, p. 158). The importance of knowledge is therefore integral to the PASS theory. A person may read English very well and have good PASS processes, but may falter when required to read Japanese text—due to a deficient knowledge of Japanese, rather than a processing deficit.

Insert Figure 7.1 here

*Planning* is a frontal lobe function. More specifically, it is associated with the pre­frontal cortex and is one of the main abilities that distinguishes humans from other primates. The prefrontal cortex plays a central role in forming goals and objectives and then in devising plans of action required to attain these goals. It selects the cognitive skills required to implement the plans, coordinates these skills, and applies them in a correct order. Finally, the prefrontal cortex is responsible for evaluating our actions as ­success or failure relative to our intentions. (Goldberg, 2001, p. 24)

Planning therefore helps us select or develop the plans or strategies needed to complete tasks for which a solution is needed, and is critical to all activities where a child or adult has to determine how to solve a problem. It includes generation, evaluation, and execution of a plan, as well as self-monitoring and impulse control. Thus planning allows for the solution of problems; the control of attention, simultaneous, and successive processes; and selective utilization of knowledge and skills (Das, Kar, & Parrila, 1996).

*Attention* is a mental process that is closely related to the orienting response. The base of the brain allows the organism to direct focused selective attention toward a stimulus over time and to resist loss of attention to other stimuli. The longer attention is required, the more the activity is one that demands vigilance. Attention is controlled by intentions and goals, and involves knowledge and skills as well as the other PASS processes.

*Simultaneous processing* is essential for organization of information into groups or a coherent whole. The parietal, occipital, and temporal brain regions provide a critical “ability” to see patterns as interrelated elements. Because of the strong spatial characteristics of most simultaneous tasks, there is a strong ­visual–­spatial dimension to activities that demand this type of processing. Simultaneous processing, however, is not limited to nonverbal content, as illustrated by the important role it plays in the grammatical components of language and comprehension of word relationships, prepositions, and inflections.

*Successive processing* is involved in the use of stimuli arranged in a specific serial order. Whenever information must be remembered or completed in a specific order, successive processing will be involved. Importantly, however, the information must not be able to be organized into a pattern (e.g., the number 9933811 organized into 99-33-8-11); instead, each element can only be related to those that precede it. Successive processing is usually involved with the serial organization of sounds and movements in order. It is therefore integral to, for example, working with sounds in sequence and early reading.

The PASS theory is an alternative to approaches to intelligence that have traditionally included verbal, nonverbal, and quantitative tests. Not only does this theory expand the view of what “abilities” should be measured, but it also puts emphasis on basic psychological processes and precludes the use of verbal ­achievement-­like tests such as vocabulary. In addition, the PASS theory is an alternative to the notion of a general intelligence. Instead, the functions of the brain are considered the building blocks of ability conceptualized within a cognitive processing framework. Although the theory may have its roots in neuropsychology, “its branches are spread over developmental and educational psychology” (Das & Varnhagen, 1986, p. 130), as well as over neurological dysfunctions. Thus, the PASS theory of cognitive processing, with its links to developmental and neuropsychology, provides an advantage in explanatory power over the notion of general intelligence (Naglieri & Das, 2002).

### Three Functional Units and PASS Theory

One source of validity from a neuropsychological perspective is the research that examines the PASS processes and brain function. For example, Luria initially associated simultaneous processing as a function of the occipital–parietal region, whereas successive processing as a function of a fronto–temporal region (each had a bilateral location). In a recent experiment from Japan (Okuhata, Okazaki & Maekawa, 2008) studied the two processes using EEG. The researchers investigated patterns during six tasks of Cognitive Assessment System (Naglieri & Das, 1997), three from Simultaneous and three from Successive scales. The results showed two significantly distinguishable coherence patterns corresponding to the two types of processing. Both processes are localized in the posterior part of the brain as Luria had suggested. Similarly, McCrea (2009) showed that simultaneous is strongly dependent occipitoparietal activity whereas successive showed fronto-temporal specificity with some evidence of interhemispheric coordination across the prefrontal cortex. McCrea’s results give support for the validity of the PASS composite scales. Additionally,Christensen, Goldberg & Bugakov (2009), provided a substantive summary of brain imaging research that support Luria’s conceptualizations and PASS theory.

