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Sensory Integration: Analyses of Patterns of Dysfunction and Clinical Application with Children with Mild Disabilities

by

Shelley Mulligan

A dissertation submitted in partial fulfillment
of the requirements for the degree of

Doctor of Philosophy

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Approved by ______________________________
Chairpersonof Supervisory Committee

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Abstract

Sensory Integration: Analyses of Patterns of Dysfunction, and Clinical Application with Children with Mild Disabilities

by Shelley Mulligan

Chairperson of the Supervisory Committee
Professor Owen White
College of Education

The aim of this dissertation was to examine sensory integration (SI) as a frame of reference for the assessment and intervention of children with mild disabilities. A description of SI and SI dysfunction is provided, and SI is compared with other approaches used in the remediation of children with learning disabilities (LD). Controversial issues regarding the application of SI are discussed, SI research is critiqued, and the current practice of occupational therapists using SI is described.

Models of SI dysfunction based on scores of children on the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989) were examined by exploratory and confirmatory factor analyses (CFA). The initial, hypothesized model tested was derived from previous multivariate analyses and consisted of five patterns of dysfunction including: a) Bilateral Integration and Sequencing; b) Somatosensory; c) Somatopraxis; d) Visuopraxis; and e) Postural-ocular-motor patterns. An existing data base including the scores of 10,475 children was used in the analyses, along with a sub-group of 995 children with LD. Using LISREL 8 (linear structural relations; Joreskog & Sorbom, 1993), CFA of the hypothesized model indicated a number of weaknesses with the model, and it was therefore rejected. Further analyses aimed towards identifying a better fitting, more parsimonious model of SI dysfunction were then performed. A second-order, 4-factor model which consisted of a general SI Dysfunction second-order factor, and Dyspraxia, Bilateral Integration and Sequencing Deficit, Visual Perceptual Deficit, and Somatosensory Deficit as first-order factors was believed to represent the best fitting model. The results of the CFA with this model indicated that it was a good fit for the data, and substantially improved upon the initial model. The second-order, 4-factor model also held true when tested with the sub-sample of children with LD. Finally, interpretation of SIPT scores based on the new, proposed model of SI dysfunction is demonstrated through the presentation of a case study of a child with LD. Specific SI intervention strategies that can be used by occupational therapists to promote motor skills, appropriate behavior and the academic success of children with SI dysfunction working in both school and clinic settings are presented.

Table of Contents

Table of Contents (continued)

List of Tables

List of Figures

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PART 1

Sensory Integration: A Viable Approach for Children with Mild Disabilities?

As in any profession, the application of theory in occupational therapy is important for providing a set of postulates or beliefs that guide "best practice." Theory helps professionals understand, explain, and predict phenomena (Reed, 1984). Theory promotes research which strives to establish a scientific legitimacy for the interventions practiced by professionals. Frames of reference are the bridge between theory and practice. Frames of reference clearly define the areas of function and dysfunction they are concerned with, and identify postulates for change (Hinojosa, Kramer, & Pratt, 1996). In occupational therapy, frames of reference typically come from theories based in the basic sciences, social sciences, and medicine. They are organized to provide explanations of the relationships between clinical practice and theory. They are useful in providing a set of guidelines for both evaluation and intervention. Frames of reference are continually being modified as our knowledge base becomes more sophisticated, as new ways of applying and integrating relevant theories are discovered, and as advances are made in our understanding of how the functional abilities and quality of life of clients can be improved.

Sensory integration (SI) is a popular frame of reference used by pediatric occupational therapists and other professionals in guiding their practice with children with mild disabilities in school and clinic settings. Although it is the most researched frame of reference within the field of occupational therapy (Miller & Kinnealey, 1993; Parham & Mailloux, 1996) and has persisted over time, the research to date has produced more questions than answers. Despite the optimism of occupational therapists regarding its value for guiding the remediation of some children with mild disabilities such as learning disabilities (LD) and attention deficit hyperactivity disorder (ADHD), the efficacy of SI for such purposes has proven inconclusive (Ottenbacher, 1991; Polatajko, Kaplan, & Wilson, 1992). SI has been particularly criticized in the educational literature where it has been dismissed by many researchers as an effective intervention approach, along with other process-oriented interventions (Hoehn & Baumeister, 1994).

The purpose of this paper is to discuss issues regarding SI interventions for children with mild disabilities. It is hoped that this discussion will direct research efforts towards further evolution of SI as a viable frame of reference, rather than suggest its dismissal. Through an increased understanding of how SI compares with other approaches used with children with mild disabilities in educational settings, this paper also aims to broaden the views of skeptics by demonstrating the potential benefits of this approach for some children.

First, the main constructs of SI and SI dysfunction will be reviewed. Second, a comparison of SI with other approaches used in the remediation of children with LD will be presented in order to place SI in context with educational interventions. The two main controversial issues which have challenged this approach: a) whether children with LD and ADHD in fact have SI dysfunction, and b) whether SI intervention is effective will also be discussed. Third, the current practice of occupational therapists using this frame of reference will be described. This paper concludes by suggesting future directions for research.

What is Sensory Integration?

SI refers to a way of viewing central nervous system (CNS) organization and processing of sensory information for functional performance. It also refers to a clinical frame of reference for the assessment and treatment of persons with sensory processing difficulties (Parham & Mailloux, 1996). SI theory, accompanied by assessment tools and an intervention approach, was developed by Jean Ayres, Ph.D., in the 1960's and 70's. SI, pulling primarily from theories based in medicine, neurology, and child development, attempted to explain relationships among neurological processes and overt behaviors (Ayres, 1972b). It aimed to increase our understanding of the underlying causes of the behavioral difficulties and learning problems of children.

Based on information from typical development, neurobiology, psychology, education, and her own clinical experience as an occupational therapist, Ayres formulated hypotheses about what neurobehavioral functions might be implicated in children with LD (Ayres, 1972b). She believed that certain types of LD may be interpreted partially in terms of a disruption within the brain's integrative functions (Ayres, 1969). She hoped to uncover specific subtypes or patterns of dysfunction among children with LD so that ultimately specific interventions for those subgroups of children could be developed.

There are three main assumptions which provide the theoretical foundation for SI (Fisher & Murray, 1991). First, it is believed that normal individuals take in sensory information from the environment and from the movement experiences of their own bodies, process and integrate this information within the CNS, and use this information to plan and organize behavior. Second, deficits or an inefficiency of integrating these sensory experiences may result in a number of motor, behavioral, and learning problems. Finally, it is believed that the provision of enhanced sensory experiences within the context of meaningful activity and the production of an adaptive response results in enhanced SI, which positively influences learning. An adaptive response is goal-directed and purposeful, and allows one to successfully meet a challenge (Kimball, 1993). This final assumption provides the basis for SI treatment.

At the time Ayres was developing her ideas regarding the ways in which children process, organize, and use sensory information, the organization of the CNS was believed by many, including Ayres, to function in a hierarchical manner (Parham & Mailloux, 1996). This model views the nervous system as having vertically-arranged levels which are interdependent, yet reflect a trend of ascending control and specialization. This hierarchical approach led Ayres to believe that the more primitive or subcortical systems such as tactile, vestibular and proprioceptive systems provide the foundation for the development of higher-order, cortical functions such as academic ability, complex motor skills, and the development of social skills (Ayres, 1972b). Therefore, evaluation and intervention based on SI focused on the functioning of these sub-cortical sensory systems.

Proponents of SI believe that the CNS has plasticity or the capacity for modification or change. The main postulate for change within this frame of reference is believed to be the adaptive response (Schaaf, 1994). The execution of an adaptive response takes place when the child is able to successfully meet a challenge within the environment. By providing just the right challenge through the provision of controlled sensory input, the child increases the complexity of his responses (Ayres, 1979).

What is Sensory Integration Dysfunction?

Important to this discussion, is that children with today's diagnostic categories of LD, ADHD, developmental coordination disorder (DCD), developmental dyspraxia (DD), and SI dysfunction once all fit under the same label. In the 1960's, such children were often labeled as having "minimal brain dysfunction" (Clements, 1966). Clements defined minimal brain dysfunction as,

> children of near-average, average, or above-average intelligence with certain learning or behavioral disabilities ranging from mild to severe, which are associated with deviations of function of the central nervous system. These deviations may manifest themselves by various combinations of impairment in perception, conceptualization, language, memory, and control of attention, impulse, or motor control (Clements, 1966, p.6).

Such disabilities are therefore believed to result from some unknown CNS dysfunction which supports homogeneity of these children at some level. Although today's discrete classification of these children into their respective diagnostic categories are based on some unique combination of presenting behaviors or problems, there continues to be much overlap among them. In many cases, children are given more than one of these labels. For example, approximately 60% of children with ADHD are also identified as having LD (Barkely, Fischer, Edelbrock, & Samallish, 1990; Zentall, 1993)

SI dysfunction also presumes CNS dysfunction and was believed by Ayres to be "....not processing or organizing the flow of sensory impulses in a manner that gives the individual good, precise information about himself or his world" (Ayres, 1979, p. 51). She also made the assumption that there are many different kinds of learning problems, each of which being associated with dysfunction in a particular neural substrate. Ayres was hopeful that the identification of different types of SI dysfunction would assist in the development of specific treatment programs. As a means to assist in the development of SI as a frame of reference, Ayres developed a series of tests which were believed to each measure a neurobehavioral process or substrate that contributed to the capacity to learn, and that could distinguish children with LD from those without. Those tests were standardized and published in 1972 as the Southern California Sensory Integration Tests (SCSIT; Ayres, 1972d), and were later revised in 1989 as the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989). It is those children who do poorly on tests of SI such as the SIPT, (whether labeled with LD, ADHD, and/or DCD) that are believed to be candidates for SI intervention.

Subtyping strives to reduce the heterogeneity of groups of children. Subtyping assists with identifying underlying etiology, helps to better define groups when conducting group research, and helps in directing intervention, as specific strategies are developed for individual subtypes. Ayres conducted a series of factor analytic studies to come up with a typology of neural systems or substrates related to learning. Comprehensive summaries of this factor analytic work are reported by Mailloux and Parham (1996), Ayres (1989), and Fisher and Murray (1991). A critique of Ayres' factor analytic work from 1965 to 1987 is provided by Cummins (1991). The results of these studies supported Ayres' idea that there exists certain patterns of dysfunction.

Six hypothesized patterns of dysfunction resulting from poor SI are described by Fisher and Murray (1991). They based their description on a comprehensive review of the factor analytic work conducted with the SCSIT and SIPT (from 1965-1990), as well as from the results of clinical observations that are typically made by therapists as a part of a comprehensive SI evaluation of a child. One other pattern also emerged from SIPT scores (Praxis on Verbal Command), but because this pattern was believed to represent a higher cortical function, it was not considered as a pattern of SI dysfunction (Fisher & Bundy, 1991). Five of the hypothesized patterns of dysfunction are consistent with factors identified by Ayres (1989) in her analysis of SIPT scores of children with mild disabilities. More specific information regarding these patterns of dysfunction, including a description of the dysfunction observed, and the components and specific evaluations involved within each pattern is found in Part 2 of this dissertation (Table 2-1).

In addition to studies using factor analytic techniques, cluster analyses were conducted during the development of the SIPT, with samples of normal children and children with disabilities (Ayres, 1989). Cluster analyses were used to identify groups of children with similar SIPT score patterns so that the children within a particular cluster were similar to other members of that cluster, and different from the members of any other cluster. A six-cluster solution was determined to be the most appropriate based on statistical and clinical criteria (Ayres, 1989), and they were associated with many of the factors that were identified earlier. These six clusters were: a) Low Average Bilateral Integration and Sequencing (many tests associated with the Bilateral Integration and sequencing factor were scored low); b) Generalized SI Dysfunction (very low scores on all but two tests); c) Visuo-and Somato-dyspraxia (moderately low scores on most tests); d) Low Average SI and Praxis (scores all within the average range, with lowest scores on many of the Praxis tests); e) Dyspraxia on Verbal Command (associated with the Praxis on Verbal Command factor), and f) High Average SI and Praxis (scores above the mean on all tests). As with the factor analyses, this technique was used to identify groups of children that might prove useful clinically.

It is evident that SI dysfunction does not refer to one specific problem, but rather to a heterogeneous, complex, group of disorders that are believed to result from inefficient processing of subcortical sensory processes. The results from both factor analytic and cluster analytic work are used today as critical components in the interpretation process of a child's results on the SIPT (SIPT interpretation course materials, Sensory Integration International, 1990) and, along with clinical and functional observations, provide the information necessary to direct intervention based on the patterns of dysfunction identified.

A Comparison of SI Interventions with Other Educational Interventions

Dependent upon one's beliefs about the etiology of LD, different types of remedial programs have been proposed and are discussed in the educational literature. They can largely be classified as process approaches or direct instruction approaches. In the late 1960's and 1970's, process approaches similar to SI were popular (Hammill, 1993) within the field of LD. Process approaches were those that were based on the premise that the functioning of specific, basic neurological systems such as auditory, visual, tactile, motor coordination and attention were required for adequate cognitive development. Proponents of processing models believe that once the disordered processes are corrected, academic learning can take place normally (Hammill). Other process approaches which will be compared with SI include perceptual-motor training, approaches based on attention-deficit theories, and information processing.

Perceptual-motor approaches such as those proposed by Frostig (1967) and Kephart, 1971) are all based on the assumptions that: a) motor learning provides a foundation for symbolic learning, b) motor development is based upon a hierarchical system, c) abnormal motor development affects academic learning and, d) remediation of motor deficits should positively influence academic performance (Clark, Mailloux, Parham, & Bissell, 1989). Although SI is based on similar assumptions, an important distinction is that in SI, academic deficits are not thought to directly result from motor problems, but from the underlying SI dysfunction that also is responsible for the motor problems. Other distinctions that have been reported in the literature are that SI treatment focuses on the integrative and organizational aspects of sensory experiences and the CNS, and is a child-centered, flexible approach, while perceptual motor programs are more cognitively oriented, adult-driven and focused on the teaching of specific skills (Cermak & Henderson 1989; Clark et al., 1989; Humphries, Snider, & McDougall, 1993).

Children with LD and children with SI dysfunction have both often been described as having an inability to filter out relevant from irrelevant sensory information (Mulligan, 1996; Silver, 1990) and often having attention difficulties and hyperactivity. The multi-modal approaches advocated for children with ADHD (Fiore, Becker, & Nero, 1993), therefore, may be applied successfully with some children with LD and/or SI dysfunction. Such approaches may include the use of stimulant medication, behavioral interventions, parent training and support, and curricular modification. Approaches used with children with ADHD that are particularly similar to SI intervention strategies include: activities and accommodations aimed at regulating levels of arousal; strategies to improve attention span and increase on-task behaviors such as preferential seating; making environmental adaptations to minimize distractions; multi-sensory hands-on learning experiences; and providing gross motor and sensory-based activities aimed at positively directing and expending energy.

SI also has similarities with information processing models such as those described by Wong (1992) and Swanson (1987). Information processing involves a number of stages of cognition including encoding, organizing, storing, retrieval, comparing, and generating and constructing information (Swanson). Information processing as a way of understanding how one "learns" has been around for a long time. However, researchers (including many who previously were process-oriented proponents) are moving in the direction of designing more sophisticated and comprehensive information processing models, not only to help define LD, but to develop innovative remediation programs (Swanson).

Such models suggest that a number of components and programs exist and function within the CNS to process incoming information throughout the various stages of cognition. The stages emphasize important contributions of both cortical (higher-order) and subcortical (lower-order) processes, and describe interactions among executive routines, control processes, and the person's acquired knowledge base (Swanson, 1987). Swanson suggested that the information processing mechanism consists of three general components: a structural component; a control or strategy component; and an execution process. He explained that the flow of information occurs in a sequence of stages through these components. Researchers are aiming to identify those specific components and stages that influence performance to increase their understanding of the difficulties experienced by children with LD. An analysis of information processing components may also provide a link to the underlying neural systems affected in children with LD or similar disorders.

The concept of information processing is such an important concept within SI that embedded within Ayres' definition of SI, she described it by stating, " ...sensory integration is information processing..." (Ayres, 1989, p.11). As with the information processing models described above, SI concerns itself with subcortical processes, and the ways in which one processes, and organizes incoming sensory information for the execution of adaptive responses. SI as a frame of reference also addresses the importance of selective attention and the efficiency of sensory processing, although the specific mechanisms by which this occurs have not been fully understood or described.

In summary, SI intervention has many aspects in common with other processing models proposed for the remediation of children with LD, DCD, ADHD and similar disorders. Perhaps because SI developed primarily from theories of medicine and with language foreign to many educators, its unique characteristics over-power these commonalities, particularly when applied in educational environments. Also, early writings regarding the use of SI treatment with children with LD often neglected to emphasize that the approach was meant to be applied only to those children with LD identified as also having SI dysfunction, and not to all children with LD. As new approaches are developed and tested, such as information processing models, it is important for researchers from different backgrounds to work together and share their expertise with one another. This collective pooling and integration of information allows for new findings to be examined from varying perspectives, which may facilitate new ideas, and ultimately the development of more comprehensive and complimentary models for the assessment and intervention of children.

Controversy #1 Do Children with LD Have SI dysfunction?

One of the arguments discussed by Hoehn & Baumeister (1994) in their critique of SI was whether children with LD have SI dysfunction. In particular, criticism has focused on the methodological weaknesses of the multivariate analyses upon which the specific patterns of SI dysfunction are based, and the research which has claimed that children with LD have vestibular processing difficulties.

There is no question that the earlier factor analytic studies should be criticized appropriately for limitations in design (Cummins, 1991; Fisher & Bundy, 1991; Hoehn & Baumeister, 1994; Parham & Mailloux, 1996). Because Ayres was constantly exploring new ideas, she used a different battery of tests in each study. Therefore, none of the studies was a true replication of a preceding one. Further, her samples were heterogeneous and consistently small, relative to the number of test scores that were analyzed. Terminology used to describe the factors which emerged in these studies was also inconsistent. Therefore, comparing the results from these studies and drawing conclusions based on their combined contributions is difficult. The review of the earlier portion of this research (Cummins) highlights concerns regarding the validity of the factors which Ayres identified in her conceptualization of SI dysfunction. In particular, Cummins reported that the claim that data from children with LD gives rise to characteristic factor structures has not been adequately tested. Despite this criticism, it is clear that certain patterns of dysfunction have emerged supporting SI dysfunction as a multi-dimensional construct. Perhaps now, confirmatory rather than exploratory techniques are needed for their verification.

It must be emphasized again that not all children with LD have SI dysfunction. The SIPT is not a test designed to distinguish children with LD from those without LD. It is used to identify and describe the specific patterns of SI dysfunction that may be present in children who might also have mild disabilities such as LD or ADHD. Throughout the assessment process, the research on specific patterns of dysfunction and identified clusters are used only as tools, which in conjunction with a number of factors (i.e., individual test scores, medical and sensory histories, clinical observations, classroom performance) are collectively examined to gain further understanding of these complex children.

There is strong support in the literature stating that LD, DCD, and ADHD co-exist (Fawcett & Nicolson, 1995; Haslum, 1989; Hellgren, Gillberg, Gillberg, & Enerskog, 1993; Mulligan, 1996; Schaffer, Law, Polatajko & Miller, 1989). In particular, proponents of SI are interested in those children who have a combination of academic difficulties, attention problems, and hyperactivity, and motor coordination and/or balance difficulties. Although estimates of the numbers of children with LD who also exhibit SI dysfunction are extremely variable, ranging from 12% (Rutter & Yule, 1975) to 70% (Morrison & Sublett, 1986), and the nature of the relationships among these disorders is poorly understood, there is overwhelming evidence that a subgroup of children with LD and ADHD also have the clinical presentation of what is described as SI dysfunction.

The second area of criticism prominent in the literature is the issue of whether children with LD have vestibular processing difficulties. Much of the criticism is based upon literature which has used post-rotary nystagmus (PRN) as the dependent measure of vestibular function. PRN is an involuntary oscillation of the eyes, characterized by fast forward motions and slow returns, that follows rapid deceleration which is elicited by spinning the individual (Ayres, 1972b). Because of the weak test-retest reliability of this measure (Ayres, 1989) and its questionable validity as a tool for measuring pure vestibular function (Cohen, 1989; Polatajko, 1983), interpretation of past research based solely on this test as a measure of vestibular processing must be made cautiously. It is also recommended that therapists only use this test in conjunction with a number of other measures of vestibular processing, such as tests of balance, when making clinical judgments (Fisher, 1991).

As Fisher (1991) and Parham and Mailloux (1996) pointed out, some studies (i.e., Polatajko, 1985) have examined the presence of vestibular processing mechanisms characteristic of measures of peripheral (semi-circular canals, utricle, saccule) functions rather than central (vestibular nuclei and its connections) functions. Because it is the central rather than the peripheral functions assumed to be disrupted in SI dysfunction, researchers have often concluded incorrectly that the type of vestibular processing problems characteristic of some children with LD do not exist.

Even if one discounts entirely the literature which has used PRN and/or peripheral measures as dependent measures, researchers do agree that many children with LD have balance difficulties, poor motor coordination, poor visual-motor control, and difficulties modulating levels of arousal (Ayres, 1989; Fisher, 1991; Fisher, Mixon, & Herman, 1986; Haslum, 1989; Horak, Shumway-Cook, Crowe, & Black, 1988; Mulligan, 1996; Schaffer, Law, Polatajko, & Miller, 1989) which at some neurological level all involve vestibular processes. Therefore, although one might dispute the literature which claims that children with disabilities such as LD or ADHD can be distinguished from children without such disorders based solely on measures of vestibular processing (particularly studies using PRN), there does remain a subgroup of such children that commonly exhibit central, vestibular processing difficulties.

Controversy #2 Is SI Intervention Effective?

In the mid 1970's and 1980's, efficacy studies evaluating process-oriented interventions concluded that these approaches were largely ineffective (Goodman & Hammill, 1973; Kavale & Mattson, 1983), and researchers began to question whether underlying neurological processes were related to cognitive or academic performance. Questioning the merit of these approaches provoked a significant controversy within the field of LD (Hammill, 1993). Eventually, more on-task, direct instruction forms of assessment and instruction replaced process approaches. "For the moment, the issue of process training is resolved, and direct instruction has emerged as the model of choice for the remediation of learning disabilities in the United States" (Hammill, 1993, p. 303). Although SI was often not tested specifically in these studies, it was cited as a perceptual motor approach, and one which is largely ineffective for remediating LD. Therefore, as a process approach, SI intervention had a very shaky beginning.

There were, however, many studies conducted in the 1970's and 1980's evaluating specifically the effectiveness of SI intervention. Detailed reviews of this literature can be found elsewhere (Cermak & Henderson, 1989; Hoehm & Baumeister, 1994; Ottenbacher, 1982; Parham & Mailloux, 1996; Polatajko, Kaplan, & Wilson, 1992) and will be summarized here.

Early studies demonstrated that SI therapy increased performance in motor, language, and academic areas (Ayres, 1972a, 1972c, 1978; Magrun et al., 1981; White, 1979). Ottenbacher (1982) did a meta-analysis of eight treatment effectiveness studies which provided support for SI intervention in the remediation of motor, academic and language functions, with the most improvements noted in the motor area. In relation to LD specifically, he reported that "the average learning disabled student receiving sensory integration therapy performed better than 75.2 percent of the learning disabled subjects not receiving therapy " (Ottenbacher, 1982, p. 576).

More recent studies have evaluated the effects of SI therapy in comparison with other approaches such as tutoring (Wilson, Kaplan, Fellowes, Gruchy, & Faris, 1992) and perceptual-motor training (Humphries, Wright, Snider, & McDougall 1992). These studies concluded that SI therapy is not any more effective than these traditional approaches. Polatajko, Kaplan, and Wilson (1992) reviewed seven, 2- or 3-group experimental studies conducted from 1979 to 1992, using SI treatment with samples of

LD students. They concluded that the results of previous studies do not indicate that SI treatment improves the academic performance of children with LD more than a placebo. With respect to sensory or motor performance, the results are inconsistent, and indicate overall that SI treatment may produce minimal positive effects. No negative effects of SI interventions were reported.

The research therefore, provides conflicting results. Overall, the results provide little supporting evidence that SI treatment is helpful in the remediation of learning or academic difficulties of children. There is some support, however, that the treatment improves sensory processing and motor abilities, yet it has not been demonstrated that SI therapy is more effective in doing so than traditional approaches such as tutoring (Wilson et al., 1992) and perceptual-motor training (Humphries et al., 1992). Ottenbacher (1991) recommended that research efforts need to be directed to establishing professional consensus.

Given these empirical data, why has SI continued to prevail? Whether the SI treatment is applied in direct, traditional ways, or in indirect ways, there is no doubt that many therapists, parents, children and teachers believe that the motor, behavioral and academic performance of children improve with SI interventions (Kaplan, Polatajko, Wilson, & Faris, 1993). These authors suggested one factor which perhaps influences these positive perceptions is the strong bond which tends to form between the child and the therapist. Successful clinical experiences of therapists and published case studies (Botticelli, 1989; Hickman, 1995) also provide support for SI.

A number of methodological flaws or concerns inherent in these group studies may also encourage clinicians to discount them. Of particular relevance to practicing clinicians is that the use of standardized protocols in studies (although it may improve procedural reliability of the study) is not representative of their clinical practice, which is most likely highly individualized and child-directed (Parham & Mailloux, 1996). Second, the population being studied is heterogeneous, and attempts to measure intervention outcomes with specific subtypes of SI dysfunction have been minimal. Therefore, such group studies mask the types of children who do respond from those who do not, and statistically significant differential responses to treatment among groups is difficult to achieve. Outcome measures also are problematic, as the specific goals of therapy and expectations for specific areas of gain differ for individual children. Therefore, these study limitations allow SI to be perceived by clinicians as a viable treatment, and one that is just very difficult to evaluate, or which works well for a select group of individuals.

SI as a frame of reference has provided a framework for occupational therapists and parents which assists in their understanding of child behaviors in ways that make sense. It also explains dysfunctional behavior such as inattention and non-compliance in a positive light (medical etiology rather than motivational or psychosocial explanations). It is important that we not lose sight of the fact that SI has a great deal in common with more global and accepted frames of reference such as developmental approaches and information processing which enhances its believability and the comfort level of the therapists who choose to use it. It is also a frame of reference that has not attempted to invent entirely new concepts, but one which has taken a unique perspective in organizing largely accepted views regarding the way in which the CNS works, what we know about child development, and how one learns and processes sensory information.

Finally, researchers in the field of SI have done a good job in the development of standardized tests and specific treatment techniques which allows it to be very practical for occupational therapists. There are also training opportunities available for therapists to develop specific skills not only with respect to SI evaluation and intervention, but on ways to apply the concepts in school settings. It is an approach to intervention that has demonstrated the ability to be integrated with other frames of reference and has been able to adapt to and accommodate for the changes observed in the programming focus of special educators. Therefore, despite weak empirical data supporting SI intervention, pediatric occupational therapists continue to use this frame of reference with many children with mild disabilities.

SI Intervention: Current Practice

The classic, "pure" form of SI intervention tends to be practiced more often in private, medically-oriented clinics, than in educational environments. SI intervention is highly specialized, and it has been recommended that it only be administered by therapists who have received advanced training. SI intervention is complex because it is extremely variable, dependent upon the individual needs of the client (Ottenbacher, 1991).

Specific characteristics of classic SI intervention were described by Kimball (1988) and include the following: a) having a goal of improving underlying neurological processes rather than the teaching of specific skills; b) active participation by the child; c) child-directed activity; d) individualized treatment; e) activities which are purposeful and result in an adaptive response; f) activities which are rich in proprioceptive, vestibular, and tactile input; and g) treatment which is administered by a trained therapist. Interventions which involve the application of sensory stimulation only, structured group treatments, combined approaches, or intervention that apply some SI principles in the development of functional skills are therefore not considered classic SI intervention. Although these other approaches are often used by occupational therapists and other professionals, and may be very appropriate for some children, in a research context, care must taken to differentiate them from classic SI intervention.

Occupational therapists rarely use pure SI intervention as their only modality. More often, therapists use SI intervention as part of a child's total occupational therapy program, and in conjunction with other types of approaches such as the provision of adapted equipment, proper positioning and seating, gross and fine motor skill training, self-care skill training, and parent support and training. Occupational therapists in clinic settings have also expanded the application of SI intervention to meet the holistic needs of children. Often, SI is combined with other approaches such as perceptual motor approaches, neurodevelopmental treatment, behavioral interventions, and play (Murray & Anzalone, 1991). Because it is a frame of reference that has been developed by and primarily for occupational therapists, efforts are also being made to frame the concepts of SI within the constructs that define the profession of occupational therapy.

In school settings, in order to abide by The Individual's with Disabilities Education Act (IDEA; PL 101-476), services by related service personnel such as occupational therapists, must be directly related to the child's individual education program (IEP). Therefore, interventions such as SI are often excluded, because they have more global goals reflecting overall neurological functioning, rather than specific goals such as those identified on a child's IEP. Occupational therapists have modified their school-based interventions to accommodate the move of educators from process approaches (approaches focusing on underlying neurological deficits) towards direct instruction models, and towards inclusive education, (Rourke, 1996). For example, the use and evaluation of consultative services has increased over the past 10-15 years (Dunn, 1988; Kemmis & Dunn, 1996) and occupational therapists are learning to apply SI principles to direct instruction classroom activities. An emphasis is placed upon assisting teachers in modifying classroom activities and environments to provide the child with the optimal sensory experiences for learning.

Occupational therapists apply the principles of SI in the classroom in much the same way that teachers adapt their presentation styles to accommodate for the diverse learning styles of their students. This does not necessarily mean that therapists are not supportive of classic SI intervention, but rather, that they are required to focus on interventions which most directly relate to the child's IEP. In response to changing service delivery models, Sensory Integration International, a national organization for the education, training, and study of SI, introduced a training course particularly for school-based therapists, which provides information related to the application of SI interventions in school settings. This training program emphasizes ways to help students succeed despite SI deficits (Bundy, personal communication, 1996). Part 3 of this dissertation provides a case example demonstrating classic SI intervention, and the application of SI principles in school settings, with a child who has LD.

Directions for Future Research

There are many directions of research which are worthwhile and need to be addressed with respect to SI (see Kaplan, Polatajko, Wilson, & Faris, 1993; Miller & Kinnealey, 1993; Ottenbacher, 1991; Tickle-Degnen, 1988). Questions range from the basic premises on which the theory and hypothesized dysfunction is based to the efficacy of the treatment. If professional consensus is to be reached, it is essential that a number of research methodological issues be improved upon.

First, we must better understand and describe the children used in group research samples. Because children with LD, ADHD, DCD, and SI dysfunction are such heterogeneous groups, classification of children based on patterns of SI dysfunction may be useful. As noted earlier, only subgroups of children with LD and ADHD have SI dysfunction, and some children with SI dysfunction do not have LD or ADHD. Therefore, specific tests of SI dysfunction are recommended to identify appropriate children for intervention. It is also recommended that the specific learning (or other) problems of children be reported so that variables which may impact the effects of intervention can be examined. It is important that we not only focus research efforts on determining the effectiveness of SI programs, but also on determining for whom the treatment is likely to be effective.

Second, SI intervention must be better defined and controlled. Kimball's criteria (1988) are useful for detailing the necessary components and characteristics of classic SI treatment. Specific questions researchers can ask themselves when operationally defining SI interventions based on Kimball's criteria are outlined by Miller and Kinnealey (1993). For example, researchers must determine how much of the therapy session is child-directed, and to what degree the sensory input is varied based on the child responses. Ottenbacher (1991) emphasized that SI is a multifaceted approach that is difficult to reduce to its component parts, and therefore special planning in defining SI as an independent variable must be made. He suggested that this begin by identifying clear requirements for the training of those persons who will administer the treatment. Second, protocols describing the intervention need to be developed and reviewed by experts in the field, and procedural reliability checks should be implemented to ensure the consistency and accuracy of the application of the protocols. If SI treatment is used in combination with other approaches, then all approaches need to be accounted for in the study.

Third, the selection of appropriate research designs needs to be considered. Miller and Kinnealey (1993) cited case studies and other qualitative approaches, and single subject research designs as being particularly relevant for studying the effects of SI interventions. Rather than mask individual differences and attempt to produce homogeneous groups, these approaches explore the effects of individual differences, allow for individualized intervention, and therefore are useful in determining for whom SI intervention is most helpful. As noted earlier, research needs in the area of SI theory and practice are great and diverse, therefore the appropriate research design depends upon the specific research question posed.

Fourth, research which explores SI as a frame of reference, its theoretical basis including the underlying mechanisms on which it is based, and the relationship of theory to SI intervention is greatly needed (Tickle-Degnen, 1988). Such research is useful in determining how and why interventions such as SI work, rather than in determining if they are effective. Further understanding of the ways in which SI fits within other information processing models such as those described by Swanson (1987) are also useful for both classification/diagnostic issues and for developing interventions, and may allow various disciplines to converge on a paradigm for the study of children with LD, ADHD and other similar conditions. Although present information processing models are far from reaching a consensus on the "best" theoretical model, by examining the ways in which our prior knowledge, self-control processes and ability to self-regulate interact in the process of learning and producing functional behavior, provides a promising beginning. Such a unified model of understanding these children would also promote complimentary instructional or remedial programs among professionals. SI theorists need to be aware of this research, how it affects the postulates of their own frame of reference and interventions, and how their perspectives and research may assist in advancing such unifying models.

Also of importance is research which attempts to sort out the nature of the relationships among children with ADHD, LD, DCD, and SI disorders. If these disorders are all related to an inefficiency of CNS functioning, consist of similar symptomology and often co-exist, then perhaps the underlying neurological abnormalities are not all that dissimilar. By merging some of the literature, we will gain more comprehensive understanding of these children who share so many of the same functional deficits. Many of the treatment techniques for these children are already being shared. Rather than emphasizing the identification of more specific typologies within each disorder which has largely resulted in increased controversy and confusion, perhaps it is time to go back and understand the nature of the similarities of children with mild disabilities. In relation to SI theory specifically, the first step in addressing this issue is to more fully, and confidently understand the construct, SI dysfunction. This issue is the topic of the research presented in Part 2.

PART 2

Patterns of Sensory Integration Dysfunction:

A Confirmatory Factor Analysis

Literature Review

The purpose of this study was to examine through confirmatory factor analyses (CFA), five hypothesized patterns of sensory integration (SI) dysfunction which are identified by scores of children with mild disabilities on the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989). These five patterns, along with one other which is identified through means other than SIPT scores, provide a model for conceptualizing SI dysfunction (Fisher & Murray, 1991).

SI dysfunction was believed by Ayres, the founder of SI theory, to be the result of an inefficient central nervous system; " ... not processing or organizing the flow of sensory impulses in a manner that gives the individual good, precise information about himself or his world" (Ayres, 1979, p. 51). She also believed that there are many different types of SI disorders, each of which being associated with dysfunction in a particular neural substrate within the central nervous system (Ayres, 1972a). She then developed a typology of SI dysfunction based on a series of multivariate analyses (Ayres, 1989).

Subtype research divides heterogeneous samples of children into homogeneous subgroups based on performance patterns across multivariate data. The identification of different types of SI dysfunction assists with the understanding of underlying etiology, provides a model for understanding the concept of SI dysfunction, and more practically, is useful for developing specific treatment programs for the discrete patterns identified. Recent categorical systems for conceptualizing SI dysfunction largely based on Ayres factor analytic work in the 1960's and 1970's have been described by Parham & Mailloux

(1996), Kimball (1993), Fisher & Murray (1991), and Ayres (1989). Although there is not perfect consensus on the best way to categorize the patterns of dysfunction, there are recurring themes and much commonality expressed across all authors.

Fisher and Murray (1991) described seven patterns of dysfunction. They based their hypothesized model on a comprehensive review of multivariate studies conducted primarily with the scores of children with mild disabilities on the Southern California Sensory Integration Tests (Ayres, 1972d) and the SIPT from 1965-1990. As well, they stressed the importance of considering the results of clinical observations that are typically administered by occupational therapists as a part of a comprehensive SI evaluation of a child. One of the patterns of dysfunction they described which emerges from SIPT scores, Praxis on Verbal Command, is believed to represent left hemisphere dysfunction, a higher cortical function rather than SI dysfunction (Ayres, 1989). Therefore, it was not considered in this study. Another pattern of dysfunction, Sensory Modulation is identified primarily by self-report measures and clinical observations rather than SIPT scores, and therefore, it was also not a pattern considered in this study. The other five patterns described by Fisher & Murray (1991) include: Bilateral Integration and Sequencing (BIAS); Postural-Ocular Movements (POM); Somatosensory Processing (SOMSEN); Visuopraxis (VSPR); and Somatopraxis (SOMPR). Table 2-1 includes a description of the hypothesized nature of the dysfunction, the components involved within each pattern, and the specific SIPT tests most useful identifying the presence of each pattern.

Table 2-1

Hypothesized patterns of dysfunction identified by the SIPT

PATTERN	HYPOTHESIZED DYSFUNCTION	COMPONENTS	EVALUATIONS
Somatosensory Processing	Central processing of tactile and possibly proprioceptive inputs	Tactile discrimination Proprioception	LTS, GRA, FI, MFP KIN, SWB
Bilateral Integration and Sequencing	Vestibular-proprioceptive inputs to higher level structures including the supplementary motor area	Bilateral Integration Sequencing and projected or anticipatory movements	BMC, SV-contralateral and preferred hand use SPr, SWB, GRA, OPr, PPr possibly
Somatopraxis	Tactile (and sometimes vestibular-proprioceptive inputs to higher level structures including the premotor areas)	General motor planning, including sequencing and projected or anticipatory movements	PPr, BMC, SPr SWB, GRA, OPr, PrVC possibly
Postural-Ocular Movements	Central processing of vestibular and and proprioceptive inputs	Vestibular-ocular Vestibular-spinal Proprioception	PRN, SWB, KIN observations of ocular pursuits, prone extension & supine flexion postures
Visuopraxis	End product of somatosensory and/or vestibular-proprioceptive disorder	Form and Space perception Visuomotor coordination Visual Construction	SV, FG, CPr, DC, MFP MAC, DC DC, CPr

Adapted from Fisher & Murray (1991); LTS=Localization of Tactile Stimulation; GRA=Graphesthesia; FI=Finger Identification; MFP=Manual Form Perception; KIN=Kinesthesia; SWB=Standing&Walking Balance; BMC= Bilateral Motor Coordination; SV= Space Visualization; SPR=Sequencing Praxis; OPR=Oral Praxis; PRVC=Praxis on Verbal Command; PRN=Post-rotary nystagmus; CPR=Constructional Praxis; DC=Design Copy; MAC=Motor Accuracy

Four of these patterns (BIAS, SOMSEN, VSPR, SOMPR), along with Praxis on Verbal Command, were identified by an exploratory factor analysis of scores of 125 children with learning and/or SI deficits, conducted during the development of the SIPT (Ayres, 1989). The results of this study, including the factor loadings of each of the SIPT tests on these five factors, are included in Appendix A. The interpretation of these factors was based on many previous studies that consistently identified that children with mild disabilities such as learning disabilities (LD), may clinically present with one or more of the following deficits: bilateral integration and sequencing difficulties (Ayres, 1965, 1969, 1971, 1972a), tactile processing problems (Ayres, 1966, 1972a); praxis or motor planning difficulties (Ayres, 1965, 1972a, 1977; Ayres, Mailloux & Wendler, 1987) tactile processing problems with motor planning problems (Ayres, 1966, 1971, 1977, Ayres, Mailloux & Wendler, 1987); vestibular processing and postural difficulties (Ayres, 1978, 1979; Horak, Shumway-Cook, Crowe, & Black, 1988) and visual-perceptual and/or visual-motor problems (Ayres, 1965,1966, 1972a, 1977).

Previous exploratory studies, however, must be interpreted with caution and can be criticized appropriately for limitations in design (Cummins, 1991; Fisher & Bundy, 1991; Hoehn & Baumeister, 1994; Parham & Mailloux, 1996). Because Ayres was constantly exploring new ideas, she used a different battery of tests in each study. Therefore, none of the studies was a true replication of a preceding one. Further, her samples were heterogeneous and consistently small in number, relative to the number of test scores that were analyzed. Terminology used to describe the factors which emerged

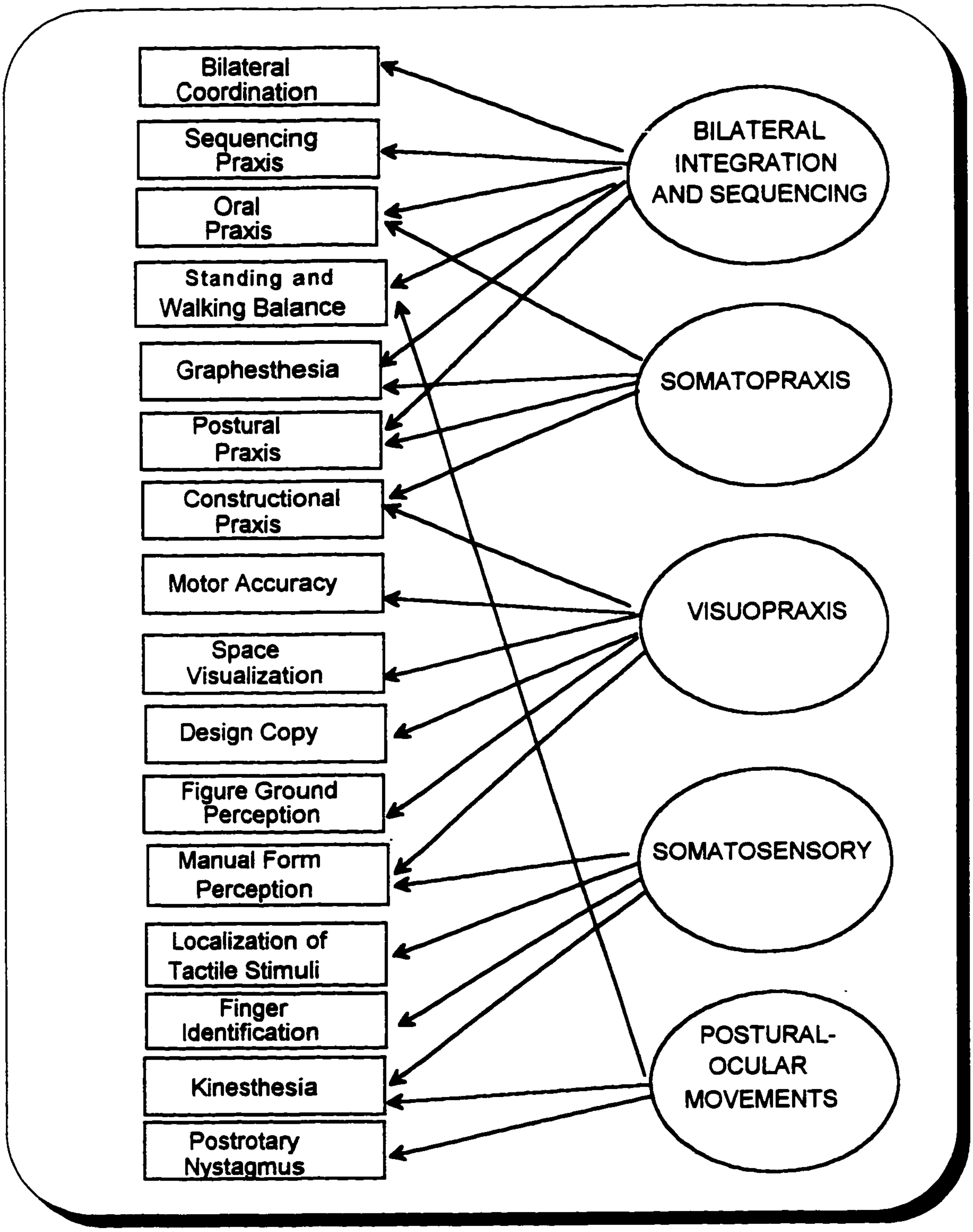

Figure 2-1 Hypothesized Model of Sensory Integration Dysfunction

in these studies was also inconsistent; therefore, comparing the results from these studies and drawing conclusions based on their combined contributions is difficult. Cummins' (1991) review of the earlier portion of this research highlighted his concerns regarding the validity of the factors which Ayres identified in her conceptualization of SI dysfunction. In particular, he reported that the claim that data from children with LD gives rise to characteristic factor structures has not been adequately tested.

Conservative interpretation of the results of these studies does support the construct of SI dysfunction as being multidimensional. However, a number of inconsistencies in previous exploratory factor analyses leave interpretation of the factors which emerged inconclusive, and controversial. The five factor model tested in this study (see Figure 1) is supported by Ayres (1989), and Fisher and Murray (1991). These patterns of dysfunction (along with sensory modulation disorders) provide the most current and comprehensive view of SI dysfunction. These patterns are presently used by occupational therapists in the interpretation of a child's results on the SIPT and they provide a basis for intervention (see Fisher & Murray, 1991).