Operationalization and Application of the Theory

The PASS theory is operationalized by the Cognitive Assessment System (CAS; Naglieri & Das, 1997a) and the forthcoming CAS-2 (Naglieri, Das, & Goldstein, in preparation). This instrument is amply described in the CAS Interpretive Handbook (Naglieri & Das, 1997b) and by Naglieri in Chapter 20 of this book. We (Naglieri & Das, 1997a) generated tests to measure the PASS theory, following a systematic and em­pi­rically based test development program ­designed to obtain efficient measures of the processes that could be individually administered. The PASS theory was used as the foundation of the CAS, so the content of the test was determined by the theory and not influenced by previous views of ability. This is further elaborated in Chapter 20 of this book.

## Empirical Support for the Theory

Dillon (1986) suggested six criteria (validity, diagnosis, prescription, comparability, rep­licability/standardizability, and psychodiag­nostic utility) for evaluation of a theory of cognitive processing. Naglieri (1989) evaluated the PASS model on these criteria, using the information available at that time; in this chapter, we use the same criteria to evaluate the current status of the PASS theory as operationalized by the CAS. This section includes summaries of research due to space limitations, but additional information is provided in Chapter 20 of this text and in other resources (Naglieri, 1999, 2003; Naglieri & Das, 1997b).

### Validity

The fundamental validity of the PASS theory is rooted in the neuropsychological work of Luria (1966, 1973a, 1973b, 1980, 1982), who associated areas of the brain with basic psychological processes as described earlier in this chapter. Luria’s research was based on an extensive combination of his and other researchers’ understanding of brain functions, amply documented in his book *The Working Brain* (1973b). Using Luria’s three functional units as a backdrop, Das and colleagues (Das, 1972; Das, Kirby, & Jarman, 1975, 1979; Das, Naglieri, & Kirby, 1994) initiated the task of finding ways to measure the PASS processes. These efforts included extensive analysis of the methods used by Luria, related procedures used within neuropsychology, experimental research in cognitive and educational psychology, and related areas. This work, subsequently summarized in several books (e.g., Das, Naglieri, & Kirby, 1994; Kirby, 1984; Kirby & Williams, 1991; Naglieri, 1999; Naglieri & Das, 1997b), demonstrated that the PASS processes associated with Luria’s concept of the three functional units could be measured. This work also illustrated that the theoretical conceptualization of basic psychological processes had considerable potential for application.

Initial studies of the validity of the PASS theory included basic and essential elements for a test of children’s cognitive competence, such as developmental changes. Researchers found that performance on early versions of tests of these processes showed evidence of developmental differences by age for children of elementary and middle school ages (Das, 1972; Das & Molloy, 1975; Garofalo, 1986; Jarman & Das, 1977; Kirby & Das, 1978; Kirby & Robinson, 1987; Naglieri & Das, 1988, 1997b) and for high school and college samples (Ashman, 1982; Das & Heemsbergen, 1983; Naglieri & Das, 1988).

We and our colleagues have also demonstrated that the constructs represented in the PASS theory are strongly related to achievement. A full discussion of those results is provided by Naglieri in Chapter 20 of this book. The results demonstrate that the PASS constructs are strongly related to achievement, and the evidence thus far suggests that the theory is more strongly related to achievement than are other measures of ability. Importantly, despite the fact that the measures of PASS processes do not include ­achievement-­like subtests (e.g., vocabulary and arithmetic), the evidence demonstrates the utility of the PASS theory as operationalized by the CAS for predication of academic performance. Because one purpose of the CAS is to anticipate levels of academic performance on the basis of levels of cognitive functioning, these results provide critical support for the theory.

### Diagnosis

There are two important aims of diagnosis: first, to determine whether variations in characteristics help distinguish one group of children from another; and second, to determine whether these data help with intervention decisions. Prescription is discussed in the next section; the question of diagnosis is addressed here. One way to examine the utility of PASS cognitive profiles is by analysis of the frequency of PASS cognitive weaknesses for children in regular and special ed­ucational settings. It is important to note, however, that these studies look at PASS *scale* profiles, not *subtest* profiles which have been the focus of profile analysis research in the past. A second way is to ­examine diagnostic utility is by examin­ation of specific populations (e.g., children with ­attention-­deficit/hyperactivity disorder [ADHD], Autism, or Learning disabilities). We summarize the relevant research in the next section.