By applying techniques from structural equation modelling (SEM), this study attempted to validate the five factor model with a large, heterogeneous group of children who were tested with the SIPT. Because many of the previous exploratory factor analyses from which this model was derived were based on performance indicators of children identified as having LD, the models examined in this study were also tested with a subgroup of children specifically identified as having LD.

This inquiry contributes significantly to the evolution of SI theory and our understanding of the concept of SI dysfunction. It is important that a frame of reference used so extensively by occupational therapists continue to be evaluated and developed to ensure its appropriate application. Because there are strong relationships among children with SI dysfunction, attention disorders, and LD, an increased understanding of the concept of SI dysfunction may also provide clues to the nature of these relationships. Finally, information gained by this inquiry may be used by therapists in the interpretation of scores of children on the SIPT, resulting in more relevant intervention plans for children.

Methods

The Sensory Integration and Praxis Tests (SIPT)

The SIPT is a comprehensive, standardized battery of tests used to identify and measure SI deficits in children ages 4 to 9 years (Ayres, 1989). The SIPT is typically administered to children who have mild disabilities such as LD, motor delays and/or motor coordination problems, dyspraxia, and behavioral problems such as hyperactivity, attention problems, or hypersensitivity to various forms of sensory input. The SIPT consists of 17 individual tests that have been categorized into four overlapping areas: (a) visual form and space perception, and visuomotor skills; (b) tactile, kinesthetic and vestibular processing; (c) praxis; and (d) bilateral integration and sequencing (Ayres & Marr, 1991). Although the test is made up of a number of individual tests, it is meant to be administered as a single battery, and interpreted based on the patterns of scores observed (Ayres, 1989).

Initial content, criterion-related, and construct validity were established throughout the development of the earlier version of the SIPT, the Southern California Sensory Integration Tests (Ayres, 1972b), and also addressed in the development of the SIPT. Support for the constructs measured by the SIPT has been demonstrated by a number of factor analytic studies and cluster analyses (see reviews by Ayres, 1989; Fisher & Murray, 1991; Parham & Mailloux, 1996). Cluster analyses identified groups of children who demonstrated similar score patterns or profiles on the SIPT (Ayres, 1989), and they were closely related to the factors that were identified. Inter-rater reliability was demonstrated as being adequate among therapists who were certified to administer the SIPT (Ayres, 1989). Test-retest reliability was found to be satisfactory for all but four of the 17 tests with Pearson product moment correlations ranging from .69 to .93. The tests with particularly weak test-retest reliability (correlations ranging from .48-.56) included PRN, KIN, LTS and FG. More information regarding the reliability and validity can be found in the test manual (Ayres, 1989). For this study, computer scoring of the SIPT provided Z-scores for each of the 17 tests.

Participants

Data for this study were provided from an existing data base. This data base was originally provided for research purposes in October 1993 by Western Psychological Services, where all SIPT tests are computer scored, . It includes the SIPT scores of 10,475 children who were tested from July 1989 to October 1993. These children represent most geographic regions of the United States, and some parts of Canada. The majority of these children were reported by their administering therapist to exhibit mild disabilities such as LD, behavioral difficulties and/or motor difficulties. The entire sample was used in the analyses, and in this study, is referred to as the heterogeneous group. Scores from children with LD were also analyzed as a separate sub-group (all children from the 10, 475 cases with the LD indicator on the transmittal SIPT score sheet checked by the administering therapist) to test models specifically with children with LD (n=995). Participant characteristics are reported in Table 2-2. It was difficult to determine exact estimates of ethnicity because race indicators were missing for about 12% of the cases. Of the total sample, 77% were reported as being Caucasian, 1% Asian, 3% Black and 7% Hispanic, demonstrating a predominantly Caucasian sample. Only .2% of the racial information was missing in the LD sample, which also was a predominately Caucasian sample (86.4%).

Data Analyses Procedures

SAS (SAS Institute Inc., 1985) was used to examine, screen and transform the data, to provide descriptive data, and to conduct exploratory factor analyses. LISREL 8 (linear structural relations; Joreskog & Sorbom, 1993) was used to conduct confirmatory factor analyses (CFA). The covariance matrices of indicator items were estimated with the Expectation Maximization (EM) algorithm (Dempster, Laird & Rubin, 1977; Little & Rubin, 1987), and input for analyses using maximum likelihood estimation.

Table 2-2

Subject Characteristics

	Heterogenous Group		LD Group	
	N	%	N	%
Gender				
Boys	7704	73.5	726	72.9
Girls	2771	26.5	269	27.1
Norm Group/Age				
1-3 (4yrs-4yrs11mos)	784	7.5	17	1.7
4-6 (5yrs-5yrs11mos)	2016	19.2	86	8.6
7-9 (6yrs-7yrs5mos)	4152	39.6	354	35.7
10-12 (7yrs6mos-8yrs11mos)	3523	33.7	538	54.0

Prior to factor analyses, preliminary screening and appropriate transformations were conducted to manage missing values, and to fit variable distributions with the assumptions of structural equation modeling (SEM) and the EM algorithm. As well, a new variable Post-rotary Nystagmus-Absolute (PRN-A) was created by performing an absolute value transformation on PRN. This was felt necessary because both high scores (Z-scores greater than 1) and low scores (Z-scores less than -1) represent dysfunction while for all other indicators only low scores represent dysfunction. An assumption of the maximum likelihood fitting function of LISREL and the EM algorithm used is that the data are multivariate normal. Because of the non-normal distribution of most indicator items, the data were transformed to normal scores. After transformation, all absolute values of skewness and kurtosis were very close to zero (see Appendix B).

The percentage of variables with missing data was 8.58%. To handle missing data, the covariance matrix of indicator items was estimated with the EM algorithm. This application of the EM algorithm is generally superior to more conventional, adhoc approaches to handling missing data such as listwise deletion (Little & Rubin, 1987). For example, listwise deletion may have resulted in almost a 50% reduction in sample size and would have biased the sample by excluding the data from children who did not complete the test battery. The algorithm converged after five iterations, and convergence was judged when no element of the estimated covariance matrix or mean vector changed by more than 0.0001 in successive iterations.

The second step in the analysis was to evaluate the hypothesized model of SI dysfunction using SEM. Conceptually, SEM demands *a priori* statements of the underlying measurement theory of abstract constructs such as SI dysfunction. SEM provides greater precision in testing theoretic propositions and more thorough understanding of the data than exploratory analytic procedures such as exploratory factor analysis. Technically, SEM assesses the error in measured indicators and estimates the structural relationships among posited unobserved constructs (Bollen, 1989).

The covariance matrix of the indicator variables used in the analyses is presented in Table 2-3. For each of the models tested, all residual variances were set to be uncorrelated. For each latent construct, one indicator was fixed at unity in order to identify the model, and factor covariances were freely estimated. The relationships among the indicator variables (SIPT tests) and the latent variables (the patterns of SI dysfunction) are depicted in Figure 2-1.

One of the major concerns in conducting SEM is the issue of what indices should be used to assess overall model fit. Historically, the chi-square statistic has been used to evaluate goodness of fit (Bollen & Long, 1992). However, there is a growing recognition of the inappropriateness of this type of hypothesis testing because of sensitivity of the chi-square statistic, particularly to sample size (Bollen & Long; Marsh, Balla, & MacDonald, 1988). Goodness-of-fit in this study was assessed by examining model chi-squares, degrees of freedom, and the difference between chi-squares of nested models It was expected that model chi-squares would be significant because of the very large N in this study. In addition, the root mean square error of approximation (RMSEA; Steiger, 1990; Steiger & Lind, 1980), the comparative fit index (CFI; Bentler, 1990), and the adjusted goodness-of-fit index (AGFI) were examined.

Generally, significant chi-squares and chi-square difference tests indicate lack of exact fit. RMSEA is a measure of the error of approximation per degree of freedom and values below .05 are suggestive of a "close fit" (Browne & Cudeck, 1993). The AGFI represents the relative amount of variance and covariance in the observed indicators that is explained by the model, with adjustments for the degrees of freedom used to estimate free parameters. The AGFI ranges from 0-1, and values greater than .90 are considered to be acceptable (Joreskog & Sorbom, 1989). The comparative fit index (CFI) was also used to evaluate overall model fit. This goodness-of-fit measure does not explicitly depend upon sample size, and basically measures how much better the model fits as compared to the independence model, with values ranging from 0 to 1, where values greater than .90 provide evidence for an acceptable fit (Bentler & Bonnett, 1980). For a more comprehensive review of these indices see Marsh, Balla and McDonald (1988) and Joreskog and Sorbom (1993).

Table 2-3

Covariance Matrix of Indicator Variables

	BMC	SPR	OPR	GRA	SWB	PPR	CPR	MAC	DC	SV	FG	MFP	LTS	FI	KIN	PRN-A
BMC	1.01															
SPR	.62	1.00														
OPR	.51	.51	1.00													
GRA	.45	.51	.49	1.01												
SWB	.41	.43	.46	.40	1.00											
PPR	.44	.47	.57	.44	.45	1.00										
CPR	.35	.42	.37	.38	.38	.45	1.01									
MAC	.33	.39	.36	.35	.45	.34	.39	1.01								
DC	.46	.55	.43	.49	.49	.49	.61	.51	1.01							
SV	.33	.43	.32	.36	.37	.41	.45	.34	.52	1.00						
FG	.27	.34	.28	.27	.28	.30	.37	.26	.43	.34	1.00					
MFP	.33	.42	.38	.39	.38	.41	.45	.32	.52	.42	.36	1.01				
LTS	.22	.22	.27	.29	.26	.23	.21	.25	.23	.18	.16	.23	1.01			
FI	.30	.37	.40	.43	.33	.37	.32	.26	.39	.29	.23	.27	.35	1.01		
KIN	.29	.39	.34	.36	.34	.34	.33	.30	.40	.31	.27	.35	.22	.29	1.01	
PRN-A	.05	.06	.08	.05	.11	.06	.06	.09	.08	.07	.03	.07	.06	.03	.06	.99

Because the results of the first analysis revealed some weaknesses with the hypothesized model, the third step in the analyses involved developing a modified model of SI dysfunction that would better fit the data, and would be more parsimonious. Rather than using post-hoc modifications suggested by the results of the confirmatory analyses of the hypothesized model, the modified model was generated from exploratory factor analyses. This decision was made because studies suggest that models based on post-hoc modifications are often unlikely to replicate (Hoyle & Panter, 1995) and because the design of this study significantly improved upon previous exploratory analyses particularly with respect to the large sample size. The new, modified model was then evaluated using the same CFA techniques, and using the same sample that was used with the initial model.

The final step in the analysis involved testing whether the modified model would hold true for a sample of LD children. As noted earlier, many of the previous exploratory factor analyses from which models of SI dysfunction were derived were based on performance indices of children identified as having LD. It was also very important to test the model with this subgroup because SI interventions are often applied to children with LD.

Results

In terms of overall fit indices, the CFA of the hypothesized model indicated that this model fit reasonably well (see Appendix A for the complete LISREL output). The RMSEA, AGFI and CFI all had values which supported the model as an acceptable fit (see Table 2-7). The chi-square value as expected was significant. Examination of the parameter estimates revealed that two of the factor loadings (CPR on SOMPR and SWB on BIAS) were non-significant (see Table 2-4), and there were five other very weak indicators with loadings less than .25. In addition, complex indicators (those associated with more than one factor) tended only to load strongly on one of their factors. To examine the model further and to locate specification problems, standardized residuals, the relationship among the factors or patterns (PHI matrix) and modification indices were examined. Of particular interest were the results of the PHI matrix which demonstrated that all patterns of dysfunction were highly correlated with one another with estimates ranging from .60 to .90. This finding strongly suggested the presence of a single, general dysfunction factor.

Therefore, despite the reasonable fit as indicated by the goodness-of-fit measures, a number of weaknesses with the model were identified. These weaknesses supported further analyses aimed towards identifying a better fitting model of SI dysfunction. In addition, because the factor structure tested was quite complex (many variables relating to more than factor), it was reasonable to attempt to find a more parsimonious solution, as well as one which might improve the "fit" of the data. Bentler and Hu (1995) reported the main advantage of model simplification as reducing the possibility of inflating the "goodness-of-fit" and that all else being equal, parsimonious models are more apt to replicate. They suggest that it is desirable to use model parsimony in addition to other factors when selecting the "best" model from a set of alternative models.

Table 2-4

Maximum Likelihood Results for the Hypothesized Model of SI Dysfunction

	Pattern of Dysfunction				
Indicator/SIPT test	BIAS	SOMPR	VSPR	SOMSEN	POM
Bilateral Motor Coord.	.74				
Sequencing Praxis	.84				
Oral Praxis	.14	.62			
Standing/Walking Balance	-.04 *ns*				.70
Graphesthesia	.24	.47			
Postural Praxis		.73			
Constructional Praxis		-.02 *ns*	.72		
Motor Accuracy			.58		
Space Visualization			.63		
Design Copy			.84		
Figure-Ground Perception			.51		
Manual Form Perception			.45	.24	
Localization of Tactile Stim.				.43	
Finger Identification				.64	
Kinesthesia				.12	.43
Postrotary Nystagmus					.11

Lambda-X values, completely standard solution; Coefficients are significant $p<.05$ unless indicated *ns.*

To develop a better fitting model, exploratory factor analyses (EFA) were conducted with SAS. Three, four, and five factor solutions were examined. Backwards elimination was also conducted by removing the weakest variable from each solution and re-estimating the factor solution until all variables had factor pattern loadings greater than .35. PRN was always eliminated first, followed by KIN, indicating that these tests were not associated with any specific pattern of dysfunction. In consideration of SI theory, the results of previous factor analyses, and the loadings generated by these solutions, a four factor solution was felt to make the most sense. The factor loadings of the four factor solution following an oblique rotation with promax are presented in Table 2-5.

As with the results of the CFA of the hypothesized model, the four factors identified were highly correlated with one another (see Table 2-6) which suggested the presence of a higher-order, general dysfunction factor. Therefore, two revised models of SI dysfunction, a first-order, 4-factor model and a second-order, 4-factor model were formulated. A second-order model is one in which a general factor, such as SI dysfunction, is hypothesized as accounting for or explaining all variance and covariance related to the first-order factors (Byrne, 1994).

In comparison with the original model, these revised models eliminated the Postural-Ocular pattern, and included a Praxis pattern in place of the Somatopraxis pattern. The number of tests (indicators) loading on each pattern also decreased, so that only the tests that had factor pattern loadings of .35 or greater were included. For example, MAC was eliminated from the Visual Perception factor, and GRA was eliminated from the Somatosensory factor. One exception was made and that was to eliminate PRVC from the Visual Perceptual Factor. Its loading was marginal (.36), and theoretically, it did not make sense that PRVC, which is a type of praxis, be associated with the Visual Perceptual factor. Although the EFA solution had some non-zero, secondary loadings, the modified models only allowed tests to load on their primary factor and therefore were much more parsimonious.

Table 2-5

EFA Factor Pattern Loadings of SIPT tests

	Visual Perceptual Factor	Bilateral Integration Factor	Somatosensory Factor	Praxis Factor
Design Copy	.72	.13		
Constructional Praxis	.69			
Space Visualization	.60			
Manual Form Perception	.52		.20	
Figure Ground Perception	.50			
Praxis on Verbal Command	.36	.19		.17
Sequencing Praxis	.15	.79		
Bilateral Motor Coordination		.68		.12
Finger Identification			.57	
Graphesthesia		.25	.44	
Localization of Tactile Stimuli			.42	
Postural Praxis	.22			.62
Oral Praxis		.24	.20	.51

Note: Standardized coefficients following oblique rotation with promax

Table 2-6

EFA Inter-factor Correlation Matrix

	Visual Perceptual Factor	Bilateral Integration Factor	Somatosensory Factor	Praxis Factor
Visual Perception	1			
Bilateral Integration	.63	1		
Somatosensory	.62	.62	1	
Praxis	.58	.62	.64	1

Both of these models were then tested with CFA using the same data set and procedures as the initial, hypothesized model. The initial analysis (first-order, 4-factor model) strongly suggested adding PRVC to the Praxis factor, as it was the largest modification index. The decision to implement this modification index was made because theoretically it made sense that PRVC be associated with Praxis.

The final, first-order and second-order models were then tested with CFA. The goodness-of-fit measures are presented in Table 2-7, and the complete LISREL output is included in Appendices D and E. The goodness-of-fit measures, RMSEA, AGFI and CFI remained strong and were almost exactly the same as the original model.

Table 2-7

Goodness of Fit Indices for the Initial and Modified Models

Model	χ^2	df	χ^2_{diff}	df_{diff}	RMSEA	AGFI	CFI
Initial Model	1933	88	----	----	.045	.96	.97
1st order 4-Factor	1665	59	----	-----	.05	.96	.97
2nd-order 4-Factor	1670	61	.5 *ns*	2	.05	.96	.97
2nd-order 4-factor (LD group)	232	61	----	----	.05	.95	.97

RMSEA = Root Mean Square Error of Approximation; AGFI=Adjusted Goodness of Fit Index; CFI=Comparative Fit Index; . χ^2 difference test from the 4-factor 1st-order model, ns=non-significant

Despite minimal differences in measures of goodness-of-fit, the parameter estimates from the first-order, four factor model significantly improved upon those from the hypothesized model. All loadings were significant, and estimates ranged from .39 (LTS) to .84 (SPR).

The 4-factor, second-order model which incorporated Generalized Practic Dysfunction as the higher-order factor, was believed to represent the best model. Figure 2-2 provides a visual representation of this model, along with the results of the completely standardized solution. The loadings from the completely standardized solution ranged from .38 (LTS) to .84 (SPR) and all values were significant, indicating an overall better solution than the original model and very similar results to the first-order model. The latent variable (pattern of dysfunction) with the strongest relationship with the higher-order factor was Praxis with Generalized Practic Dysfunction explaining more than 90% of the variation in Praxis.

The final analysis involved testing the model with a subgroup of children with LD. The results of the CFA were very similar to the results from the heterogeneous group. The goodness-of-fit measures remained strong. On examination of the parameter estimates, the indicator loadings were for the most part slightly stronger, indicating the scores of LD children fit this revised model better than the scores of children from the heterogeneous group (see Figure 2-2). The relationships among the patterns of dysfunction with Generalized Practic Dysfunction factor remained almost identical.

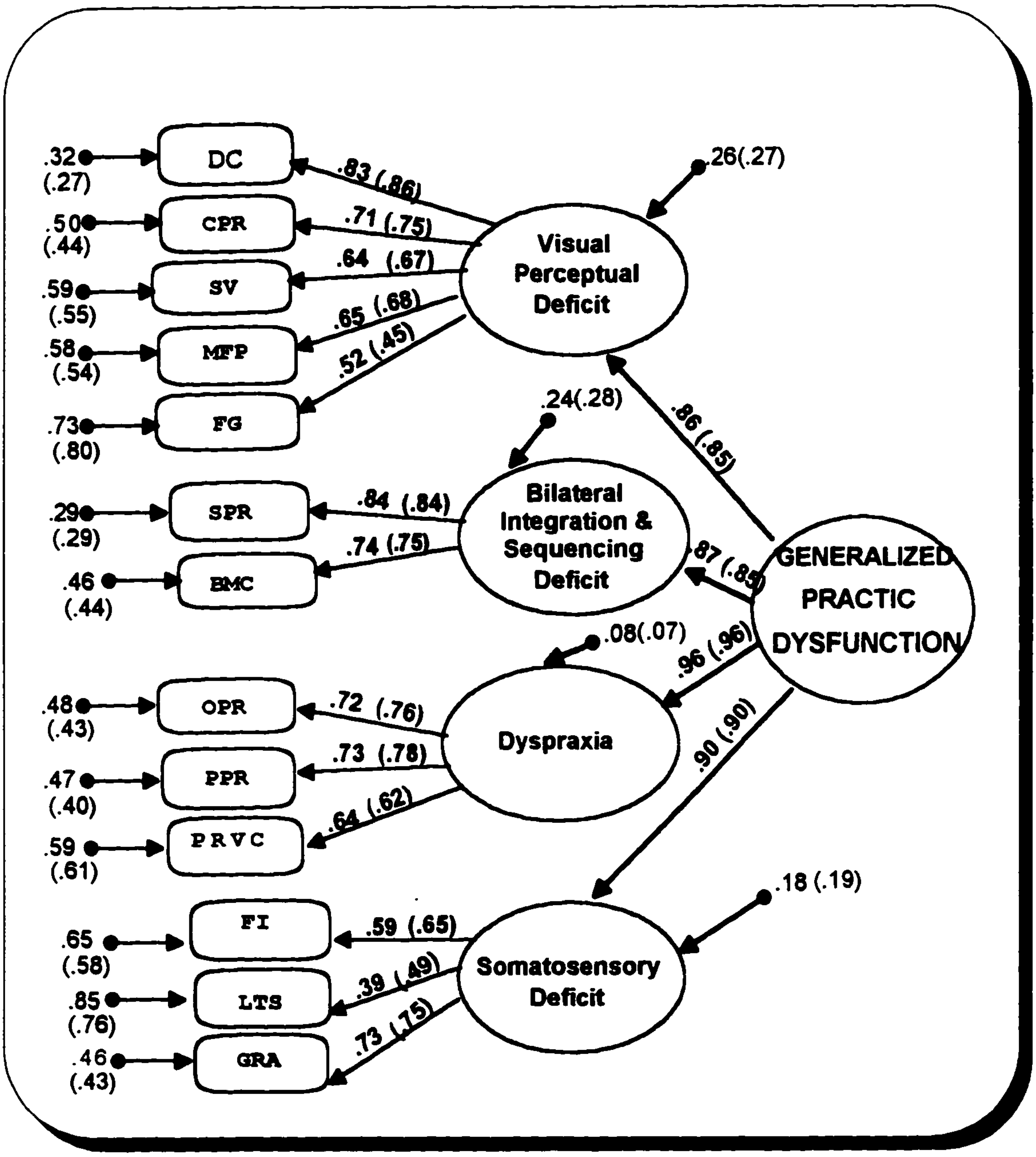

Figure 2-2 Factor Loadings, Modified 2nd-order, 4-factor Model of Sensory Integration Dysfunction *Note*: LD group results in parentheses

Discussion of Results

The results of this study support the idea that SI dysfunction is a multidimensional construct as articulated in previous studies (see reviews by Ayres, 1989; Fisher & Murray, 1991; Kimball, 1993; Parham & Mailloux, 1996). Although fit indices supported the hypothesized model as a reasonable fit, a number of weaknesses were identified with it, which supported further analyses of alternative models. Because of the very strong relationships identified among the various patterns included in the models tested, a higher-order model including a general factor, Generalized Practic Dysfunction, was felt to be more appropriate. Rather than purport the existence of separate patterns of SI dysfunction (related to dysfunction in particular neural substrates) as previous studies have done, the results of this study suggest that specific patterns of dysfunction (based on deficient SIPT scores) should be viewed as extensions of Generalized Practic Dysfunction. For example, rather than viewing a child as having a Bilateral Integration and Sequencing Deficit, it appears more accurate to view the child as having General Practic Dysfunction with a particular weakness in the area of bilateral integration and sequencing. Although this idea has been articulated before in the literature (Parham & Mailloux, 1996) it has not been demonstrated quantitatively nor has it been sufficiently emphasized.

What do these results mean for our understanding of basic neural processes related to SI dysfunction? Despite this study's suggestion of a shift to a more simplistic, parsimonious model of SI dysfunction, the idea of a general factor, Generalized Practic

Dysfunction emphasizes the complexity of our central nervous system (CNS). This model supports an inter-relatedness or holistic view of the CNS and disputes the idea that well-defined neural pathways (systems or substrates) which when impaired result in specific, characteristic patterns of dysfunction, actually exist. Lai, Fisher, Magalhaes & Bundy (1996) examined the construct validity of the SIPT. They provided evidence that praxis is a unidimensional construct, and that both Bilateral Integration and Sequencing and Somatopraxis patterns of dysfunction represent this unidimensional construct (praxis). Although their study did not examine all patterns of dysfunction previously believed to comprise SI dysfunction, these results indicate a shift in thinking regarding the multidimensionality of SI dysfunction. Because of the very strong relationship between Dyspraxia and Generalized Practic Dysfunction identified in this study, one may question whether this higher-order factor is just Dyspraxia.

The results of this study indicate that the SIPT measures more than SI functions and areas of praxis, and questions our ability to distinguish higher cortical processes from lower cortical processes. The purpose of the SIPT is to identify dyspraxia in children, along with the underlying etiology (SI dysfunction) contributing to dyspraxia. For example, upon examination of the factors identified in this study, if a child exhibits Dyspraxia (based on low PPR, OPR and PRVC scores) and/or Bilateral Integration and Sequencing problems (low BMC and SPR scores) the SIPT should also provide insight into the underlying sites or sensory systems contributing to this dysfunction. The SIPT does indicate if the somatosensory system is contributing to these deficits (low LTS, FI and GRA scores) which would indicate a lower cortical, SI problem. However, if the somatosensory system is intact despite dyspraxia, then one is left to wonder whether or not this is a lower cortical SI problem (perhaps relating to poor vestibular-proprioceptive processing) or a higher cortical problem such as poor idea formation. It is very likely that some children with dyspraxia have higher cortical problems and not SI dysfunction or a combination of higher and lower cortical problems. In addition, the SIPT identifies visual perceptual deficits in children which are considered to be higher cortical, right hemisphere functions, and end products of SI dysfunction. Therefore, therapists interpreting the SIPT scores of children must be careful not to conclude that all children with low scores on the SIPT have SI dysfunction, or only SI dysfunction.

It appears as though we must better be able to distinguish between the underlying causes of Generalized Practic Dysfunction (higher versus lower cortical). The end-product problems we are interested in, such as motor skill deficits, behavioral, and learning problems may be similar, however, approaches to intervention would differ significantly dependent upon the source of the problem. In view of the complexity of the CNS, and the idea of SI dysfunction as a more global, construct, it seems possible that lower cortical and higher cortical processes may be too tightly woven and dependent upon one another to be measured as separate entities. Perhaps we need to consider higher cortical processes as part of SI dysfunction, rather than merely contributing factors.

Second, the results of this study provide little evidence supporting the ability of the SIPT to detect problems related to postural-ocular functioning (i.e. PRN with SWB and KIN did not emerge as a pattern). This is not to say that a child with SI dysfunction may not have a weakness in this area, but rather, that the SIPT alone is not sufficient to detect such weaknesses. Fisher and Bundy (1991) discussed the importance of using other clinical observations such as examining equilibrium reactions and antigravity postures to determine postural-ocular problems, which was supported by the results of this study.

Third, Somatopraxis did not emerge as a separate pattern as it had it previous studies (Ayres, 1966, 1971, 1977, Ayres, Mailloux, & Wendler, 1987). This was particularly evident by the results of the exploratory factor analysis, upon which the final model was largely based. Perhaps, because there were strong associations among all patterns of dysfunction, this pattern did not emerge as a noticeable entity. The final, 2nd order, 4-factor model proposed, however, does support a relationship between tactile processing and praxis. However, unlike previous models, the relationship between these two patterns is explained by the presence of Generalized Practic Dysfunction, rather than by the creation of a separate "somatopraxis" pattern. Accordingly, based on the proposed model, children with poor scores on LTS, GRA and FI, and low scores in OPR and PPR may be viewed as having Generalized Practic Dysfunction, with weaknesses in the areas of praxis and somatosensory processing.

The results of this study have implications for test development related to measuring SI dysfunction. The usefulness of including some of the SIPT tests as part of the battery is questioned by the results of the study. In addition to PRN, KIN and SWB, MAC also did not support any of the SI, second-order patterns. This finding minimizes the overall assessment value or contributions these four tests have in identifying specific strengths and weakness of children related to SI functions. Because five tests were associated with the visual perceptual pattern, eliminating one or two of them; those with the lowest loadings such as FG, would perhaps increase the efficiency of the assessment tool without a significant loss of assessment information. It is also noteworthy that in comparison with other SIPT tests, KIN, PRN and FG are tests with the weakest test-retest reliability (in Ayres study, 1989, when administered to a sample of approximately 38 children with LD, Pearson-r scores were .33, .47, and .54 respectively).

A new shorter test which is less time consuming (more economical) to administer, and which emphasizes the identification of praxis problems and the underlying SI functions which may be contributing to the praxis problems is recommended. Such a test should aim to clearly identify whether or not SI deficits are contributing to praxis problems, and therefore would include the praxis tests and bilateral integration and sequencing tests, and the three somatosensory tests. In addition, tests of vestibular function and tests measuring sensory modulation should be included as it believed that these systems are lower cortical, SI processes (Fisher & Bundy, 1991), but have not yet been captured adequately within the SIPT. Finally, the measurement tool must be able to clearly identify whether or not Generalized Practic Dysfunction exists, by providing an overall SIPT score, and indicating the level of severity of any dysfunction reflected by the test scores.

Clinically, how can the results of this study be applied by occupational therapists who are using the SIPT, and SI as their primary frame of reference? First, in view of the new information gained from this study, it is suggested that therapists be cautioned when identifying a child as fitting one of the five specific patterns of dysfunction (based on SIPT scores) previously identified in the literature. This is especially true for POM and Somatopraxis, which did not emerge as factors in this study. As in previous factor analytic studies, patterns including Visual Perceptual Deficit, Bilateral Integration and Sequencing Deficit (BIAS), Somatosensory Deficit, and Dyspraxia were identified in this study. However, it is important to note that many of tests that were previously thought to be reflective of these patterns did not hold true in this study. For example, only BMC and SPR loaded strongly on BIAS, and only OPR, PRVC and PPR loaded strongly on Dyspraxia. To help understand the strengths and weaknesses of their clients, occupational therapists may find it useful to review the loadings of the exploratory factor analysis with those from previous studies to identify the relative importance each test has in identifying these patterns. In addition, it is important to note that these patterns are all strongly associated with a general factor, interpreted in this study as Generalized Practic Dysfunction, and therefore, should be viewed as extensions (or strengths and weaknesses) of this general factor.

In view of the complexity of the CNS, and the idea of Generalized Practic Dysfunction supported by the results of this study, specific treatment protocols or regimes for discrete patterns of SI dysfunction is unfortunately not possible. Rather, the results of this study supports a holistic SI intervention approach, and one which must be tailored to meet each child's individual strengths and weaknesses. In addition, it may also be appropriate to address higher cortical processes in intervention, as the separation of subcortical and higher-cortical functions does not appear be well differentiated. The interpretation of the SIPT and related OT evaluation procedures, and the application of SI for the evaluation and intervention of children based on the results of this study is discussed in more detail in Part 3 of this dissertation, through the presentation of a case study.

The use of SEM to test the factor structures of theoretical constructs has rarely been considered in the field of occupational therapy. The application of CFA in this study was felt to be appropriate because there were many previous exploratory studies to draw upon when specifying the model of SI dysfunction tested. As Joreskog and Sorbom (1993) stated, "It is highly desirable that a hypothesis which has been suggested by mainly exploratory procedures be subsequently confirmed or disproved, by obtaining new data and subjecting these to more rigorous statistical techniques" (p. 22). Using statistical techniques offered by SEM, the results of this study supported a modified model of SI dysfunction, which has many similarities to previous models. The results also demonstrated that the SIPT does not provide a comprehensive evaluation of SI functions, and that it measures some higher cortical fucntions in addition to lower cortical functions.

It is important for future research to replicate the findings of this study with a new sample, as well as investigate the value of the proposed model for clinical purposes. The results of this study, support a holistic, individualized treatment approach. Rather than viewing this as a disadvantage, it does allow therapists to focus on the unique characteristics, and unique patterns of sensory processing observed in individual children. It may also be more appropriate to view SI dysfunction in conjunction with higher cortical functions, as separating these functions may not be reflective of the way in which our CNS processes information. Integrating SI theoretical research with other frames of reference such as information processing models may provide valuable insights and a more comprehensive view of SI dysfunction and CNS functioning, and ultimately allow for more effective methods for assessing and intervening with children with mild disabilities.

PART 3

Sensory Integration Evaluation and Intervention: A Case Example of a Child with Learning Disabilities

Occupational therapists have been treating children with learning disabilities (LD) for many years (Ayres, 1979). Children with LD represent a heterogeneous group of children that are presumed to have a neurobiological deficit resulting in a discrepancy between their academic achievement, and what their academic potential is believed to be based on measures of intelligence (American Psychological Association, 1993). Children with LD are typically referred to occupational therapy (OT) not specifically because they have academic problems, but because they have associated problems such as poor balance and motor coordination (Fawcett & Nicholson, 1995; Wolff, Michel, & Ovrut, 1990), poor visual-motor skills and/or handwriting problems (Fisher & Bundy, 1991) dyspraxia or motor planning problems (Cermak, 1991) and/or behavioral problems such as poor organizational skills, hyperactivity and attention difficulties (Mulligan, 1996). It is these problems that are often viewed by OTs as products of sensory integration (SI) dysfunction (Fisher & Murray, 1991).

Within this frame of reference, a child's academic problems are believed to result largely from inefficient sensory processing of the vestibular, somatosensory and other sensory systems (Ayres, 1979), which are considered to be lower or subcortical functions. This view is in contrast to the views of most educators and psychologists who believe that LD results from problems in higher cortical areas such as right or left hemisphere dysfunction (Rourke, 1988). It is, however, important to note that not all children with LD have SI deficits and even for those that do, it is likely that most of these children also have higher cortical processing problems which contribute to their academic difficulties (Murray, 1991).

The application of SI as a guiding frame of reference for the evaluation and intervention of a child with LD will be presented. This case was selected from an existing data base which includes the SIPT scores of over 10,000 children on the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989) who were tested from July 1989 to October 1993. Because specific demographic information, educational and medical history information, and clinical observation data were not provided for the individual cases, this information was fabricated. However, the characteristics of the child (John) were carefully contrived to be representative of a typical child with LD seen by the author in her clinical experience as a pediatric OT specializing in SI interventions and working in both clinic settings and educational settings.

The evaluation process and interventions that are described also illustrate the differences between OT services that may be viewed as "educationally relevant," and services that may be viewed as "medically relevant." This differentiation represents a very important issue, as the responsible payor (special education dollars or health care insurance/resources) for OT services is often determined by the way in which the services are perceived, and provided.

Case Presentation: John

Referral: John was referred by his pediatric neurologist, to a private, out-patient, OT clinic for a SI evaluation. John is a 7-year-old child who attends a regular first grade school program. He was identified the year previous as having LD, and receives some special education programming specifically for written language and reading. Although it is anticipated that the information gained by the SI evaluation (and outcomes of intervention if recommended) would positively impact John's school performance indirectly, the evaluation and interventions provided by the OT clinic would be considered medically rather than educationally relevant. The services were provided based upon a physician's referral, and were not limited to the evaluation and remediation of areas related specifically to his individual education plan (IEP). Rather, they involved an examination of the integrity of his central nervous system (CNS), and how his CNS functioning relates to his performance both within and outside of educational environments.

Occupational Therapy Evaluation:

The methods used to evaluate John included parent interview, a sensory and medical history questionnaire completed by his mother, informal interview with his school teacher, the administration of the SIPT, and clinical observations of vestibular-proprioceptive processing and sensory modulation indicators, and gross and fine motor play behaviors, The parent interview and the medical/sensory history questionnaire indicated that John was a full-term infant born after a very long and difficult labor. His mother's pregnancy was uncomplicated. She described him as a fussy baby, who did not sleep through the night until he was about 2 years of age. He was, however, generally healthy, and achieved major motor milestones within the age-appropriate ranges. Once he began walking, she reported that he was very hard to control, and tended to fall a great deal. She reported having to go to the emergency room on four occasions during his second year for minor bumps, and bruises. However, because John was her first born, she really didn't know if this was "normal". She did feel that he was very bright, and reported that he developed language skills ahead of schedule.

At the time of the evaluation, his mother reported she was most concerned about his difficulties in learning to read. She was also concerned with his general disorganization, inability to follow directions, his lack of attention in the classroom, and his low frustration tolerance. She reported that John was very reluctant to try anything new, and rarely persisted or asked for help when he was experiencing difficulty. He also was very set in his ways, wearing only certain clothing, eating very few foods, and playing with only a select group of friends and activities. She was also concerned with his poor motor skills which greatly affected his handwriting, his safety especially on playground equipment, and his ability to keep up with his peers during sports activities.

John's SIPT scores are shown in Table 3-1. According to the model of SI dysfunction proposed in Part 2 (refer to Figure 2-1), there is some support that John has Dyspraxia, with low scores on Postural Praxis and Praxis on Verbal Command. A Bilateral Integration and Sequencing problem is less clear with one out of the two tests scored low (Sequencing Praxis) in that category. John clearly demonstrated Somatosensory problems with all three tests in that area scoring significantly below average. With respect to a Visual Perceptual Deficit, John scored low on only one of the

Table 3-1

John's Sensory Integration and Praxis Test Results

Test	SD Score
Space Visualization (SV)	.15
Figure Ground Perception (FG)	.54
Manual Form Perception (MFP)	-4.67
Kinesthesia (KIN)	-.24
Finger Identification (FI)	-1.41
Graphesthesia (GRA)	-1.37
Localization of Tactile Stimuli (LTS)	-1.58
Praxis on Verbal Command (PrVC)	-2.72
Design Copy (DC)	-.59
Constructional Praxis (CPr)	-.75
Postural Praxis (PPr)	-1.25
Oral Praxis (OPr)	-.63
Sequencing Praxis (SPr)	-1.11
Bilateral Motor Coordination (BMC)	-.33
Standing & Walking Balance (SWB)	-1.96
Motor Accuracy (MAC)	-.49
Postrotary Nystagmus (PRN)	-1.09

John was not likened to any of the SIPT cluster groups

five tests in that pattern, Manual Form Perception (MFP). Because MFP has a strong tactile component in addition to a visual perceptual component, it was not suprising he scored low on this test. John has Generalized Practic Dysfunction because he exhibits two (and maybe three) of the first-order patterns of dysfunction which all correlate highly with the second-order, general factor. On SIPT tests not associated with any of the patterns of dysfunction proposed by the new model, John scored significantly below average on

SWB, average on MAC, and low on PRN. To summarize, John's SIPT scores demonstrate that he has SI dysfunction characterized by a praxis problem or dyspraxia, including a motor sequencing problem, and a somatosensory processing deficit. He also has a relative strength in the area of visual perception which is primarily a higher cortical function.

Clinical observations of vestibular-proprioceptive processing, and of behaviors indicative of sensory modulation were also important in completing his SI evaluation, as these areas are considered important aspects of SI, but are not evaluated sufficiently by the SIPT. In John's case, there was evidence of vestibular-proprioceptive dysfunction. For example, he was unable to assume anti-gravity postures such as prone extension for more than five seconds. His muscle tone overall, was assessed to be in the low average range. His balance reactions (righting and equilibrium responses) were present, but were found to be inefficient at times, with poor gradation of movement, and poor anticipatory control and initiation. Subsequently, he tended to fall more than one would expect during gross motor play. These clinical observations also supported his low z-score on the SIPT, Standing & Walking Balance test. He seemed to enjoy falling (crashing) into the large pillows, and often sought deep pressure, proprioceptive sensory input. This type of sensory information, provides us with a clearer picture of where we are in space, and how our bodies are moving in space (Fisher, 1991).

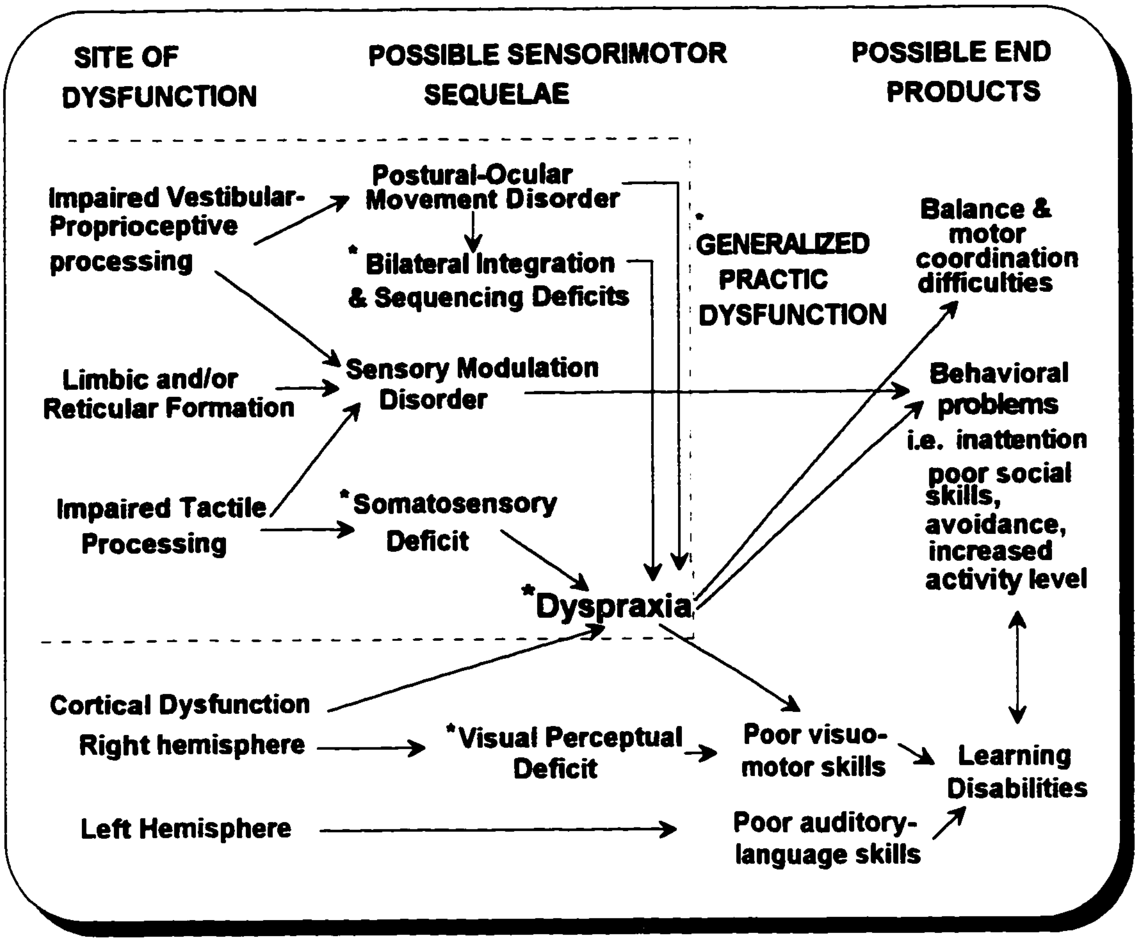

Figure 3-1 Model for Interpretation of the SIPT and Related Clinical Observations adapted from Fisher and Bundy (1991) * areas evaluated by the SIPT

Performance related to sensory modulation was evaluated through observations of John's behavior in response to a variety of sensory experiences, and through structured interview with his mother. John seemed comfortable with movement experiences and sought out rough-house type play. His movements, however, were sluggish and he fatigued easily. He needed instructions to be repeated often, even though he seemed to be paying attention. These behaviors are signs indicating that his CNS is under-aroused. In relation to tactile processing, his dislike for various food textures and types of clothing indicated some hyper-responsivity or tactile defensiveness.

A model for interpreting SIPT scores and related clinical observations is presented in Figure 3-1. This model highlights potential sites of dysfunction, related patterns of SI dysfunction and possible end products. John demonstrates many of the end products described by this model. Upon examination of the sites of dysfunction hypothesized to contribute to John's problems (and Generalized Practic Dysfunction), it does appear that his many difficulties are rooted in subcortical processes such as tactile processing, vestibular-proprioceptive processing, and areas responsible for sensory modulation. It is also likely that his SI deficits are contributing to some degree to his academic difficulties, which also may be in part be due to higher cortical problems. It is therefore recommended that John receive OT intervention, and that SI as a frame of reference would be very useful. It is also evident from this model that problems such as John's involve a complex interplay of neural systems which may be rooted in both lower cortical, SI processes, and higher cortical cognitive processes. Therefore, therapists must be take care in the interpretation of the SIPT and consider other clinical and functional observations, to determine if certain children are appropriate for SI intervention.

Occupational Therapy Intervention

SI as an intervention approach, is based on the postulate that functioning of the CNS is enhanced (thereby providing the foundation for improved motor and academic skills) by providing the client with opportunities to take in controlled, and carefully selected sensory information in the context of active participation in activities that are meaningful to the client, and that elicit adaptive behaviors (Koomar & Bundy, 1991). Specific characteristics of SI therapy were reported by Kimball (1988) and are discussed in Part 1 of this dissertation.

In John's case, examples of general therapy goals might include: a) to improve basic balance and postural mechanisms (vestibular-proprioceptive processing; b) to enhance tactile processing such as decreasing hypersensitivity to tactile stimuli and increasing tactile discriminative abilities; and c) to improve motor planning skills. A typical therapy session might include an initial period of approximately 10-15 minutes of activities that provide a great deal of proprioceptive and vestibular sensory input to heighten his general sensory awareness. Equipment such as a large cloth hammock, a large platform swing with an inner tube inside, or play on a large air mattress would be effective for providing such sensory experiences. It is, however, important that John's activity level and responses to these activities be monitored. This monitoring allows the therapist to provide the optimal intensity of the stimulation he receives.