#### Children with Reading Disability

 The application of PASS and CAS to understanding reading disabilities has important implications for diagnosing (and treating) reading disabilities (see Das (2009) for a more complete discussion). Essentially, reading researchers generally agree that phonological skills play an important role in early reading and some have suggested this to be the major cause of reading disability for children (Stanovich, 1988; Wagner, Torgesen, & Rashotte, 1994). One of the most frequently cited articles in the field, by Torgesen, Wagner, and Rashotte (1994), proposes that phonological skills are causally related to normal acquisition of reading skills. Support for this claim can also be found in the relationship between pre-readers’ phonological scores and their reading development 1–3 years later (e.g., Bradley & Bryant, 1985). Moreover, Share and Stanovich (1995) concluded that there is strong evidence that poor readers, as a group, are impaired in a very wide range of basic tasks in the phonological domain. We have suggested, however, (Das, Naglieri, & Kirby, 1994) that underlying a phonological skills deficit is a specific cognitive processing deficit in Successive processing that underlies word-reading deficits.

 Das, Mishra, and Kirby (1994) found that successive processing scores from the CAS were better at distinguishing normal readers from children with dyslexia than a test of phonemic segmentation. Additional studies on the relationship between PASS and reading disability have since supported the hypothesis that in predicting reading disability, PASS processes are as important as phonological skills (Das, Parrila, & Papadopoulos, 2000). Several recent studies which involved Canadian First Nations children are particularly important. Das, Janzen and Georgiou (2007) reported that successive processing had a unique contribution in predicting both word identification and reading pseudo-words (word attack). Furthermore, the poor readers demonstrated a significant weakness in successive processing both in relation to the norm and in relation to their scores in the other three CAS scales. Similarly, Naglieri, Otero, DeLauder and Matto (2007) reported deficits in Successive processing for bilingual children with reading disabilities who were administered the CAS in English and Spanish. Additionally, 90% of children had a cognitive weakness on the English and Spanish versions of the CAS.

In contrast to the relationship between reading decoding and successive processing, disability in comprehension has been shown to be primarily related to deficits in simultaneous processing (Das, Kar, & Parrila, 1996; Das, Naglieri, & Kirby, 1994; Naglieri & Das, 1997c). In a recent study conducted with English speaking children in India Mahapatra, Das, Stack-Cutler and Parrila (2011) Found that children with comprehension problems had a substantially lower mean score on the CAS Simultaneous scale. These studies suggest that PASS profiles could have utility for diagnosis of reading disabilities as suggested by Naglieri (1999, 2000, 2011).

#### Children with ADHD

A deficit on the CAS Planning, not attention, scale has been found for groups of children with a diagnosis of ADHD. This finding is consistent with Barkley’s (1997) view that ADHD is a failure of self-control (e.g., planning in the PASS theory) rather than a failure of attention. The research in this area clearly confirms Barkley’s view. For example, Naglieri, Goldstein, Iseman, and Schwebach (2003) examined CAS and the Wechsler Intelligence Scale for ­Children—­Third Edition (WISC-III) scores for children with ADHD. The results showed a large effect size for planning between the children with ADHD and the standardization sample and a small effect size was found for the Attention scale. The differences between the two samples on the CAS Simultaneous and Successive scales were not significant. In regard to the WISC-III, the only difference that had a significant but small effect size was the Processing Speed Index.

Naglieri, Salter, and Edwards (2004) confirmed the weakness of planning, but not attention, among children with ADHD. Participants in their study were 48 children (38 males and 10 females) referred to an ADHD clinic. The contrast group consisted of 48 children (38 males and 10 females) in regular education. The results indicated that the children in regular education settings earned mean PASS scale scores on the CAS that were all above average, ranging from 98.6 to 103.6. In contrast, the experimental group earned mean scores close to the norm on the CAS Attention, Simultaneous, and Successive scales (ranging from 97.4 to 104.0), but a significantly lower mean score on the Planning scale (90.3).

The low mean Planning score for the children with ADHD in these studies is consistent with the poor Planning performance reported in the previous research (Dehn, 2000; Paolitto, 1999; Naglieri et al., 2003) for children identified as having ADHD of the ­hyperactive–­impulsive or combined types (Barkley, 1997). The consistency across these various studies suggests that some of these children have difficulty with planning rather than attention as measured by the CAS. Importantly, the PASS profiles of children with ADHD are different from those with reading decoding failure (low successive) and anxiety disorders (no distinctive PASS profile) (Naglieri & Conway, 2009). In addition, these findings suggest that determining if a child with ADHD has a deficit in planning as measured by the CAS could be important for both diagnosis and intervention planning (Goldstein & Naglieri, 2006; Naglieri & Pickering, 2010).

These findings suggest that the PASS theory as operationalized by the CAS may have utility for differential diagnosis in Reading Disabilities and ADHD. The brain - related studies presented in an earlier section go a step further in providing evidence for the validity of PASS constructs. Both kinds of research have implications for prescription that includes constructing intervention programs. We discuss prescription in a subsequent section.

In concluding this section on the uses of PASS theory, we have presented some samples of empirical studies on all four processes, especially, successive and simultaneous ­processing in reading disabilities. A second aspect of our research has focused on PASS processes as that helps in understanding the role of planning in ADHD. Moreover, PASS theory has had several applications in current areas of concern in education relating to diagnosis and placement, as Naglieri (1999; 2011) has discussed. Because of space limitations in this chapter, we cannot present them here. However, Chapter 20 of this book includes this discussion.

In summary, the research on PASS profiles has suggested that different homogeneous groups have distinctive weaknesses. Children with reading disabilities perform adequately on all PASS constructs except successive processing. This is consistent with Das’ view (see Das, 2001; Das, Naglieri, & Kirby, 1994) that reading failure is the results of a deficit in sequencing of information (successive processing). Those with the combined type of ADHD perform poorly in planning (they lack cognitive control), but adequately on the remaining PASS constructs (Dehn, 2000; Naglieri et al., 2003; Paolitto, 1999). Children with the inattentive type of ADHD have adequate PASS scores except on attention (Naglieri & Pickering, 2010). Finally, Naglieri and colleagues (2003) found that children with anxiety disorders had a different PASS profile from those with ADHD. These findings strongly support the view that PASS has relevance for understanding the cognitive processing components of these disorders.

#### PASS Profiles

Glutting, McDermott, Konold, Snelbaker, and Watkins (1998) have suggested that research concerning profiles for specific children is typically confounded, because the “use of subtest profiles for both the initial formation of diagnostic groups and the subsequent search for profiles that might inherently define or distinguish those groups” (p. 601) results in methodological problems. They further suggested that researchers should “begin with unselected cohorts (i.e., representative samples, a proportion of which may be receiving special education), identify children with and without unusual subtest profiles, and subsequently compare their performance on external criteria” (p. 601). Naglieri (2000) followed this research methodology, using the PASS theory and his (Naglieri, 1999) concepts of *relative weakness* and *cognitive weakness.*

Naglieri (1999) described how to find ­disorders in one or more of the basic PASS processes as follows. A *relative weakness* is a significant weakness in relation to the child’s mean PASS score determined using the ipsative methodology originally proposed by Davis (1956) and modified by Silverstein (1982, 1993). A problem with the approach is that a child may have a significant weakness that falls within the average range if the majority of scores are above average. In contrast, a *cognitive weakness* is found when a child has a significant intraindividual difference on the PASS scale scores of the CAS (according to the ipsative method), and the lowest score *also* falls below some cutoff designed to indicate what is typical or average. The difference between a relative weakness and a cognitive weakness, therefore, is that the determination of a cognitive weakness is based on dual criteria (a low score relative to the child’s mean and a low score relative to the norm group). Naglieri further suggested that a cognitive weakness should be accompanied by an achievement test weakness comparable to the level of the PASS scale cognitive weakness. Children who have both a cognitive and an achievement test weakness should be considered candidates for special educational services if other appropriate conditions are also met (especially that the children’s academic needs cannot be met in the regular educational environment).

Naglieri (2000) found that the ­relative-­weakness method (the approach more commonly used in school psychology) identified children who earned average scores on the CAS as well as on achievement, and that approximately equal percentages of children from regular and special education classes had a relative weakness. Thus the concept of relative weakness did not identify children who achieved differently from children in regular education. By contrast, children with a cognitive weakness earned lower scores on achievement, and the more pronounced the cognitive weakness, the lower the achievement scores. Third, children with a PASS scale cognitive weakness were more likely to have been previously identified and placed in special education. Finally, the presence of a cognitive weakness was significantly related to achievement, whereas the presence of a relative weakness was not.