Following this initial sensory phase of the treatment session, activities selected may be directed towards developing more efficient balance reactions, and more coordinated postural responses. Ideal activities would be those that require dynamic movement along with a providing a strong amount of proprioceptive feedback, such as play on swings suspended with bungi cords. In order to address tactile processing, blankets of various textures can be incorporated into the play situations. The flow of the treatment session might then move towards activities to promote motor planning and sequencing. John may be asked to follow simple motor sequences from verbal directions, or to copy motor sequences from demonstration, and then to create his own motor sequences to achieve a set goal. He could be asked to draw out (with stick figures) the sequence of a motor activity (which also addresses his pencil skills) and then perform them.

It is important to point out that intervention based on SI theory is complex, and very individualized. There are not "set" activities or pieces of equipment to use in therapy. Rather, various activities are selected based on their ability to provide the child with just the right challenge to those the sensory systems and processes that have been identified as deficit areas. In addition to considering the therapy goals, activities selected are based factors such as the child's interest and motivation and the child's responses to them at any given time. It is important that John have fun in therapy, and that he demonstrate success with activities that continually challenge him. It is anticipated that to achieve his therapy goals, John will receive such intervention weekly for approximately 6 months to a year.

Recommendations for School Programming

As noted earlier, John attends a regular first grade program in a public school. A typical scenario for John is that he receives about 3 hours of special education assistance per week specifically for reading and writing. Because of the trend towards full inclusion (Hammill, 1993), many schools are choosing to provide special education services to children such as John in their regular classrooms, and within the context of regular classroom activities. In addition to the assistance he receives for reading and writing, it is recommended that John receive OT services at school to minimize the ways in which his SI deficits impact his school performance. It would be important for John's clinic OT and school OT to share information with one another. This sharing of information helps the clinic-based therapist understand how her interventions are influencing John at school, and provides the school OT with a greater understanding of John's overall neurological functioning and with ideas to help John at school. An example of school-based OT assessment and intervention based on John's case follows, to demonstrate how SI as a frame of reference may be applied in educational settings.

The school OT evaluates John using the following procedures: a) telephone interview with his mother regarding John's medical history and her perceptions of his strengths, weaknesses and needs; b) interview with his classroom teacher regarding his strengths and weaknesses in the classroom; c) structured observations in the classroom and on the playground; d) clinical observations of balance and postural mechanisms and his response to various forms of sensory input; e) administration of a standardized test of motor skills, The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP; Bruininks, 1978); and f) informal interview with his clinic-based OT.

The results of the evaluation indicate that John has some "soft" neurological signs including minimally lowered muscle tone, and immature balance and postural mechanisms. His gross motor composite score on the BOTMP was at the 20th percentile, and his fine motor composite score was at the 2nd percentile. Difficulties were particularly evident with bilateral coordination and balance, and he scored significantly below average on these subtests. In the classroom John requires frequent cues to keep focused during large group activities. He experiences difficulty managing his space when seated on the floor. During seat-work he is often disorganized. He experiences difficulty with activity transitions and requires frequent contact from his teacher to complete assignments. He frequently rocks in his chair, and occasionally falls out of his chair. During pencil work, his size and spacing of letters is poor and it takes John much longer than the other children in his class to complete written work. He dislikes physical education (PE) and is often disruptive during this time.

Although the results of the school-based OT evaluation are consistent with the results from the evaluation by the clinic-based OT regarding John's SI functioning, the areas emphasized in their evaluations differ. The school-based OT evaluation highlights his difficulties functioning in school environments, and also includes a standardized test of motor skills which helps to determine his eligibility to receive OT services at school in the state in which he resides. The school-based evaluation suggests that he would benefit from, and is eligible for OT services. This evaluation, however, does not provide detailed information regarding specific strengths and weaknesses related to SI functioning, as was provided by his medically-related evaluation.

Following the trend towards full inclusion, the school-based OT intervention suggested and described below is integrated within the context of John's regularly scheduled, classroom activities. Suppose the educational team (regular teacher, special education teacher, school psychologist, school OT, parents) decides that John receives 30 minutes of OT per week. The OT is responsible for monitoring and assisting with the achievement of two of his special education goals that are already in place: a) John will be able to complete written classroom assignments in the allotted time; and b) John's organization in the classroom will improve such that he will keep his desk tidy, and will be able to follow the classroom schedule independently. Two new goals based on the OT evaluation results are added to his IEP (primarily the responsibility of the OT): c) John will be able to use and play safely on playground equipment during recess; and d) John will be able to participate successfully in PE and will improve his gross motor skills.

Using SI as a guiding frame of reference, his school OT provides suggestions to help John compensate for his SI deficits, and others to help promote SI functions. For example, in order to compensate for John's vestibular-proprioceptive deficits, his classroom seating is modified to ensure his chair provides adequate postural stability. Because John seeks out proprioceptive sensory input and he needs to move around more than other children, the OT suggests he be given frequent opportunities to move around, such as going to the office to pick up messages or to pass out papers in the classroom. A mini-trampoline is also provided and placed in a corner in the classroom for intermittent use throughout the day by all of the children.

To improve vestibular-proprioceptive processing and his gross motor skills, John is seen by OT sometimes during recess and sometimes during PE. During recess, John is encouraged to play on playground equipment that provides a great deal of proprioceptive and vestibular sensory input such as the moving/bouncing walkway. Bilateral integration, motor sequencing and creativity of play are addressed by having John initiate play with novel pieces of equipment, by asking him to copy and create motor sequences, and by having John figure out different ways to move on and propel various swings. Motor planning and 'thinking before doing' is emphasized to promote safety with his play. Tether ball, an activity commonly found on school playgrounds is used to address bilateral coordination and visual motor skills. Encouraging one or two of his classmates to join in during his OT time is effective for motivating John, and provides more options for play activities. Although such OT sessions with John outside are relatively short, they allow him to become more confident and capable of using the play equipment. Subsequently, he uses the playground more frequently on his own, which gives him more opportunities to process enhanced sensory input.

The school OT assists John's PE teacher by explaining his SI deficits, how they affect his motor performance, and by providing some programming suggestions. This helps the PE teacher to develop realistic expectations regarding John's performance in PE and gives the teacher ideas about how to improve John's performance. For example, when teaching new skills, the OT suggests that the PE teacher use a great deal of verbal cueing and demonstration. Physically prompting John is suggested to facilitate his learning of new skills. Activities that are particularly good for promoting balance and bilateral integration are suggested.

To enhance his organization in the classroom, the school OT sets up and posts a permanent schedule of classroom activities, and suggests that his teachers prepare him when deviations from the schedule are anticipated. It is also suggested that John review the directions for completing classroom assignments with one of his peers or his teacher. A filing system with clearly labeled folders is devised to help him organize his desk, and to reduce the chances of him losing his work. The school OT is available to his classroom and special education teachers on an ongoing basis to help address classroom behavioral issues related to his SI deficits.

John's tactile processing deficits are also addressed at school. First, the school OT helps John's teachers understand that his body tends to over-react to tactile stimuli. Therefore, placing him in situations where unexpected touch is inevitable (such as busy lunch lines) should be avoided. Also, John's use of tactile media such as clay and glue in the classroom should be monitored to ensure that his experiences with these materials are positive and within his tolerance levels

In summary, this case presentation demonstrates how SI as a frame of reference may be practically applied to a child with mild disabilities in a clinic and school setting. The model of SI dysfunction proposed in Part 2 of this dissertation provided a helpful guide in the interpretation of John's SIPT scores, especially when viewed in context with other clinical evaluation techniques typically used by OTs. By considering John's problems as end products of SI dysfunction and by examining the first-order factors, and potential underlying sites of CNS dysfucntion, the OTs working with him tailored his intervention to address his unique needs. As a related service, John's school-based OT addressed his difficulties as they relate directly to his IEP and used SI principles to help John compensate for his SI deficits in school environments. The clinic-based OT addressed his deficits as they relate to his overall CNS functioning, and focused on enhancing his ability to process sensory information more normally. In both settings, SI was useful for guiding evaluation and intervention.

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APPENDIX A

Factor Loadings of SIPT scores of 125 Children with Learning or SI Deficits (Ayres, 1989)

	FACTOR				
Test Name	Bilateral Integration & Sequencing	Praxis on Verbal Command	Somato-sensory	Visuo-praxis	Somato-praxis
Space Visualization	-.08	-.11	-.08	**.64**	.30
Figure Ground Perception	.20	**-.36**	.05	**.54**	-.02
Standing & Walking Balance	**.54**	.15	.16	.26	-.07
Design Copy	.18	.00	.06	**.67**	.06
Postural Praxis	-.07	-.03	-.02	.07	**.89**
Bilateral Motor Coordination	**.69**	-.31	-.04	.07	-.10
Praxis on Verbal Command	.32	**-.59**	.14	.06	**.67**
Constructional Praxis	.07	-.07	.10	**.38**	**.54**
Postrotary Nystagmus	.06	**.76**	.04	.07	.01
Motor Accuracy	-.03	.20	.09	**.78**	-.11
Sequencing Praxis	**.78**	.04	-.02	.04	.08
Oral Praxis	**.40**	.00	**.37**	-.22	**.51**
Manual Form Perception	**.38**	-.10	.12	.20	.17
Kinesthesia	.24	.13	**.74**	.02	-.14
Finger Identification	.24	.31	-.07	**.37**	.30
Graphesthesia	**.57**	.09	-.03	-.04	**.42**
Localization of Tactile Stim.	-.27	-.11	**.83**	.04	.09

adapted from Ayres, 1989

APPENDIX B

Means, Standard Deviations, Skewness and Kurtosis
of Indicator Variables After Transformation

```
==========================================================================
                      Simple Stats for Total Sample

Variable  Label                                 N         Mean   Std Dev
--------------------------------------------------------------------------
SV        space visualization                9715      -0.0000    0.9998
FG        figure/ground perception           9768       0.0000    0.9998
SWB       standing/walking balance           9794      -0.0000    0.9998
DC        design copy                        9905       0.0000    0.9998
PPR       postural praxis                   10013       0.0000    0.9998
BMC       bilateral motor coordination       9731      -0.0000    0.9997
PRVC      praxis on verbal command           9806       0.0000    0.9996
CPR       constructional praxis              9684       0.0000    0.9998
PRN_ABS   ABS(post-rotary nystagmus)         9298      -0.0000    0.9992
MAC       motor accuracy                     9297      -0.0000    0.9998
SPR       sequencing praxis                  9377      -0.0000    0.9998
OPR       oral praxis                        9802      -0.0000    0.9998
MFP       manual form perception             9317      -0.0000    0.9997
KIN       kinesthesia                        9296      -0.0000    0.9998
FI        finger ID                          9654       0.0000    0.9997
GRA       graphesthesia                      9463      -0.0000    0.9998
LTS       localization of tactile stimuli    8883      -0.0000    0.9998
PRN       post-rotary nystagmus              9298      -0.0000    0.9968
--------------------------------------------------------------------------

Variable  Label                              Skewness       Kurtosis
--------------------------------------------------------------------------
SV        space visualization                -0.0000        -0.0082
FG        figure/ground perception            0.0000        -0.0082
SWB       standing/walking balance            0.0000        -0.0082
DC        design copy                        -0.0000        -0.0082
PPR       postural praxis                    -0.0000        -0.0082
BMC       bilateral motor coordination        0.0007        -0.0124
PRVC      praxis on verbal command           -0.0017        -0.0133
CPR       constructional praxis              -0.0000        -0.0084
PRN_ABS   ABS(post-rotary nystagmus)         -0.0054        -0.0225
MAC       motor accuracy                      0.0000        -0.0085
SPR       sequencing praxis                   0.0002        -0.0098
OPR       oral praxis                        -0.0000        -0.0084
MFP       manual form perception             -0.0002        -0.0099
KIN       kinesthesia                        -0.0000        -0.0088
FI        finger ID                          -0.0001        -0.0089
GRA       graphesthesia                       0.0001        -0.0088
LTS       localization of tactile stimuli     0.0000        -0.0089
PRN       post-rotary nystagmus               0.0380        -0.1368
--------------------------------------------------------------------------
```

```
==========================================================================----
                         Simple Stats for LD Sample

Variable  Label                                N          Mean   Std Dev
--------------------------------------------------------------------------
SV         space visualization                937       -0.2763   0.9477
FG         figure/ground perception           947       -0.2036   0.9984
SWB        standing/walking balance           949       -0.2166   1.0671
DC         design copy                        954       -0.4283   1.0106
PPR        postural praxis                    973       -0.3310   1.0622
BMC        bilateral motor coordination       951       -0.3186   1.0225
PRVC       praxis on verbal command           960       -0.3080   1.0227
CPR        constructional praxis              933       -0.2980   0.9661
PRN_ABS    ABS(post-rotary nystagmus)         891        0.0991   1.0177
MAC        motor accuracy                     903       -0.1219   1.0629
SPR        sequencing praxis                  919       -0.4489   0.9659
OPR        oral praxis                        960       -0.3178   1.0831
MFP        manual form perception             904       -0.2708   1.0428
KIN        kinesthesia                        893       -0.2531   1.0273
FI         finger ID                          931       -0.1720   1.0469
GRA        graphesthesia                      912       -0.3043   1.0629
LTS        localization of tactile stimuli    840       -0.0540   1.0278
PRN        post-rotary nystagmus              891        0.0109   1.0555
--------------------------------------------------------------------------


Variable  Label                                    Skewness      Kurtosis
--------------------------------------------------------------------------
SV         space visualization                     0.0285       -0.4637
FG         figure/ground perception                0.0044       -0.0620
SWB        standing/walking balance               -0.1166       -0.0976
DC         design copy                             0.0307       -0.1801
PPR        postural praxis                        -0.0912       -0.3084
BMC        bilateral motor coordination           -0.0879       -0.2854
PRVC       praxis on verbal command                0.0175       -0.3028
CPR        constructional praxis                   0.0874        0.1702
PRN_ABS    ABS(post-rotary nystagmus)              0.0605       -0.1755
MAC        motor accuracy                         -0.0098       -0.1362
SPR        sequencing praxis                      -0.0638       -0.2467
OPR        oral praxis                            -0.0306       -0.1602
MFP        manual form perception                 -0.1082       -0.1956
KIN        kinesthesia                             0.2156        0.0841
FI         finger ID                              -0.0146       -0.1664
GRA        graphesthesia                          -0.0446       -0.3040
LTS        localization of tactile stimuli         0.1169       -0.3875
PRN        post-rotary nystagmus                   0.1541       -0.2338
--------------------------------------------------------------------------
```

APPENDIX C

LISREL Output: CFA of the Initial, Hypothesized Model

```
WINDOWS  L I S R E L  8.14
BY KARL G. JORESKOG AND DAG SORBOM

 The following lines were read from file
C:\DATA\CONSULT\MULLIGAN\DATA\LISREL\HYPO_MOD.LS8:

 Mulligan: Hypothesized Model
 da no=10475 ni=17 ma=cm
 label
 *
 sv fg swb dc ppr bmc prvc cpr prn mac spr opr mfp kin fi gra lts
 se
 bmc spr opr gra swb ppr cpr mac dc sv fg mfp lts fi kin prn/

 cm fu file=\data\consult\mulligan\data\lisrel\cov_prn.emc
 mo nk=5 nx=16 lx=fu,fi ph=sy,fr td=di,fr
 free lx 2 1 lx 3 1 lx 4 1 lx 5 1
 free lx 4 2 lx 6 2 lx 7 2
 free lx 8 3 lx 9 3 lx 10 3 lx 11 3 lx 12 3
 free lx 13 4 lx 14 4 lx 15 4
 free lx 5 5 lx 16 5
 st 1.0 lx 1 1 lx 3 2 lx 7 3 lx 12 4 lx 15 5
 ou ml sc

 Mulligan: Hypothesized Model
                  NUMBER OF INPUT VARIABLES 17
                  NUMBER OF Y - VARIABLES    0
                  NUMBER OF X - VARIABLES   16
                  NUMBER OF ETA - VARIABLES  0
                  NUMBER OF KSI - VARIABLES  5
                  NUMBER OF OBSERVATIONS 10475

    COVARIANCE MATRIX TO BE ANALYZED
          bmc      spr      opr      gra      swb      ppr
        -------- -------- -------- -------- -------- --------
   bmc    1.01
   spr    0.62     1.00
   opr    0.51     0.51     1.00
   gra    0.45     0.51     0.49     1.01
   swb    0.41     0.43     0.46     0.40     1.00
```

```
ppr     0.44    0.47    0.57    0.44    0.45    1.00
cpr     0.35    0.42    0.37    0.38    0.38    0.45
mac     0.33    0.39    0.36    0.35    0.45    0.34
 dc     0.46    0.55    0.43    0.49    0.49    0.49
 sv     0.33    0.43    0.32    0.36    0.37    0.41
 fg     0.27    0.34    0.28    0.27    0.28    0.30
mfp     0.33    0.42    0.38    0.39    0.38    0.41
lts     0.22    0.22    0.27    0.29    0.26    0.23
 fi     0.30    0.37    0.40    0.43    0.33    0.37
kin     0.29    0.39    0.34    0.36    0.34    0.34
prn     0.05    0.06    0.08    0.05    0.11    0.06

         cpr     mac      dc      sv      fg     mfp
       -------- -------- -------- -------- -------- --------
cpr     1.01
mac     0.39    1.01
 dc     0.61    0.51    1.01
 sv     0.45    0.34    0.52    1.00
 fg     0.37    0.26    0.43    0.34    1.00
mfp     0.45    0.32    0.52    0.42    0.36    1.01
lts     0.21    0.25    0.23    0.18    0.16    0.23
 fi     0.32    0.26    0.39    0.29    0.23    0.37
kin     0.33    0.30    0.40    0.31    0.27    0.35
prn     0.06    0.09    0.08    0.07    0.03    0.07

         lts      fi     kin     prn
       -------- -------- -------- --------
lts     1.01
 fi     0.27    1.01
kin     0.22    0.29    1.01
prn     0.06    0.03    0.06    0.99

PARAMETER SPECIFICATIONS

   LAMBDA-X

        KSI 1    KSI 2    KSI 3    KSI 4    KSI 5
       -------- -------- -------- -------- --------
bmc        0        0        0        0        0
spr        1        0        0        0        0
opr        2        0        0        0        0
gra        3        4        0        0        0
swb        5        0        0        0        6
ppr        0        7        0        0        0
```

```
 cpr       0        8       0       0       0
 mac       0        0       9       0       0
 dc        0        0      10       0       0
 sv        0        0      11       0       0
 fg        0        0      12       0       0
 mfp       0        0      13       0       0
 lts       0        0       0      14       0
 fi        0        0       0      15       0
 kin       0        0       0      16       0
 prn       0        0       0       0      17

   PHI
         KSI 1     KSI 2    KSI 3     KSI 4     KSI 5
       --------  -------- --------  --------  --------
 KSI 1      18
 KSI 2      19       20
 KSI 3      21       22       23
 KSI 4      24       25       26        27
 KSI 5      28       29       30        31        32

   THETA-DELTA
         bmc       spr      opr       gra       swb       ppr
       --------  -------- --------  --------  --------  --------
          33        34       35        36        37        38

         cpr       mac       dc        sv        fg       mfp
       --------  -------- --------  --------  --------  --------
          39        40       41        42        43        44

         lts        fi      kin       prn
       --------  -------- --------  --------
          45        46       47        48


Number of Iterations = 64

LISREL ESTIMATES (MAXIMUM LIKELIHOOD)
   LAMBDA-X
         KSI 1     KSI 2    KSI 3     KSI 4     KSI 5
       --------  -------- --------  --------  --------
  bmc     1.00       - -      - -       - -       - -

  spr     1.13       - -      - -       - -       - -
         (0.02)
```