The findings for relative weakness partially support previous authors’ arguments against the use of profile analysis for tests like the Wechsler (see Glutting et al., 1998, for a summary). The results for cognitive weakness support the PASS-­theory-­driven approach that includes the dual criteria of a significant profile with ­below-­normal performance called the discrepancy/consistency model (Naglieri, 1999, 2011). The approach is also different from the subtest analysis approach, because the method uses the PASS ­theory-­based-scales included in the CAS, rather than the traditional approach of analyzing a pattern of specific subtests. Finally, the approach is different because the focus is on cognitive, rather than relative, weaknesses (Naglieri, 1999).

#### The Discrepancy/Consistency Model

Naglieri’s (2000) findings support the view that PASS theory can be used to identify children with cognitive and related academic difficulties for the purpose of eligibility determination and, by extension, instructional planning. Naglieri (2003, 2010) and Naglieri and Pickering (2010) provide theoretical and practical guidelines about how a child’s PASS-based cognitive weakness and accompanying academic weakness might meet criteria for special educational programming. If a child has a cognitive weakness on one of the four PASS constructs and comparable scores in reading and spelling, along with other appropriate data, the child may qualify for specific learning disability (SLD) services.

The example presented in Figure 7.2 illustrates how this theory could be used to identify a child as having an SLD. The 1997 amendments to the Individuals with Disabilities Education Act define an SLD as “a disorder in one or more of the basic psychological processes [PASS processes are clearly consistent with this language] involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, read, write, spell, or to do mathematical calculations” (p. 27). In the hypothetical case described here, there is a disorder in successive processing that is involved in the child’s academic failure in reading and spelling. Assuming that the difficulty with successive processing has made attempts to teach the child ineffective, some type of special educational program may be appropriate.

Insert Figure 7.2 here

The PASS theory provides a workable framework for determination of a disorder in basic psychological processes that can be integrated with academic performance and all other relevant information to help make a diagnosis. Of course, the determination of an SLD or any other disorder is not made solely on the basis of PASS constructs, but these play an important role in the identification process. The connections between PASS and academic instruction (discussed elsewhere in this chapter and in Chapter 20) have also led researchers to begin an examination of the diagnostic potential of PASS profiles.

It is important to note that emphasis is placed at the PASS theoretical level rather than the specific subtest level. Subtests are simply varying ways of measuring each of the four processes, and by themselves have less reliability than the composite scale score that represents each of the PASS processes. It is also important to recognize that profile analysis of the PASS constructs should not be made in isolation or without vital information about a child’s academic performance. The procedure described here illustrates that PASS profile analysis must include achievement variation, which allows differential diagnosis based upon a configuration of variables across tests rather than simply within one test. Thus a child with a written language disorder could have a cognitive weakness in planning, with similarly poor performance on tests that measure skills in writing a story (Johnson, Bardos, & Tayedi, 2003). In contrast, a child with an attention deficit may have a cognitive weakness in planning, along with behavioral disorganization, im­pulsivity, and general loss of regulation (Naglieri & Conway, 2009). Planning weaknesses may be seen in both children, but the larger context of their problems is different.

### Prescription

Dillon (1986) argued that the extent to which a theory of cognitive processing in­forms the user about interventions is an important dimension of validity. The PASS theory appears to have an advantage in this regard. There are several resources for applying the PASS theory to academic remediation and instruction, which we discuss briefly. The first is the PASS Remedial Program (PREP), and Cognition Enhancement Training (COGENT) developed by Das (2009); the second is the Planning Facilitation Method, described by Naglieri; and the third is Naglieri and Pickering’s (2010) book *Helping Children Learn: Intervention Handouts for Use in School and at Home - Second Edition*. The first two methods are based on empirical studies and discussed by Das (2001) in experiments on intervention (Das, Mishra, & Pool, 1995), Das and colleagues (2000), Hayward, Das, Janzen (2007), and summarized in *Reading Difficulties and Dyslexia: An interpretation for teachers* (Das, 2009). These books contain several approaches to academic interventions using PASS as the interpretive framework. The instructional methods typically use inductive method, encourage discovery learning rather than direct instruction. In the following section of this chapter, the concepts behind the methods are more fully described.

#### Description of the PREP & COGENT

The PREP was developed as a cognitively based remedial program based on the PASS theory of cognitive functioning (Das, Naglieri, & Kirby, 1994). It aims at improving the processing ­strategies—­specifically, simultaneous and successive ­processing—­that underlie reading, while at the same time avoiding the direct teaching of word-reading skills such as phoneme segmentation or blending. PREP is also founded on the premise that the transfer of principles is best facilitated through inductive, rather than deductive, inference (see Das, 2009, for details). The program is, therefore, structured so that indirectly acquired strategies are likely to be used in appropriate ways.

PREP is appropriate for poor readers in grades 2-5 who are experiencing reading problems. Each of the 10 tasks in PREP involves both a cognitive processing focused emphasis component and a ­curriculum-­related component. The cognitive processing components, which require the application of simultaneous or successive strategies, include structured non-­reading tasks. These tasks also facilitate transfer by providing the opportunity for children to develop and internalize strategies in their own way (Das et al., 1995). The ­curriculum-­related components involve the same cognitive demands as their matched cognitive processing ­components (e.g., simultaneous and successive processing). These cognitive processes have been closely linked to reading and spelling (Das, Naglieri, & Kirby, 1994). Several studies attest to the efficacy of PREP for enhancement of reading and comprehension (Das and colleagues, 1995; Boden and Kirby, 1995; Carlson and Das, 1997; Parrila, Das, Kendrick, Papadopoulos, and Kirby 1999)

The utility of PASS Reading Enhancement Program (PREP) was examined (Das, Hayward, Georgiou, Janzen, Boora, & Neelam, 2008) on Canadian First Nations children. Effectiveness of two reading intervention programs (phonics-based and PREP) was investigated in Study 1with 63 First Nations children identified as poor readers in Grades 3 and 4. In Study 2, the efficacy of additional sessions for inductive learning was compared to PREP. Results of Study 1 showed a significant improvement for word reading and pseudo-word decoding reading tasks following *PREP*. The *phonics-based program* resulted in similar improvement in *only one* of the reading tasks, word decoding. In Study 2, the important dependent variables were word reading and word decoding, as well as passage comprehension. Results showed that PREP participants evidenced continued improvements in their reading decoding and comprehension. The next study on PREP (Mahapatra , Das , Stack-Cutler & Parrila, 2011) involved two groups of children, selected from two English schools in India. One group consisted of 15 poor readers in Grade 4 who experienced difficulty in comprehension and a comparison group of 15 normal readers in Grade 4 did not receive PREP. Performance on word reading and reading comprehension scores (Woodcock’s Reading Mastery Test), and performance on tests of Planning Attention Simultaneous and Successive (PASS cognitive processes were recorded pre and posttest. Results showed a significant improvement in comprehension, as well as in Simultaneous processing scores in the PREP group suggesting that this approach is effective even in children whose first language is not English. This has obvious application possibilities for all children who learn English as a second language.

COGENT is a program designed to improve the cognitive development of children aged 4 to 7 or those who are beginning readers. The COGENT program is designed for the enhancement of cognition especially linked to literacy and school learning. The main objective is to supplement children's literacy skills and the program should benefit cognitive development of normal children as well as children with special needs. COGENT consists of five distinct modules, each designed to activate different aspects of cognitive processes, language and literacy. The tasks are also designed to enhance phonological awareness and working memory and spatial relationships expressed in statements provided by the facilitator, for example. Further elaboration of the COGENT program is provided by Das (2009) and in a recent study by Hayward et al (2007). This last study is important because it suggests that COGENT and PREP were effective in samples of First Nations children who have a larger proportion of children with reading difficulties

Hayward et al (2007) studied the effects of PREP and COGENT for Canadian First Nations children. Forty-five Grade 3 students from a reservation school in WesternCanada were divided into remedial groups and a no-risk controlgroups. One remedial group was given a classroom-administeredcognitive enhancement program (COGENT) throughout the schoolyear. The second group received COGENT for the first half ofthe year followed by a pull-out cognitive-based reading enhancementprogram (PREP). Results showed significant improvements word reading and comprehension for those exposed to COGENT.

#### Essentials of Planning Facilitation

The effectiveness of teaching children to be more strategic when completing in-class math calculation problems is well illustrated by research that has examined the relationship between strategy instruction and CAS Planning scores. Four studies have focused on planning and math calculation (Hald, 1999; Naglieri & Gottling, 1995, 1997; Naglieri & Johnson, 2000). The methods used by these researchers were based on similar research by Cormier, Carlson, and Das (1990) and Kar, Dash, Das, and Carlson (1992). The researchers utilized methods designed to stimulate children’s use of planning, which in turn had positive effects on problem solving on nonacademic as well as academic tasks. The method was based on the assumption that planning processes should be facilitated rather than directly taught, so that the children would discover the value of strategy use without being specifically told to do so.