	73.30				
opr	0.18	1.00	--	--	--
	(0.03)				
	5.59				
gra	0.32	0.75	--	--	--
	(0.03)	(0.04)			
	10.77	20.64			
swb	-0.05	--	--	--	1.62
	(0.06)				(0.16)
	-0.87				9.99
ppr	--	1.17	--	--	--
		(0.05)			
		24.15			
cpr	--	-0.03	1.00	--	--
		(0.03)			
		-1.04			
mac	--	--	0.81	--	--
			(0.02)		
			33.49		
dc	--	--	1.17	--	--
			(0.03)		
			36.09		
sv	--	--	0.88	--	--
			(0.03)		
			34.36		
fg	--	--	0.71	--	--
			(0.02)		
			31.83		
mfp	--	--	0.62	1.00	--
			(0.03)		
			22.00		
lts	--	--	--	1.80	--
				(0.16)	

```
                       11.59

 fi      - -     - -     - -     2.70      - -
                               (0.23)
                                11.65
 kin     - -     - -     - -     0.52     1.00
                               (0.15)
                                 3.59

 prn     - -     - -     - -      - -     0.26
                                        (0.03)
                                          8.38

   PHI
           KSI 1    KSI 2    KSI 3    KSI 4    KSI 5
        -------- -------- -------- -------- --------
 KSI 1     0.55
          (0.01)
          40.68

 KSI 2     0.36     0.39
          (0.02)   (0.03)
          20.43    13.50

 KSI 3     0.40     0.35     0.52
          (0.01)   (0.02)   (0.03)
          29.46    19.24    18.85

 KSI 4     0.12     0.13     0.12     0.06
          (0.01)   (0.01)   (0.01)   (0.01)
          11.32    10.73    11.28     6.19

 KSI 5     0.26     0.24     0.28     0.08     0.18
          (0.02)   (0.02)   (0.02)   (0.01)   (0.03)
          13.59    11.73    12.70     8.79     7.08

   THETA-DELTA
            bmc      spr      opr      gra      swb      ppr
        -------- -------- -------- -------- -------- --------
           0.45     0.30     0.46     0.55     0.56     0.46
          (0.01)   (0.01)   (0.01)   (0.01)   (0.01)   (0.01)
          54.12    36.11    54.51    63.56    38.58     46.7

            cpr      mac       dc       sv       fg      mfp
```

```
  --------  --------  --------  --------  --------  --------
     0.51      0.66      0.29      0.60      0.74      0.60
   (0.01)    (0.01)    (0.01)    (0.01)    (0.01)    (0.01)
    58.47     66.97     44.78     65.42     68.70     65.77
 THETA-DELTA
      lts        fi       kin       prn
  --------  --------  --------  --------
     0.82      0.59      0.73      0.98
   (0.01)    (0.01)    (0.01)    (0.01)
    65.26     41.78     65.39     72.21

 SQUARED MULTIPLE CORRELATIONS FOR X - VARIABLES

      bmc       spr       opr       gra       swb       ppr
  --------  --------  --------  --------  --------  --------
     0.55      0.71      0.54      0.45      0.44      0.54

      cpr       mac        dc        sv        fg       mfp
  --------  --------  --------  --------  --------  --------
     0.49      0.34      0.71      0.40      0.26      0.41

      lts        fi       kin       prn
  --------  --------  --------  --------
     0.18      0.42      0.28      0.01

                 GOODNESS OF FIT STATISTICS

   CHI-SQUARE WITH 88 DEGREES OF FREEDOM = 1933.42 (P = 0.0)
     ESTIMATED NON-CENTRALITY PARAMETER (NCP) = 1845.42
         MINIMUM FIT FUNCTION VALUE = 0.18
     POPULATION DISCREPANCY FUNCTION VALUE (F0) = 0.18
    ROOT MEAN SQUARE ERROR OF APPROXIMATION (RMSEA) = 0.045
      EXPECTED CROSS-VALIDATION INDEX (ECVI) = 0.19
           ECVI FOR SATURATED MODEL = 0.026
         ECVI FOR INDEPENDENCE MODEL = 5.52
 CHI-SQUARE FOR INDEPENDENCE MODEL WITH 120 DEGREES OF
   FREEDOM = 57795.32
             INDEPENDENCE AIC = 57827.32
                MODEL AIC = 2029.42
               SATURATED AIC = 272.00
             INDEPENDENCE CAIC = 57959.43
                MODEL CAIC = 2425.74
               SATURATED CAIC = 1394.9
        ROOT MEAN SQUARE RESIDUAL (RMR) = 0.024
```

```
                STANDARDIZED RMR = 0.024
                 GOODNESS OF FIT INDEX (GFI) = 0.98
             ADJUSTED GOODNESS OF FIT INDEX (AGFI) = 0.96
            PARSIMONY GOODNESS OF FIT INDEX (PGFI) = 0.63
                 NORMED FIT INDEX (NFI) = 0.97
                 NON-NORMED FIT INDEX (NNFI) = 0.96
              PARSIMONY NORMED FIT INDEX (PNFI) = 0.71
                 COMPARATIVE FIT INDEX (CFI) = 0.97
                 INCREMENTAL FIT INDEX (IFI) = 0.97
                  RELATIVE FIT INDEX (RFI) = 0.95
                      CRITICAL N (CN) = 660.67
 CONFIDENCE LIMITS COULD NOT BE COMPUTED DUE TO TOO SMALL
P-VALUE FOR CHI-SQUARE
 SUMMARY STATISTICS FOR FITTED RESIDUALS
 SMALLEST FITTED RESIDUAL =   -0.06
   MEDIAN FITTED RESIDUAL =    0.00
  LARGEST FITTED RESIDUAL =    0.10

         STEMLEAF PLOT
 - 6|2
 - 5|
 - 4|5421
 - 3|87655210
 - 2|99766542100
 - 1|988766644221110000
 - 0|98877777644333332111000000000000000000
   0|1122233345567899
   1|0000111344567889
   2|1123444468
   3|0113456
   4|0688
   5|7
   6|5
   7|3
   8|
   9|
  10|0
 SUMMARY STATISTICS FOR STANDARDIZED RESIDUALS
 SMALLEST STANDARDIZED RESIDUAL = -15.57
   MEDIAN STANDARDIZED RESIDUAL =   0.00
  LARGEST STANDARDIZED RESIDUAL =  17.21

STEMLEAF PLOT
 -14|6
```

```
-12|6
 -10|
 - 8|6
 - 6|885198444220
 - 4|85439984320
 - 2|776521177766542222l
 - 0|976622200977643320000000000000000
   0|12224444566015556
   2|1123455800033456 7799
   4|0351235
   6|056006
   8|234
  10|
  12|568
  14|9
  16|2

LARGEST NEGATIVE STANDARDIZED RESIDUALS
 RESIDUAL FOR    spr AND    bmc  -4.88
 RESIDUAL FOR    opr AND     spr  -6.23
 RESIDUAL FOR    swb AND     spr  -4.19
 RESIDUAL FOR    ppr AND     spr  -6.39
 RESIDUAL FOR    ppr AND     gra -12.59
 RESIDUAL FOR    cpr AND     bmc  -6.82
 RESIDUAL FOR    cpr AND     spr  -4.95
 RESIDUAL FOR    cpr AND     opr  -8.58
 RESIDUAL FOR    cpr AND     swb  -7.55
 RESIDUAL FOR    mac AND     cpr  -5.29
 RESIDUAL FOR     dc AND    bmc  -2.73
 RESIDUAL FOR     dc AND    opr -15.57
 RESIDUAL FOR     dc AND    swb  -3.52
 RESIDUAL FOR     sv AND    bmc  -3.18
 RESIDUAL FOR     sv AND    opr  -7.84
 RESIDUAL FOR     sv AND    mac  -6.39
 RESIDUAL FOR     sv AND     dc  -3.67
 RESIDUAL FOR     fg AND    bmc  -2.64
 RESIDUAL FOR     fg AND    opr  -3.72
 RESIDUAL FOR     fg AND    swb  -4.31
 RESIDUAL FOR     fg AND    mac  -6.00
 RESIDUAL FOR    mfp AND     bmc  -7.09
 RESIDUAL FOR    mfp AND     opr  -6.18
 RESIDUAL FOR    mfp AND     mac  -7.81
 RESIDUAL FOR    lts AND    spr  -3.14
 RESIDUAL FOR    lts AND    ppr  -5.76
```

```
RESIDUAL FOR   lts AND    dc  -4.76
RESIDUAL FOR    fi AND   bmc  -3.06
RESIDUAL FOR    fi AND   swb  -4.35
RESIDUAL FOR    fi AND   ppr  -6.38
RESIDUAL FOR   kin AND   bmc  -6.86
RESIDUAL FOR   kin AND   opr  -5.52
RESIDUAL FOR   kin AND   swb  -5.38
RESIDUAL FOR   kin AND   ppr  -4.00
RESIDUAL FOR   prn AND   bmc  -2.74
RESIDUAL FOR   prn AND   spr  -2.71
RESIDUAL FOR   prn AND    fi  -3.57

LARGEST POSITIVE STANDARDIZED RESIDUALS
RESIDUAL FOR   opr AND   bmc  13.60
RESIDUAL FOR   swb AND   bmc   4.29
RESIDUAL FOR   swb AND   opr   3.34
RESIDUAL FOR   ppr AND   bmc   3.86
RESIDUAL FOR   ppr AND   opr  14.92
RESIDUAL FOR   cpr AND   ppr  13.81
RESIDUAL FOR   mac AND   spr   3.97
RESIDUAL FOR   mac AND   opr   3.45
RESIDUAL FOR   mac AND   gra   5.13
RESIDUAL FOR   mac AND   swb  17.21
RESIDUAL FOR    dc AND   spr   5.99
RESIDUAL FOR    dc AND   gra   6.96
RESIDUAL FOR    dc AND   ppr   2.81
RESIDUAL FOR    dc AND   cpr   7.01
RESIDUAL FOR    dc AND   mac   3.51
RESIDUAL FOR    sv AND   spr   6.64
RESIDUAL FOR    sv AND   ppr   8.29
RESIDUAL FOR    fg AND   spr   2.99
RESIDUAL FOR    fg AND    sv   2.96
RESIDUAL FOR   mfp AND    sv   5.29
RESIDUAL FOR   mfp AND    fg   6.54
RESIDUAL FOR   lts AND   gra   7.56
RESIDUAL FOR   lts AND   swb   5.23
RESIDUAL FOR   lts AND   mac   9.44
RESIDUAL FOR    fi AND   spr   3.01
RESIDUAL FOR    fi AND   gra  12.49
RESIDUAL FOR   kin AND   spr   8.17
RESIDUAL FOR   kin AND   gra   4.46
RESIDUAL FOR   kin AND   mac   3.57
RESIDUAL FOR   kin AND    fg   3.30
RESIDUAL FOR   kin AND   mfp   3.94
```

```
RESIDUAL FOR   kin AND   lts  3.66
RESIDUAL FOR   prn AND   swb  5.51
RESIDUAL FOR   prn AND   mac  3.69

MODIFICATION INDICES AND EXPECTED CHANGE

MODIFICATION INDICES FOR LAMBDA-X
        KSI 1     KSI 2     KSI 3     KSI 4     KSI 5
      --------  --------  --------  --------  --------
bmc      - -     57.95     81.74     11.17     23.54
spr      - -     55.93     97.52      0.02     31.22
opr      - -       - -    294.93     34.66    234.85
gra      - -       - -     41.56    273.50     34.72
swb      - -     25.53     24.57      4.92       - -
ppr     69.25      - -    133.98     72.98     98.88
cpr     69.26      - -       - -      1.02    113.37
mac     24.83     62.44      - -     29.62    166.01
dc       3.69     39.84      - -     38.33     32.99
sv       9.27      5.35      - -      3.73      4.93
fg       0.09      0.95      - -      0.29      2.14
mfp     11.73      6.40      - -       - -      5.56
lts      0.94      2.74      0.28      - -      7.20
fi       8.13      5.38      0.03      - -      2.67
kin     14.25     19.76     26.08      - -       - -
prn     14.25      5.71      0.05      4.92      - -

  EXPECTED CHANGE FOR LAMBDA-X
        KSI 1     KSI 2     KSI 3     KSI 4     KSI 5
      --------  --------  --------  --------  --------
bmc      - -      0.55     -0.30     -0.37     -0.57
spr      - -     -0.61      0.36      0.02      0.74
opr      - -       - -     -0.50     -1.04     -1.60
gra      - -       - -      0.17      2.52      0.54
swb      - -      0.68     -0.62      1.93       - -
ppr     -8.09      - -      0.39     -1.77      1.20
cpr     -0.22      - -       - -      0.14     -2.16
mac      0.12      0.26      - -      0.46      1.05
dc       0.04     -0.22      - -     -0.54     -0.51
sv       0.07      0.07      - -      0.16      0.18
fg       0.01     -0.03      - -      0.05     -0.12
mfp     -0.09     -0.15      - -       - -     -0.30
lts     -0.03      0.16     -0.02      - -      0.31
fi       0.12      0.38     -0.01      - -     -0.30
kin      0.51     -0.38      0.40      - -       - -
```

```
     prn    -0.13    -0.16    -0.01    -0.30     - -

 STANDARDIZED EXPECTED CHANGE FOR LAMBDA-X
         KSI 1    KSI 2    KSI 3    KSI 4    KSI 5
        -------- -------- -------- -------- --------
 bmc       - -     0.35    -0.21    -0.09    -0.24
 spr       - -    -0.38     0.26     0.00     0.32
 opr       - -      - -    -0.36    -0.25    -0.69
 gra       - -      - -     0.13     0.60     0.23
 swb       - -     0.43    -0.45     0.46      - -
 ppr     -6.02      - -     0.28    -0.42     0.52
 cpr     -0.16      - -      - -     0.03    -0.93
 mac      0.09     0.16      - -     0.11     0.45
 dc       0.03    -0.14      - -    -0.13    -0.22
 sv       0.05     0.05      - -     0.04     0.08
 fg       0.01    -0.02      - -     0.01    -0.05
 mfp     -0.06    -0.10      - -      - -    -0.13
 lts     -0.02     0.10    -0.01      - -     0.13
 fi       0.09     0.24    -0.01      - -    -0.13
 kin      0.38    -0.24     0.29      - -      - -
 prn     -0.10    -0.10    -0.01    -0.07      - -

 COMPLETELY STANDARDIZED EXPECTED CHANGE FOR LAMBDA-X
         KSI 1    KSI 2    KSI 3    KSI 4    KSI 5
        -------- -------- -------- -------- --------
 bmc       - -     0.34    -0.21    -0.09    -0.24
 spr       - -    -0.38     0.26     0.00     0.32
 opr       - -      - -    -0.36    -0.25    -0.69
 gra       - -      - -     0.12     0.60     0.23
 swb       - -     0.43    -0.45     0.46      - -
 ppr     -6.01      - -     0.28    -0.42     0.52
 cpr     -0.16      - -      - -     0.03    -0.92
 mac      0.09     0.16      - -     0.11     0.45
 dc       0.03    -0.14      - -    -0.13    -0.22
 sv       0.05     0.05      - -     0.04     0.08
 fg       0.01    -0.02      - -     0.01    -0.05
 mfp     -0.06    -0.10      - -      - -    -0.13
 lts     -0.02     0.10    -0.01      - -     0.13
 fi       0.09     0.23    -0.01      - -    -0.13
 kin      0.38    -0.24     0.28      - -      - -
 prn     -0.10    -0.10    -0.01    -0.07      - -

NO NON-ZERO MODIFICATION INDICES FOR PHI
```

MODIFICATION INDICES FOR THETA-DELTA

	bmc	spr	opr	gra	swb	ppr
bmc	- -					
spr	23.84	- -				
opr	162.10	26.26	- -			
gra	3.58	0.10	4.31	- -		
swb	29.34	29.27	34.94	15.12	- -	
ppr	8.55	30.69	223.55	157.61	0.14	- -
cpr	5.15	21.68	5.65	3.90	47.45	133.58
mac	0.32	0.09	25.62	2.00	266.41	21.51
dc	0.08	15.51	106.72	47.57	3.39	0.25
sv	13.76	41.83	40.90	0.24	3.37	46.80
fg	4.15	11.21	0.62	5.91	17.02	0.05
mfp	32.00	4.01	4.58	0.01	2.29	1.57
lts	1.51	19.30	2.24	40.35	25.64	35.58
fi	16.92	7.90	0.08	114.75	20.31	37.68
kin	49.23	57.31	14.78	15.43	28.78	17.45
prn	2.60	2.32	2.89	2.76	29.81	2.21

MODIFICATION INDICES FOR THETA-DELTA

	cpr	mac	dc	sv	fg	mfp
cpr	- -					
mac	27.13	- -				
dc	48.62	12.29	- -			
sv	2.26	40.81	13.46	- -		
fg	0.89	35.96	1.55	8.76	- -	
mfp	5.30	75.05	3.27	26.12	43.36	- -
lts	0.05	96.80	31.14	7.75	0.07	1.28
fi	0.12	16.51	4.56	0.01	0.51	4.29
kin	1.23	1.57	2.42	2.61	9.91	14.22
prn	0.90	12.87	0.55	0.17	5.75	0.53

	lts	fi	kin	prn
lts	- -			
fi	6.54	- -		
kin	11.45	4.03	- -	
prn	7.83	13.61	0.52	- -

EXPECTED CHANGE FOR THETA-DELTA

	bmc	spr	opr	gra	swb	ppr
bmc	- -					

```
spr   -0.28     - -
opr    0.08    -0.03     - -
gra   -0.01     0.00    -0.01     - -
swb    0.03    -0.04     0.04    -0.03     - -
ppr    0.02    -0.04     0.15    -0.09     0.00     - -
cpr   -0.01    -0.02    -0.01    -0.01    -0.04     0.07
mac    0.00     0.00     0.03     0.01     0.11    -0.03
 dc    0.00     0.02    -0.05     0.03    -0.01     0.00
 sv   -0.02     0.04    -0.04     0.00    -0.01     0.04
 fg   -0.01     0.02    -0.01    -0.02    -0.03     0.00
mfp   -0.03     0.01    -0.01     0.00    -0.01     0.01
lts    0.01    -0.03     0.01     0.05     0.04    -0.04
 fi   -0.03     0.02     0.00     0.07    -0.05    -0.05
kin   -0.05     0.06    -0.03     0.03    -0.15    -0.03
prn   -0.01    -0.01     0.01    -0.01     0.04    -0.01
 EXPECTED CHANGE FOR THETA-DELTA
        cpr      mac       dc       sv       fg      mfp
     -------- -------- -------- -------- -------- --------
cpr     - -
mac   -0.03     - -
 dc    0.05     0.02     - -
 sv    0.01    -0.04    -0.02     - -
 fg    0.01    -0.04    -0.01     0.02     - -
mfp    0.01    -0.06    -0.01     0.03     0.05     - -
lts    0.00     0.08    -0.03    -0.02     0.00    -0.01
 fi    0.00    -0.03     0.01     0.00    -0.01     0.02
kin   -0.01     0.01    -0.01     0.01     0.02     0.03
prn   -0.01     0.03     0.00     0.00    -0.02     0.01

 EXPECTED CHANGE FOR THETA-DELTA
        lts       fi      kin      prn
     -------- -------- -------- --------
lts     - -
 fi   -0.04     - -
kin    0.03    -0.02     - -
prn    0.03    -0.03     0.01     - -

 COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-DELTA
        bmc      spr      opr      gra      swb      ppr
     -------- -------- -------- -------- -------- --------
bmc     - -
spr   -0.28     - -
opr    0.08    -0.03     - -
gra   -0.01     0.00    -0.01     - -
```

```
swb     0.03    -0.04    0.04    -0.02     - -
ppr     0.02    -0.04    0.15    -0.09    0.00     - -
cpr    -0.01    -0.02   -0.01    -0.01   -0.04    0.07
mac     0.00     0.00    0.03     0.01    0.11   -0.03
dc      0.00     0.02   -0.05     0.03   -0.01    0.00
sv     -0.02     0.04   -0.04     0.00   -0.01    0.04
fg     -0.01     0.02   -0.01    -0.02   -0.03    0.00
mfp    -0.03     0.01   -0.01     0.00   -0.01    0.01
lts     0.01    -0.03    0.01     0.05    0.04   -0.04
fi     -0.03     0.02    0.00     0.07   -0.05   -0.05
kin    -0.05     0.06   -0.03     0.03   -0.15   -0.03
prn    -0.01    -0.01    0.01    -0.01    0.04   -0.01

  COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-DELTA

          cpr      mac      dc       sv       fg       mfp
        -------- -------- -------- -------- -------- --------
cpr      - -
mac     -0.03     - -
dc       0.05     0.02     - -
sv       0.01    -0.04    -0.02     - -
fg       0.01    -0.04    -0.01     0.02     - -
mfp      0.01    -0.06    -0.01     0.03     0.05     - -
lts      0.00     0.08    -0.03    -0.02     0.00    -0.01
fi       0.00    -0.03     0.01     0.00    -0.01     0.02
kin     -0.01     0.01    -0.01     0.01     0.02     0.03
prn     -0.01     0.03     0.00     0.00    -0.02     0.01

          lts      fi       kin      prn
        -------- -------- -------- --------
lts      - -
fi      -0.04     - -
kin      0.03    -0.02     - -
prn      0.03    -0.03     0.01     - -

 MAXIMUM MODIFICATION INDEX IS  294.93 FOR ELEMENT ( 3, 3) OF
LAMBDA-X

 STANDARDIZED SOLUTION

  LAMBDA-X
          KSI 1    KSI 2    KSI 3    KSI 4    KSI 5
        -------- -------- -------- -------- --------
bmc      0.74     - -      - -      - -      - -
```

```
 spr     0.84     - -      - -      - -      - -
 opr     0.14     0.63     - -      - -      - -
 gra     0.24     0.47     - -      - -      - -
 swb    -0.04     - -      - -      - -      0.70
 ppr     - -      0.73     - -      - -      - -
 cpr     - -     -0.02     0.72     - -      - -
 mac     - -      - -      0.59     - -      - -
  dc     - -      - -      0.85     - -      - -
  sv     - -      - -      0.63     - -      - -
  fg     - -      - -      0.51     - -      - -
 mfp     - -      - -      0.45     0.24     - -
 lts     - -      - -      - -      0.43     - -
  fi     - -      - -      - -      0.65     - -
 kin     - -      - -      - -      0.12     0.43
 prn     - -      - -      - -      - -      0.11

   PHI
          KSI 1    KSI 2    KSI 3    KSI 4    KSI 5
        -------- -------- -------- -------- --------
 KSI 1    1.00
 KSI 2    0.78     1.00
 KSI 3    0.75     0.77     1.00
 KSI 4    0.67     0.84     0.71     1.00
 KSI 5    0.81     0.90     0.90     0.79     1.00

COMPLETELY STANDARDIZED SOLUTION

   LAMBDA-X
          KSI 1    KSI 2    KSI 3    KSI 4    KSI 5
        -------- -------- -------- -------- --------
 bmc     0.74     - -      - -      - -      - -
 spr     0.84     - -      - -      - -      - -
 opr     0.14     0.62     - -      - -      - -
 gra     0.24     0.47     - -      - -      - -
 swb    -0.04     - -      - -      - -      0.70
 ppr     - -      0.73     - -      - -      - -
 cpr     - -     -0.02     0.72     - -      - -
 mac     - -      - -      0.58     - -      - -
  dc     - -      - -      0.84     - -      - -
  sv     - -      - -      0.63     - -      - -
  fg     - -      - -      0.51     - -      - -
 mfp     - -      - -      0.45     0.24     - -
 lts     - -      - -      - -      0.43     - -
  fi     - -      - -      - -      0.64     - -
```

```
   kin     - -     - -     - -     0.12    0.43
   prn     - -     - -     - -     - -     0.11

PHI
          KSI 1   KSI 2   KSI 3   KSI 4   KSI 5
         -------- -------- -------- -------- --------
  KSI 1   1.00
  KSI 2   0.78    1.00
  KSI 3   0.75    0.77    1.00
  KSI 4   0.67    0.84    0.71    1.00
  KSI 5   0.81    0.90    0.90    0.79    1.00

     THETA-DELTA
          bmc      spr      opr      gra      swb      ppr
         -------- -------- -------- -------- -------- --------
          0.45     0.29     0.46     0.55     0.56     0.46

          cpr      mac      dc       sv       fg       mfp
         -------- -------- -------- -------- -------- --------
          0.51     0.66     0.29     0.60     0.74     0.59

          lts      fi       kin      prn
         -------- -------- -------- --------
          0.82     0.58     0.72     0.99
```