The Planning Facilitation Method has been applied with individuals (Naglieri & Gottling, 1995) and groups of children (Iseman & Naglieri, in press; Naglieri & Gottling, 1997; Naglieri & Johnson, 2000). Students completed mathematics worksheets that were developed according to the math curriculum in a series of baseline and intervention sessions over a 2-month period. During baseline and intervention phases, ­three-­part sessions consisted of 10 minutes of math, followed by 10 minutes of discussion, followed by a further 10 minutes of math. During the baseline phase, discussion was irrelevant to the mathematics problems; in the intervention phase, however, a group discussion designed to encourage self-reflection was facilitated, so that the children would understand the need to plan and use efficient strategies.

The teachers provided questions or observations that facilitated discussion and encouraged the children to consider various ways to be more successful. Such questions included “How did you do the math?”, “What could you do to get more correct?”, or “What will you do next time?” The teachers made no direct statements such as “That is correct,” or “Remember to use that same strategy.” Teachers also did not provide feedback about the accuracy of previous math work completed, and they did not give mathematics instruction. The role of the teachers was to facilitate self-reflection and encourage the children to complete the worksheets in a planful manner. A description of this method, presented as a handout for teachers is provided by Naglieri and Pickering (2010). The positive effects of this intervention have been consistent across the research studies, as presented in Chapter 20 of this book.

#### Naglieri & Pickering’s Approach

In *Helping Children Learn: Intervention Handouts for Use in School and at Home* Naglieri and Pickering (2010) provide a way to apply PASS concepts across a wide variety of academic and non-academic areas. The book contains chapters that explain, using case examples, how to select interventions based on PASS strengths and weaknesses. There are instructional handouts for the major academic areas (e.g., reading, writing, math) and general areas as well (e.g., test taking, memory) and handouts in Spanish. The use of this tool is more fully described in Chapter 20 of this book.

### Comparability

The extent to which cognitive processing constructs have relevance to some target task is an important criterion of validity for a theory, and one that is relevant to evaluation of the PASS theory. One example of the comparability of PASS and classroom performance can be found in the examination of the relationships between the attention portion of the theory and in-class behaviors of children.

#### Attention Tests and Teachers’ Ratings of Attention

A good example of the comparability of PASS is the relationship between the constructs and classroom performance. Earlier in this chapter, we have discussed the re­lationship between PASS and academic achievement scores. In this section we look at one particular issue: the relationship between attention measures and ratings of attention in the classroom. This is an environment where a child must selectively attend to some stimuli and ignores others. The selectivity aspect relates to intentional discrim­ination between stimuli. Ignoring irrelevant stimuli implies that the child is resisting distraction. In terms of the PASS theory, this means that attention involves at least three essential dimensions, which are selection, shifting, and resistance to distraction. One way to examine the comparability of the PASS theory to classroom attention is therefore to look at the relationships between measures of attention and attending in the classroom.

Das, Snyder, and Mishra (1992) examined the relationship between teachers’ rating of children’s attentional behavior in the classroom and those children’s performances on the CAS subtests of Expressive Attention and Receptive Attention. An additional test, Selective Auditory Attention, was included in this study; this test was taken from an earlier version of the CAS (Naglieri & Das, 1988). All three of these tasks had been shown to form a separate factor identified as Attention, which is independent of the three other PASS processes (Das et al., 1992).

Teachers’ ratings of students’ attention status in class were made with Das’s Attention Checklist (ACL). This is a checklist containing 12 items that rate the degree to which attentional behavior is shown by a child. All the items on this checklist load on one factor that accounts for more than 70% of the variance, and the ACL has high reliability (alpha of .94; Das & Melnyk, 1989). In addition to the CAS and ACL, the children were given the Conners 28-item rating scale. Das and colleagues (1992) found that the ACL and Conners Inattention/Passivity items were strongly correlated (*r* = .86), but that the correlation between the ACL and the Conners Hyperactivity scale was substantially lower (*r* = .54). This is logical, because the ACL is more a measure of inattention than of hyperactivity.