APPENDIX D

LISREL Output: Modified 4-Factor, First-order Model

```
WINDOWS  L I S R E L  8.14
 BY  KARL G JORESKOG AND DAG SORBOM

The following lines were read from file
C:\DATA\CONSULT\MULLIGAN\LISREL\4FACTOR.LS8:
Mulligan: 4factor
The modified model has PRVC loading on the 4th factor instead of the 1st factor
da no=10475 ni=17 ma=cm !da no=995 ni=17 ma=cm label
* sv fg swb dc ppr bmc prvc cpr prn mac spr opr mfp kin fi gra lts se dc cpr sv mfp fg
  ! 1-5 spr bmc             ! 6-7 fi lts gra           ! 8-10 ppr opr prvc /          ! 11-13
 cm fu file=\data\consult\mulligan\lisrel\cov_aprn.emc !cm fu
file=\data\consult\mulligan\lisrel\cov_ld.emc
mo nk=4 nx=13 lx=fu,fi ph=sy,fr td=di,fr free lx 2 1 lx 3 1 lx 4 1 lx 5 1 free lx 7 2 free lx 9
3 lx 10 3 free lx 12 4 lx 13 4 st 1.0 lx 1 1 lx 6 2 lx 8 3 lx 11 4   ou ml sc

NUMBER OF INPUT VARIABLES 17
NUMBER OF Y - VARIABLES   0
NUMBER OF X - VARIABLES   13
 NUMBER OF ETA - VARIABLES  0
NUMBER OF KSI - VARIABLES  4
NUMBER OF OBSERVATIONS 10475

COVARIANCE MATRIX TO BE ANALYZED
 dc      cpr      sv     mfp      fg      spr
-------- -------- -------- -------- -------- --------
dc     1.01
cpr     0.61     1.01
sv    0.52     0.45     1.00
mfp     0.52     0.45     0.42     1.01
fg    0.43     0.37     0.34     0.36     1.00
spr     0.55     0.42     0.43     0.42     0.34     1.00
bmc     0.46     0.35     0.33     0.33     0.27     0.62
fi    0.39     0.32     0.29     0.37     0.23     0.37
lts     0.23     0.21     0.18     0.23     0.16     0.22
gra     0.49     0.38     0.36     0.39     0.27     0.51
ppr     0.49     0.45     0.41     0.41     0.30     0.47
opr     0.43     0.37     0.32     0.38     0.28     0.51
prvc     0.46     0.40     0.40     0.42     0.32     0.50

bmc       fi       lts      gra      ppr      opr
```

```
-------- -------- -------- -------- -------- --------
bmc     1.01      fi     0.30     1.01
lts    0.21     0.27     1.01    gra     0.45     0.43     0.29     1.01
ppr     0.44     0.37     0.23     0.44     1.00
opr     0.51     0.40     0.27     0.49     0.57     1.00
prvc     0.39     0.31     0.21     0.38     0.45     0.42

prvc           --------
prvc     1.00
Mulligan: 4factor

PARAMETER SPECIFICATIONS
LAMBDA-X
KSI 1    KSI 2    KSI 3    KSI 4
-------- -------- -------- --------
dc       0        0        0        0
cpr      1        0        0        0
 sv      2        0        0        0
mfp      3        0        0        0
fg       4        0        0        0
spr      0        0        0        0
bmc      0        5        0        0
fi       0        0        0        0
lts      0        0        6        0
gra      0        0        7        0
ppr      0        0        0        0
opr      0        0        0        8
prvc     0        0        0        9
PHI
KSI 1    KSI 2    KSI 3    KSI 4
-------- -------- -------- --------
KSI 1      10
KSI 2      11       12
KSI 3      13       14       15
KSI 4      16       17       18       19

THETA-DELTA
dc       cpr      sv       mfp      fg       spr
-------- -------- -------- -------- -------- --------
20       21       22       23       24       25

 bmc     fi       lts      gra      ppr      opr
-------- -------- -------- -------- -------- --------
26       27       28       29       30       31
```

```
prvc
--------            32

Number of Iterations =  6

LISREL ESTIMATES (MAXIMUM LIKELIHOOD)
LAMBDA-X
        KSI 1    KSI 2    KSI 3    KSI 4
-      -------  -------- -------- --------
dc      1.00     - -      - -      - -
cpr     0.85     - -      - -      - -
       (0.01)
        74.53
sv      0.77     - -      - -      - -
       (0.01)
        66.26
mfp     0.78     - -      - -      - -
       (0.01)
        67.08
fg      0.63     - -      - -      - -
       (0.01)
        52.43
spr     - -      1.00     - -      - -
bmc     - -      0.87     - -      - -
                (0.01)
                 72.93
fi      - -      - -      1.00     - -
lts     - -      - -      0.66     - -
                         (0.02)
                          33.20
gra     - -      - -      1.24     - -
                         (0.02)
                          52.09
ppr     - -      - -      - -      1.00
opr     - -      - -      - -      1.00
                                  (0.01)
                                   67.33
prvc    - -      - -      - -      0.88
                                  (0.01)
                                   59.78
```

```
PHI
        KSI 1    KSI 2    KSI 3    KSI 4
        --------  --------  --------  --------
KSI 1    0.69
        (0.01)
        48.59
KSI 2    0.52     0.71
        (0.01)   (0.02)
        49.32    47.27
KSI 3    0.39     0.39     0.35
        (0.01)   (0.01)   (0.01)
        41.08    40.94    29.50
KSI 4    0.49     0.52     0.37     0.53
        (0.01)   (0.01)   (0.01)   (0.01)
        48.41    49.17    40.67    39.80

THETA-DELTA
dc       cpr      sv       mfp      fg       spr
-------- -------- -------- -------- -------- --------
0.32     0.50     0.59     0.59     0.73     0.29
(0.01)   (0.01)   (0.01)   (0.01)   (0.01)   (0.01)
47.47    60.89    64.49    64.20    68.17    35.19

bmc      fi       lts      gra      ppr      opr      prvc
-------- -------- -------- -------- -------- -------- --------
0.46     0.65     0.85     0.47     0.47     0.48     0.59
(0.01)   (0.01)   (0.01)   (0.01)   (0.01)   (0.01)   (0.01)
54.65    61.75    69.02    45.81    56.82    56.88    63.14


SQUARED MULTIPLE CORRELATIONS FOR X - VARIABLES
dc       cpr      sv       mfp      fg       spr
-------- -------- -------- -------- -------- --------
0.68     0.50     0.41     0.42     0.27     0.71

bmc      fi       lts      gra      ppr      opr
-------- -------- -------- -------- -------- --------
0.54     0.35     0.15     0.54     0.53     0.53
prvc
--------
0.41
```

```
                    GOODNESS OF FIT STATISTICS
   CHI-SQUARE WITH 59 DEGREES OF FREEDOM = 1664.70 (P = 0.0)
  ESTIMATED NON-CENTRALITY PARAMETER (NCP) = 1605.70
               MINIMUM FIT FUNCTION VALUE = 0.16
     POPULATION DISCREPANCY FUNCTION VALUE (F0) = 0.15
 ROOT MEAN SQUARE ERROR OF APPROXIMATION (RMSEA) = 0.051
      EXPECTED CROSS-VALIDATION INDEX (ECVI) = 0.17
              ECVI FOR SATURATED MODEL = 0.017
                ECVI FOR INDEPENDENCE MODEL = 4.83
 CHI-SQUARE FOR INDEPENDENCE MODEL WITH 78 DEGREES OF FREEDOM
                         = 50524.46
               INDEPENDENCE AIC = 50550.46
                   MODEL AIC = 1728.70
                  SATURATED AIC = 182.00
              INDEPENDENCE CAIC = 50657.80
                  MODEL CAIC = 1992.92
                  SATURATED CAIC = 933.36
        ROOT MEAN SQUARE RESIDUAL (RMR) = 0.027
                  STANDARDIZED RMR = 0.027
               GOODNESS OF FIT INDEX (GFI) = 0.98
         ADJUSTED GOODNESS OF FIT INDEX (AGFI) = 0.96
      PARSIMONY GOODNESS OF FIT INDEX (PGFI) = 0.63
                 NORMED FIT INDEX (NFI) = 0.97
              NON-NORMED FIT INDEX (NNFI) = 0.96
         PARSIMONY NORMED FIT INDEX (PNFI) = 0.73
             COMPARATIVE FIT INDEX (CFI) = 0.97
             INCREMENTAL FIT INDEX (IFI) = 0.97
              RELATIVE FIT INDEX (RFI) = 0.96
                      CRITICAL N (CN) = 549.44
CONFIDENCE LIMITS COULD NOT BE COMPUTED DUE TO TOO SMALL
P-VALUE FOR CHI-SQUARE

SUMMARY STATISTICS FOR FITTED RESIDUALS
SMALLEST FITTED RESIDUAL =  -0.06  MEDIAN FITTED RESIDUAL =   0.00
LARGEST FITTED RESIDUAL =   0.08
STEMLEAF PLOT -
 4|951960  -
 2|8732111832210
- 0|98743321111999766533332211000000000000000
0|444891359
2|333666778890338
4|1329
6|37
```

```
8|4
SUMMARY STATISTICS FOR STANDARDIZED RESIDUALS
SMALLEST STANDARDIZED RESIDUAL = -14.82
MEDIAN STANDARDIZED RESIDUAL =   0.00
LARGEST STANDARDIZED RESIDUAL =  14.42
STEMLEAF PLOT
- 1|55
- 1|200
- 0|7777666555
- 0|4444433333322222211111111100000000000000000000
0|11112223444
0|55555666677789
1|000344
LARGEST NEGATIVE STANDARDIZED RESIDUALS
RESIDUAL FOR     mfp AND     dc  -7.49
RESIDUAL FOR     mfp AND    cpr  -3.16
RESIDUAL FOR     spr AND    cpr  -6.70
RESIDUAL FOR     bmc AND    cpr  -7.37
RESIDUAL FOR     bmc AND     sv  -3.66
RESIDUAL FOR     bmc AND    mfp  -5.40
RESIDUAL FOR     bmc AND     fg  -3.16
RESIDUAL FOR      fi AND    spr  -4.17
RESIDUAL FOR      fi AND    bmc  -6.99
RESIDUAL FOR     lts AND     dc  -3.76
RESIDUAL FOR     lts AND     sv  -2.64
RESIDUAL FOR     lts AND    spr  -6.42
RESIDUAL FOR     gra AND    cpr  -6.11
RESIDUAL FOR     gra AND     fg  -4.33
RESIDUAL FOR     gra AND     fi  -4.32
RESIDUAL FOR     ppr AND    spr -14.75
RESIDUAL FOR     ppr AND    bmc  -2.84
RESIDUAL FOR     ppr AND    gra  -4.58
RESIDUAL FOR     opr AND     dc -14.82
RESIDUAL FOR     opr AND    cpr  -9.92
RESIDUAL FOR     opr AND     sv  -9.77
RESIDUAL FOR     opr AND     fg  -5.26
RESIDUAL FOR    prvc AND     fi  -2.84
RESIDUAL FOR    prvc AND    gra  -6.30
RESIDUAL FOR    prvc AND    ppr  -3.36
RESIDUAL FOR    prvc AND    opr -11.79
LARGEST POSITIVE STANDARDIZED RESIDUALS
RESIDUAL FOR     cpr AND     dc   9.49
RESIDUAL FOR      fg AND    mfp   3.30
RESIDUAL FOR     spr AND     dc   8.05
```

```
RESIDUAL FOR   spr AND    sv  5.45
RESIDUAL FOR    fi AND   mfp  10.38
RESIDUAL FOR   lts AND   mfp  4.45
RESIDUAL FOR   lts AND    fi  5.88
RESIDUAL FOR   gra AND    dc  3.98
RESIDUAL FOR   gra AND   spr  7.47
RESIDUAL FOR   gra AND   bmc  5.47
RESIDUAL FOR   ppr AND   cpr  5.71
RESIDUAL FOR   ppr AND    sv  4.69
RESIDUAL FOR   ppr AND   mfp  4.82
RESIDUAL FOR   opr AND   bmc  13.84
RESIDUAL FOR   opr AND    fi  5.32
RESIDUAL FOR   opr AND   lts  4.13
RESIDUAL FOR   opr AND   gra  6.80
RESIDUAL FOR   opr AND   ppr  14.42
RESIDUAL FOR  prvc AND    dc  6.43
RESIDUAL FOR  prvc AND   cpr  5.74
RESIDUAL FOR  prvc AND    sv  10.05
RESIDUAL FOR  prvc AND   mfp  13.50
RESIDUAL FOR  prvc AND    fg  7.44
RESIDUAL FOR  prvc AND   spr  10.41

Mulligan: 4factor
MODIFICATION INDICES AND EXPECTED CHANGE
MODIFICATION INDICES FOR LAMBDA-X
        KSI 1     KSI 2     KSI 3     KSI 4
        --------  --------  --------  --------
dc       - -      27.14      2.08      9.72
 cpr     - -      79.10     48.38     20.40
sv       - -       5.00      0.72      2.19
mfp      - -       2.28     87.39     72.83
fg       - -       0.45     11.48      2.25
spr     73.20      - -       1.51     68.76
bmc     73.20      - -       1.51     68.76
fi      10.45     47.34      - -       0.77
lts      6.43     37.07      - -       6.08
gra      1.69    124.26      - -       2.23
ppr     21.25    206.63     28.76      - -
opr    395.32     41.78     56.12      - -
prvc   279.65     74.61      5.31      - -

 EXPECTED CHANGE FOR LAMBDA-X
        KSI 1     KSI 2     KSI 3     KSI 4
        --------  --------  --------  --------
```

```
dc          - -     0.11     0.05    -0.10
cpr         - -    -0.18    -0.25    -0.14
sv          - -     0.05    -0.03     0.05
mfp         - -     0.03     0.34     0.26
fg          - -    -0.01    -0.13    -0.05
spr        0.29      - -     0.10    -1.24
bmc       -0.26      - -    -0.08     1.09
fi         0.11    -0.23      - -     0.07
lts       -0.07    -0.18      - -    -0.14
gra       -0.05     0.46      - -     0.16
ppr        0.14    -0.50    -0.36      - -
opr       -0.59     0.22     0.50      - -
prvc       0.48     0.29    -0.15      - -
```

```
STANDARDIZED EXPECTED CHANGE FOR LAMBDA-X
        KSI 1    KSI 2    KSI 3    KSI 4
        -------- -------- -------- --------
dc       - -     0.09     0.03    -0.07
cpr      - -    -0.15    -0.15    -0.10
sv       - -     0.04    -0.02     0.03
mfp      - -     0.03     0.20     0.19
fg       - -    -0.01    -0.08    -0.03
spr     0.24      - -     0.06    -0.90
bmc    -0.21      - -    -0.05     0.79
fi      0.09    -0.20      - -     0.05
lts    -0.06    -0.15      - -    -0.10
gra    -0.04     0.39      - -     0.11
ppr     0.11    -0.42    -0.21      - -
opr    -0.49     0.19     0.29      - -
prvc    0.40     0.24    -0.09      - -
```

```
COMPLETELY STANDARDIZED EXPECTED CHANGE FOR LAMBDA-X
        KSI 1    KSI 2    KSI 3    KSI 4
        -------- -------- -------- --------
dc       - -     0.09     0.03    -0.07
cpr      - -    -0.15    -0.15    -0.10
sv       - -     0.04    -0.02     0.03
mfp      - -     0.03     0.20     0.19
fg       - -    -0.01    -0.08    -0.03
spr     0.24      - -     0.06    -0.90
bmc    -0.21      - -    -0.05     0.79
fi      0.09    -0.20      - -     0.05
lts    -0.06    -0.15      - -    -0.10
gra    -0.04     0.39      - -     0.11
```

```
ppr     0.11    -0.42    -0.21      - -
opr    -0.49     0.19     0.29      - -
prvc    0.40     0.24    -0.09      - -

NO NON-ZERO MODIFICATION INDICES FOR PHI
 MODIFICATION INDICES FOR THETA-DELTA
         dc       cpr      sv      mfp       fg       spr
       -------- -------- -------- -------- -------- --------
dc      - -
cpr    89.98     - -
sv      4.46     0.09     - -
mfp    56.09     9.99     0.73     - -
fg      0.75     0.35     2.01    10.92     - -
spr    36.09    33.24    31.28     0.10     6.56     - -
bmc     4.34     6.94    16.10    35.14     5.21     - -
fi      0.89     0.23     1.15    79.46     1.20     4.34
lts    15.10     0.96     4.24    20.40     0.86    32.03
gra    31.80    22.92     3.48     1.02    15.63    23.07
ppr     5.82    58.71    16.93     1.83     4.29   154.47
opr    85.18    20.34    59.95     0.51     4.71    18.74
prvc    0.00     5.93    45.60    74.81    32.62   111.41

MODIFICATION INDICES FOR THETA-DELTA
bmc       fi      lts      gra      ppr      opr
-------- -------- -------- -------- -------- --------
bmc      - -
fi     35.34     - -
lts     0.15    34.55     - -
gra    16.55    18.64     0.06     - -
ppr     0.22     2.17     0.97    19.19     - -
opr   185.33    22.55    22.33    37.83   207.97     - -
prvc   34.11     8.38     1.10    51.19    11.28   138.96

prvc
--------
prvc     - -

EXPECTED CHANGE FOR THETA-DELTA
         dc       cpr      sv      mfp       fg       spr
       -------- -------- -------- -------- -------- --------
dc      - -
cpr     0.06     - -
sv     -0.01     0.00     - -
mfp    -0.05    -0.02     0.01     - -
```

```
fg    -0.01   0.00    0.01    0.02     - -
spr    0.03  -0.03    0.03    0.00    0.02     - -
bmc    0.01  -0.01   -0.02   -0.04   -0.01     - -
fi    -0.01   0.00   -0.01    0.06   -0.01   -0.01
lts   -0.02   0.01   -0.02    0.03    0.01   -0.04
gra    0.03  -0.03   -0.01   -0.01   -0.03    0.03
ppr   -0.01   0.04    0.02    0.01   -0.01   -0.07
opr   -0.05  -0.03   -0.05    0.00   -0.01   -0.02
prvc   0.00   0.01    0.04    0.06    0.04    0.06
```

```
 EXPECTED CHANGE FOR THETA-DELTA
          bmc      fi      lts      gra      ppr      opr
        -------- -------- -------- -------- -------- --------
bmc      - -
fi     -0.04     - -
lts     0.00    0.05     - -
gra     0.02   -0.05    0.00     - -
ppr     0.00    0.01   -0.01   -0.03     - -
opr     0.08    0.03    0.03    0.04    0.11     - -
prvc   -0.04   -0.02   -0.01   -0.05   -0.02   -0.08
```

```
EXPECTED CHANGE FOR THETA-DELTA
prvc
 --------
prvc     - -
```

```
COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-DELTA
          dc       cpr      sv       mfp      fg       spr
        -------- -------- -------- -------- -------- --------
dc       - -
cpr     0.06     - -
sv     -0.01    0.00     - -
mfp    -0.05   -0.02    0.01     - -
fg     -0.01    0.00    0.01    0.02     - -
spr     0.03   -0.03    0.03    0.00    0.02     - -
bmc     0.01   -0.01   -0.02   -0.04   -0.01     - -
fi     -0.01    0.00   -0.01    0.06   -0.01   -0.01
lts    -0.02    0.01   -0.02    0.03    0.01   -0.04
gra     0.03   -0.03   -0.01   -0.01   -0.03    0.03
ppr    -0.01    0.04    0.02    0.01   -0.01   -0.07
opr    -0.05   -0.03   -0.05    0.00   -0.01   -0.02
prvc    0.00    0.01    0.04    0.06    0.04    0.06
```

```
COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-DELTA
        bmc       fi      lts      gra      ppr      opr
      -------- -------- -------- -------- -------- --------
bmc     - -
fi    -0.04     - -
lts    0.00     0.05     - -
gra    0.02    -0.05     0.00     - -
ppr    0.00     0.01    -0.01    -0.03     - -
opr    0.08     0.03     0.03     0.04     0.11     - -
prvc  -0.04    -0.02    -0.01    -0.05    -0.02    -0.08

COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-DELTA
        prvc
--------
prvc    - -
MAXIMUM MODIFICATION INDEX IS  395.32 FOR ELEMENT (12, 1) OF
LAMBDA-X

STANDARDIZED SOLUTION
LAMBDA-X
KSI 1    KSI 2    KSI 3    KSI 4
-------- -------- -------- --------
dc     0.83     - -      - -      - -
cpr    0.71     - -      - -      - -
sv     0.64     - -      - -      - -
mfp    0.65     - -      - -      - -
fg     0.52     - -      - -      - -
spr    - -      0.85     - -      - -
bmc    - -      0.74     - -      - -
fi     - -      - -      0.59     - -
lts    - -      - -      0.39     - -
gra    - -      - -      0.74     - -
ppr    - -      - -      - -      0.73
opr    - -      - -      - -      0.73
prvc   - -      - -      - -      0.64

PHI
         KSI 1    KSI 2    KSI 3    KSI 4
        -------- -------- -------- --------
KSI 1    1.00
KSI 2    0.75     1.00
KSI 3    0.78     0.78     1.00
KSI 4    0.82     0.84     0.86     1.00
```

```
COMPLETELY STANDARDIZED SOLUTION
LAMBDA-X
KSI 1    KSI 2    KSI 3    KSI 4
-------- -------- -------- --------
dc      0.83     - -      - -      - -
cpr     0.71     - -      - -      - -
sv      0.64     - -      - -      - -
mfp     0.65     - -      - -      - -
fg      0.52     - -      - -      - -
spr     - -      0.84     - -      - -
bmc     - -      0.74     - -      - -
fi      - -      - -      0.59     - -
lts     - -      - -      0.39     - -
gra     - -      - -      0.73     - -
ppr     - -      - -      - -      0.73
opr     - -      - -      - -      0.72
prvc    - -      - -      - -      0.64

PHI
         KSI 1    KSI 2    KSI 3    KSI 4
         -------- -------- -------- --------
KSI 1    1.00
KSI 2    0.75     1.00
KSI 3    0.78     0.78     1.00
KSI 4    0.82     0.84     0.86     1.00

THETA-DELTA
dc       cpr      sv       mfp      fg       spr
-------- -------- -------- -------- -------- --------
0.32     0.50     0.59     0.58     0.73     0.29
THETA-DELTA
bmc      fi       lts      gra      ppr      opr
-------- -------- -------- -------- -------- --------
0.46     0.65     0.85     0.46     0.47     0.47
THETA-DELTA
prvc
--------
0.59
```