The correlations of ACL and the Attention subtest scores suggested that classroom behaviors and performance on measures of cognitive processing were related. The ACL correlated significantly (*p* < .01) with Expressive Attention (*r* = .46) and the Selective Auditory Attention ­false-­detection score (*r* = .37). All other correlations with the ACL were not significant. The relationship between the ACL and children’s performance on the CAS was further examined via factor analysis. Two factors were obtained: One had high loadings on the CAS Attention subtest scores (Receptive Attention and a smaller loading on Expressive Attention) and the omission score on the Selective Auditory Attention task, whereas the other factor had high loadings on the ACL, the commission errors on the Selective Auditory Attention task (which reflects distractibility), and the Expressive Attention task. Thus it was clear that the ACL, which measures teachers’ ratings of attention in the classroom, was associated with performance on objective tasks that require resistance to distraction. Their common link is most probably failure of inhibition of attention to distractors. This was further supported in subsequent studies (Das, 2002). Therefore we suggest that attention as defined by the PASS theory is ­useful to explain why teachers’ ratings of attention in the classroom correlated with performance on the two CAS tasks that require selectivity and resistance to distraction.

### Replicability/Standardizability

The value of any theory of cognitive processing is ultimately related to the extent to which it can be uniformly applied across ­examiners and organized into a formal and standardized method to assure replication across practitioners. The availability of norms and interpretive guidelines provided the basis for accurate, consistent, and reliable interpretation of PASS scores as operationalized by the CAS (Naglieri & Das, 1997a). The CAS instrument is a reliable measure of PASS constructs normed on a large representative sample of children 5 through 17 years of age (see Naglieri, Chapter 20, this volume). In summary, we suggest that the CAS is acceptable as a reliable and valid assessment of the PASS processes, and that it can be used in a variety of settings for a number of different purposes, as shown in several books and the CAS interpretive handbook (Naglieri & Das, 1997b).

### Psychodiagnostic Utility

Dillon’s (1986) *psychodiagnostic utility* criterion deals with the ease with which a particular theory of cognitive processing can be used in practice. This criterion is linked to Messick’s (1989) idea of *consequential validity* and emphasizes the transition from theory to practice, the extent to which the theory can be effectively applied. The best theory of intelligence, ability, or cognitive processing will ultimately have little impact on the lives of children unless the constructs (1) have been operationalized into a practical method that can be efficiently administered; (2) can be assessed in a reliable manner; and (3) yield scores that are interpretable within the context of some relevant comparison system. As we have mentioned here and in other publications, the PASS theory and the CAS appear to have sufficient applications for diagnosis and treatment. They have value in detecting the cognitive difficulties ex­perienced by children in several diagnostic groups (children with dyslexia, ADHD/traumatic brain injury, and mental retardation [including Down syndrome]), as well as in constructing programs for cognitive enhancement (Das, 2002; Naglieri, 2003).

# Concluding Remarks

The field of intelligence and intelligence testing has been experiencing a healthy evolution in concept and practice. Researchers and practitioners have seen an increase in attention given to the importance of theory, and especially to having a theory of intelligence upon which a test a intelligence has been built. It has been more than 90 years since Pintner (1923) noted that researchers who were studying ability were “attempting to define it more sharply and endow it with a stricter scientific connotation (p. 53)”. Although tests built on the general intelligence perspective are still widely used today, the need for newer conceptualizations of ability and especially ability defined on the basis of basic psychological processes are becoming more popular; especially as the evidence for this approach grows.

The most important difference between measures of general intelligence and PASS theory as operationalized by the CAS lies in the fact that that test was built on a specific view of intelligence defined on a neuropsychological conceptualization of four distinct, but inter-related abilities. We use the term cognitive process as a modern term for ability and choose a multidimensional, rather than unidimensional, view (Das & Naglieri, 1992). It is a theory for which research has increasingly demonstrated utility (as summarized in this chapter and in Chapter 20 and elsewhere (Naglieri, 2011; Naglieri & Conway, 2009)). We suggest that PASS is a modern alternative to *g* and IQ, based on neuropsychology and cognitive psychology, and that it is well suited to meet the needs of school psychologists practicing in the 21st century.

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FIGURE 7.1.  Diagram of the PASS theory of intelligence.



FIGURE 7.2. Discrepancy/Consistency Model for Diagnosis