APPENDIX E

LISREL Output: Modified, 4-Factor Second Order Model - Heterogeneous Group

```
The following lines were read from file
C:\DATA\CONSULT\MULLIGAN\LISREL\4F_2ND.LS8:
Mulligan: 4factor 2nd order factor analysis
da no=10475 ni=17 ma=cm
!da no=993 ni=17 ma=cm
label
*
sv fg swb dc ppr bmc prvc cpr prn mac spr opr mfp kin fi gra lts
se
dc cpr sv mfp fg        ! 1-5
spr bmc                 ! 6-7
fi lts gra              ! 8-10
ppr opr prvc /              ! 11-13

cm fu file=\data\consult\mulligan\lisrel\cov_aprn.emc  ! FULL SAMPLE
!cm fu file=\data\consult\mulligan\lisrel\cov_ld.emc  ! LD SAMPLE

mo ne=4 ny=13 ly=fu,fi ps=di,fr te=di,fr      C
nk=1      ph=sy,fr ga=fu,fr
free ly 2 1 ly 3 1 ly 4 1 ly 5 1
free ly 7 2
free LY 9 3 ly 10 3
free ly 12 4 ly 13 4
st 1.0 ly 1 1 ly 6 2 ly 8 3 ly 11 4

fi ga 1 1
st 1.0 ga 1 1

ou ml sc
                    NUMBER OF INPUT VARIABLES 17
                    NUMBER OF Y - VARIABLES   13
                    NUMBER OF X - VARIABLES    0
                    NUMBER OF ETA - VARIABLES  4
                    NUMBER OF KSI - VARIABLES  1
                    NUMBER OF OBSERVATIONS 10475

Mulligan: 4factor 2nd order factor analysis
```

```
COVARIANCE MATRIX TO BE ANALYZED
           dc       cpr      sv       mfp      fg       spr
        -------- -------- -------- -------- -------- --------
   dc     1.01
  cpr     0.61     1.01
   sv     0.52     0.45     1.00
  mfp     0.52     0.45     0.42     1.01
   fg     0.43     0.37     0.34     0.36     1.00
  spr     0.55     0.42     0.43     0.42     0.34     1.00
  bmc     0.46     0.35     0.33     0.33     0.27     0.62
   fi     0.39     0.32     0.29     0.37     0.23     0.37
  lts     0.23     0.21     0.18     0.23     0.16     0.22
  gra     0.49     0.38     0.36     0.39     0.27     0.51
  ppr     0.49     0.45     0.41     0.41     0.30     0.47
  opr     0.43     0.37     0.32     0.38     0.28     0.51
 prvc     0.46     0.40     0.40     0.42     0.32     0.50

          bmc      fi       lts      gra      ppr      opr
        -------- -------- -------- -------- -------- --------
  bmc     1.01
   fi     0.30     1.01
  lts     0.21     0.27     1.01
  gra     0.45     0.43     0.29     1.01
  ppr     0.44     0.37     0.23     0.44     1.00
  opr     0.51     0.40     0.27     0.49     0.57     1.00
 prvc     0.39     0.31     0.21     0.38     0.45     0.42

          prvc
        --------
 prvc     1.00


PARAMETER SPECIFICATIONS
    LAMBDA-Y
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
   dc       0        0        0        0
  cpr       1        0        0        0
   sv       2        0        0        0
  mfp       3        0        0        0
   fg       4        0        0        0
  spr       0        0        0        0
  bmc       0        5        0        0
   fi       0        0        0        0
```

```
 lts       0       0       6       0
 gra       0       0       7       0
 ppr       0       0       0       0
 opr       0       0       0       8
 prvc      0       0       0       9

    GAMMA
        KSI 1
      --------
 ETA 1      0
 ETA 2     10
 ETA 3     11
 ETA 4     12

    PHI
        KSI 1
      --------
          13

    PSI
        ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
          14       15       16       17

    THETA-EPS
         dc      cpr       sv      mfp       fg      spr
      -------- -------- -------- -------- -------- --------
          18       19       20       21       22       23

        bmc       fi      lts      gra      ppr      opr
      -------- -------- -------- -------- -------- --------
          24       25       26       27       28       29

        prvc
      --------
          30

Number of Iterations = 23

LISREL ESTIMATES (MAXIMUM LIKELIHOOD)
    LAMBDA-Y
        ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
   dc     1.00      - -      - -      - -
```

cpr	0.85 (0.01) 74.53	- -	- -	- -
sv	0.77 (0.01) 66.28	- -	- -	- -
mfp	0.78 (0.01) 67.04	- -	- -	- -
fg	0.63 (0.01) 52.44	- -	- -	- -
spr	- -	1.00	- -	- -
bmc	- -	0.87 (0.01) 72.87	- -	- -
fi	- -	- -	1.00	- -
lts	- -	- -	0.66 (0.02) 33.17	- -
gra	- -	- -	1.24 (0.02) 52.04	- -
ppr	- -	- -	- -	1.00
opr	- -	- -	- -	1.00 (0.01) 67.32
prvc	- -	- -	- -	0.88 (0.01) 59.82

GAMMA
KSI 1

```
      --------
ETA 1     1.00

ETA 2     1.04
        (0.02)
         68.12

ETA 3     0.75
        (0.01)
         50.30

ETA 4     0.98
        (0.02)
         63.87

   COVARIANCE MATRIX OF ETA AND KSI
         ETA 1    ETA 2    ETA 3    ETA 4    KSI 1
      -------- -------- -------- -------- --------
ETA 1     0.69
ETA 2     0.53     0.72
ETA 3     0.38     0.39     0.35
ETA 4     0.49     0.51     0.37     0.53
KSI 1     0.51     0.53     0.38     0.49     0.51

   PHI
         KSI 1
      --------
          0.51
        (0.01)
         39.81

   PSI
         ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
          0.18     0.17     0.06     0.04
        (0.01)   (0.01)   (0.01)   (0.01)
         27.49    21.12    12.46     8.31

   SQUARED MULTIPLE CORRELATIONS FOR STRUCTURAL EQUATIONS

         ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
          0.74     0.76     0.82     0.92
```

```
THETA-EPS
          dc      cpr      sv      mfp      fg      spr
       -------- -------- -------- -------- -------- --------
         0.32    0.50    0.59    0.59    0.73    0.29
        (0.01)  (0.01)  (0.01)  (0.01)  (0.01)  (0.01)
         47.50   60.88   64.48   64.20   68.17   35.01

         bmc      fi      lts      gra      ppr      opr
       -------- -------- -------- -------- -------- --------
         0.46    0.66    0.85    0.47    0.47    0.48
        (0.01)  (0.01)  (0.01)  (0.01)  (0.01)  (0.01)
         54.72   61.79   69.03   45.67   56.74   56.95

         prvc
       --------
         0.59
        (0.01)
         63.13

      SQUARED MULTIPLE CORRELATIONS FOR Y - VARIABLES
          dc      cpr      sv      mfp      fg      spr
       -------- -------- -------- -------- -------- --------
         0.68    0.50    0.41    0.42    0.27    0.71

         bmc      fi      lts      gra      ppr      opr
       -------- -------- -------- -------- -------- --------
         0.54    0.35    0.15    0.54    0.53    0.52

         prvc
       --------
         0.41

                   GOODNESS OF FIT STATISTICS

       CHI-SQUARE WITH 61 DEGREES OF FREEDOM = 1670.37 (P = 0.0)
         ESTIMATED NON-CENTRALITY PARAMETER (NCP) = 1609.37

              MINIMUM FIT FUNCTION VALUE = 0.16
         POPULATION DISCREPANCY FUNCTION VALUE (F0) = 0.15
        ROOT MEAN SQUARE ERROR OF APPROXIMATION (RMSEA) = 0.050

           EXPECTED CROSS-VALIDATION INDEX (ECVI) = 0.17
               ECVI FOR SATURATED MODEL = 0.017
```

```
              ECVI FOR INDEPENDENCE MODEL = 4.83

   CHI-SQUARE FOR INDEPENDENCE MODEL WITH 78 DEGREES OF
FREEDOM = 50524.46
                  INDEPENDENCE AIC = 50550.46
                    MODEL AIC = 1730.37
                   SATURATED AIC = 182.00
                  INDEPENDENCE CAIC = 50657.80
                    MODEL CAIC = 1978.07
                   SATURATED CAIC = 933.36
             ROOT MEAN SQUARE RESIDUAL (RMR) = 0.027
                   STANDARDIZED RMR = 0.027
               GOODNESS OF FIT INDEX (GFI) = 0.98
            ADJUSTED GOODNESS OF FIT INDEX (AGFI) = 0.96
           PARSIMONY GOODNESS OF FIT INDEX (PGFI) = 0.65
                 NORMED FIT INDEX (NFI) = 0.97
               NON-NORMED FIT INDEX (NNFI) = 0.96
             PARSIMONY NORMED FIT INDEX (PNFI) = 0.76
               COMPARATIVE FIT INDEX (CFI) = 0.97
               INCREMENTAL FIT INDEX (IFI) = 0.97
                RELATIVE FIT INDEX (RFI) = 0.96
                   CRITICAL N (CN) = 562.79

 CONFIDENCE LIMITS COULD NOT BE COMPUTED DUE TO TOO SMALL
P-VALUE FOR CHI-SQUARE

 SUMMARY STATISTICS FOR FITTED RESIDUALS
 SMALLEST FITTED RESIDUAL =  -0.06
   MEDIAN FITTED RESIDUAL =   0.00
  LARGEST FITTED RESIDUAL =   0.08

 STEMLEAF PLOT
 - 6|1
 - 4|627510
 - 2|943227532111
 - 0|9774432211976666543322110000000000000000
   0|1347899799
   2|003445566779268
   4|160
   6|121
   8|3

 SUMMARY STATISTICS FOR STANDARDIZED RESIDUALS
 SMALLEST STANDARDIZED RESIDUAL =  -14.50
```

```
MEDIAN STANDARDIZED RESIDUAL =   0.00
 LARGEST STANDARDIZED RESIDUAL =   14.42

STEMLEAF PLOT
- 1|5
- 1|3200
- 0|7777765555
- 0|444443332222222111111100000000000000000000
  0|111122334444
  0|5555555666679
  1|011344
LARGEST NEGATIVE STANDARDIZED RESIDUALS
RESIDUAL FOR    mfp AND     dc  -7.38
RESIDUAL FOR    mfp AND     cpr  -3.15
RESIDUAL FOR    spr AND     cpr  -6.72
RESIDUAL FOR    bmc AND     cpr  -7.31
RESIDUAL FOR    bmc AND     sv  -3.74
RESIDUAL FOR    bmc AND     mfp  -5.39
RESIDUAL FOR    bmc AND     fg  -3.25
RESIDUAL FOR    fi AND     spr  -4.37
RESIDUAL FOR    fi AND     bmc  -6.98
RESIDUAL FOR    lts AND     dc  -3.14
RESIDUAL FOR    lts AND     spr  -6.64
RESIDUAL FOR    gra AND     cpr  -4.90
RESIDUAL FOR    gra AND     fg  -3.75
RESIDUAL FOR    gra AND     fi  -4.31
RESIDUAL FOR    ppr AND     spr -12.84
RESIDUAL FOR    ppr AND     gra  -4.79
RESIDUAL FOR    opr AND     dc -14.50
RESIDUAL FOR    opr AND     cpr  -9.98
RESIDUAL FOR    opr AND     sv  -9.87
RESIDUAL FOR    opr AND     fg  -5.39
RESIDUAL FOR    prvc AND     fi  -2.88
RESIDUAL FOR    prvc AND     gra  -6.38
RESIDUAL FOR    prvc AND     ppr  -3.50
RESIDUAL FOR    prvc AND     opr -11.65
LARGEST POSITIVE STANDARDIZED RESIDUALS
RESIDUAL FOR    cpr AND     dc   9.49
RESIDUAL FOR    fg AND     mfp   3.30
RESIDUAL FOR    spr AND     dc   6.38
RESIDUAL FOR    spr AND     sv   4.92
RESIDUAL FOR    fi AND     mfp  10.64
RESIDUAL FOR    lts AND     mfp   4.71
RESIDUAL FOR    lts AND     fi   5.93
```

```
RESIDUAL FOR   gra AND    dc  4.52
RESIDUAL FOR   gra AND    mfp  2.80
RESIDUAL FOR   gra AND    spr  4.76
RESIDUAL FOR   gra AND    bmc  4.28
RESIDUAL FOR   ppr AND    cpr  5.21
RESIDUAL FOR   ppr AND     sv  4.30
RESIDUAL FOR   ppr AND    mfp  4.46
RESIDUAL FOR   opr AND    bmc 14.02
RESIDUAL FOR   opr AND     fi  5.12
RESIDUAL FOR   opr AND    lts  4.05
RESIDUAL FOR   opr AND    gra  6.03
RESIDUAL FOR   opr AND    ppr 14.42
RESIDUAL FOR   prvc AND    dc  5.96
RESIDUAL FOR   prvc AND   cpr  5.43
RESIDUAL FOR   prvc AND    sv  9.76
RESIDUAL FOR   prvc AND   mfp 13.22
RESIDUAL FOR   prvc AND    fg  7.26
RESIDUAL FOR   prvc AND   spr 10.51

MODIFICATION INDICES AND EXPECTED CHANGE
     MODIFICATION INDICES FOR LAMBDA-Y
          ETA 1     ETA 2     ETA 3     ETA 4

        --------  --------  --------  --------
  dc       - -     25.10      4.12     11.15
  cpr      - -     82.62     44.07     20.75
  sv       - -      4.27      0.35      1.74
  mfp      - -      2.00     88.33     75.49
  fg       - -      0.63     10.20      2.67
  spr     37.85      - -      0.39     28.86
  bmc     66.66      - -      0.72     71.95
  fi      15.68     47.23      - -      2.27
  lts      3.97     40.05      - -      5.49
  gra      0.10     60.63      - -      0.02
  ppr     12.98    159.86     38.97      - -
  opr    367.93     48.89     64.70      - -
  prvc   259.58     79.19      9.13      - -

     EXPECTED CHANGE FOR LAMBDA-Y
          ETA 1     ETA 2     ETA 3     ETA 4

        --------  --------  --------  --------
  dc       - -      0.10      0.07     -0.11
  cpr      - -     -0.18     -0.23     -0.14
  sv       - -      0.04     -0.02      0.04
  mfp      - -      0.03      0.33      0.27
```

```
 fg       - -    -0.02    -0.12    -0.05
 spr     0.17      - -    -0.04    -0.60
 bmc    -0.23      - -    -0.06     0.95
 fi      0.12    -0.22      - -     0.12
 lts    -0.06    -0.19      - -    -0.13
 gra     0.01     0.26      - -    -0.01
 ppr     0.10    -0.40    -0.39      - -
 opr    -0.54     0.22     0.50      - -
 prvc    0.45     0.28    -0.19      - -

  STANDARDIZED EXPECTED CHANGE FOR LAMBDA-Y
         ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
 dc       - -     0.08     0.04    -0.08
 cpr      - -    -0.15    -0.13    -0.10
 sv       - -     0.04    -0.01     0.03
 mfp      - -     0.02     0.19     0.20
 fg       - -    -0.01    -0.07    -0.04
 spr     0.14      - -    -0.02    -0.43
 bmc    -0.19      - -    -0.03     0.69
 fi      0.10    -0.19      - -     0.08
 lts    -0.05    -0.16      - -    -0.10
 gra     0.01     0.22      - -    -0.01
 ppr     0.08    -0.34    -0.23      - -
 opr    -0.45     0.19     0.30      - -
 prvc    0.38     0.24    -0.11      - -

  COMPLETELY STANDARDIZED EXPECTED CHANGE FOR LAMBDA-Y
         ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
 dc       - -     0.08     0.04    -0.08
 cpr      - -    -0.15    -0.13    -0.10
 sv       - -     0.04    -0.01     0.03
 mfp      - -     0.02     0.19     0.19
 fg       - -    -0.01    -0.07    -0.04
 spr     0.14      - -    -0.02    -0.43
 bmc    -0.19      - -    -0.03     0.69
 fi      0.10    -0.19      - -     0.08
 lts    -0.05    -0.16      - -    -0.10
 gra     0.01     0.22      - -    -0.01
 ppr     0.08    -0.34    -0.23      - -
 opr    -0.45     0.19     0.30      - -
 prvc    0.38     0.24    -0.11      - -
```

```
NO NON-ZERO MODIFICATION INDICES FOR GAMMA
 NO NON-ZERO MODIFICATION INDICES FOR PHI
     MODIFICATION INDICES FOR PSI
         ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
  ETA 1     - -
  ETA 2    0.83     - -
  ETA 3    5.49     2.05     - -
  ETA 4    2.05     5.50     0.83     - -

     EXPECTED CHANGE FOR PSI
         ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
  ETA 1     - -
  ETA 2   -0.01     - -
  ETA 3    0.01    -0.01     - -
  ETA 4   -0.01     0.01     0.00     - -

     STANDARDIZED EXPECTED CHANGE FOR PSI
         ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
  ETA 1     - -
  ETA 2   -0.01     - -
  ETA 3    0.02    -0.01     - -
  ETA 4   -0.01     0.02    -0.01     - -

     MODIFICATION INDICES FOR THETA-EPS
            dc      cpr       sv      mfp       fg      spr
      -------- -------- -------- -------- -------- --------
   dc      - -
   cpr   90.03     - -
   sv     4.56     0.13     - -
   mfp   54.43     9.90     0.73     - -
   fg     0.78     0.40     1.90    10.91     - -
   spr   30.69    33.85    30.01     0.16     6.24     - -
   bmc    3.55     7.16    16.41    35.36     5.35     - -
   fi     0.27     0.03     0.77    81.98     0.87     5.44
   lts   13.05     1.37     3.76    21.37     1.05    33.62
   gra   36.08    18.23     2.52     0.57    13.81    14.24
   ppr    6.83    55.07    15.94     1.41     4.67   131.65
   opr   85.06    21.58    60.45     0.38     4.89    12.86
   prvc   0.04     5.05    44.17    72.39    31.75   114.21
```

```
 MODIFICATION INDICES FOR THETA-EPS
         bmc       fi       lts      gra      ppr      opr
      -------- -------- -------- -------- -------- --------
 bmc      - -
 fi     37.36      - -
 lts     0.06    35.16      - -
 gra    12.29    18.62     0.08      - -
 ppr     0.82     1.77     1.12    18.85      - -
 opr   191.56    19.07    20.44    30.28   207.93      - -
 prvc   30.57     8.50     1.17    49.35    12.26    135.6

         prvc
      --------
 prvc     - -

 EXPECTED CHANGE FOR THETA-EPS
         dc       cpr      sv       mfp      fg       spr
      -------- -------- -------- -------- -------- --------
 dc       - -
 cpr     0.06      - -
 sv     -0.01     0.00      - -
 mfp    -0.05    -0.02     0.01      - -
 fg     -0.01     0.00     0.01     0.02      - -
 spr     0.03    -0.03     0.03     0.00     0.01      - -
 bmc     0.01    -0.02    -0.02    -0.04    -0.01      - -
 fi      0.00     0.00    -0.01     0.06    -0.01    -0.01
 lts    -0.02     0.01    -0.01     0.03     0.01    -0.04
 gra     0.03    -0.03    -0.01     0.00    -0.02     0.02
 ppr    -0.01     0.04     0.02     0.01    -0.01    -0.06
 opr    -0.05    -0.03    -0.05     0.00    -0.01    -0.02
 prvc    0.00     0.01     0.04     0.05     0.04     0.06

 EXPECTED CHANGE FOR THETA-EPS
         bmc       fi       lts      gra      ppr      opr
      -------- -------- -------- -------- -------- --------
 bmc      - -
 fi     -0.04      - -
 lts     0.00     0.05      - -
 gra     0.02    -0.05     0.00      - -
 ppr     0.01     0.01    -0.01    -0.03      - -
 opr     0.08     0.03     0.03     0.03     0.11      - -
 prvc   -0.03    -0.02    -0.01    -0.05    -0.02    -0.08

 EXPECTED CHANGE FOR THETA-EPS
```

```
        prvc
      --------
 prvc     - -

  COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-EPS
          dc      cpr      sv     mfp      fg      spr
      -------- -------- -------- -------- -------- --------
  dc      - -
  cpr    0.06     - -
  sv    -0.01    0.00     - -
  mfp   -0.05   -0.02    0.01     - -
  fg    -0.01    0.00    0.01    0.02     - -
  spr    0.03   -0.03    0.03    0.00    0.01     - -
  bmc    0.01   -0.02   -0.02   -0.04   -0.01     - -
  fi     0.00    0.00   -0.01    0.06   -0.01   -0.01
  lts   -0.02    0.01   -0.01    0.03    0.01   -0.04
  gra    0.03   -0.02   -0.01    0.00   -0.02    0.02
  ppr   -0.01    0.04    0.02    0.01   -0.01   -0.06
  opr   -0.05   -0.03   -0.05    0.00   -0.01   -0.02
  prvc   0.00    0.01    0.04    0.05    0.04    0.06

  COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-EPS
          bmc      fi      lts     gra      ppr     opr
      -------- -------- -------- -------- -------- --------
  bmc     - -
  fi    -0.04     - -
  lts    0.00    0.05     - -
  gra    0.02   -0.05    0.00     - -
  ppr    0.01    0.01   -0.01   -0.03     - -
  opr    0.08    0.03    0.03    0.03    0.11     - -
  prvc  -0.03   -0.02   -0.01   -0.04   -0.02   -0.01
         prvc
      --------
  prvc    - -
 MAXIMUM MODIFICATION INDEX IS  367.93 FOR ELEMENT (12, 1) OF
LAMBDA-Y

 STANDARDIZED SOLUTION
    LAMBDA-Y
         ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
  dc     0.83     - -      - -      - -
  cpr    0.71     - -      - -      - -
  sv     0.64     - -      - -      - -
```

```
 mfp    0.65     - -      - -      - -
  fg    0.52     - -      - -      - -
 spr     - -    0.85      - -      - -
 bmc     - -    0.74      - -      - -
  fi     - -     - -     0.59      - -
 lts     - -     - -     0.39      - -
 gra     - -     - -     0.74      - -
 ppr     - -     - -      - -     0.73
 opr     - -     - -      - -     0.72
prvc     - -     - -      - -     0.64
   GAMMA
       KSI 1
    --------
ETA 1     0.86
ETA 2     0.87
ETA 3     0.90
ETA 4     0.96

   CORRELATION MATRIX OF ETA AND KSI
       ETA 1    ETA 2    ETA 3    ETA 4    KSI 1
    -------- -------- -------- -------- --------
ETA 1     1.00
ETA 2     0.75     1.00
ETA 3     0.77     0.79     1.00
ETA 4     0.82     0.84     0.87     1.00
KSI 1     0.86     0.87     0.90     0.96     1.00

   PSI
       ETA 1    ETA 2    ETA 3    ETA 4
    -------- -------- -------- --------
        0.26     0.24     0.18     0.08

COMPLETELY STANDARDIZED SOLUTION
   LAMBDA-Y
       ETA 1    ETA 2    ETA 3    ETA 4
    -------- -------- -------- --------
  dc    0.83     - -      - -      - -
 cpr    0.71     - -      - -      - -
  sv    0.64     - -      - -      - -
 mfp    0.65     - -      - -      - -
  fg    0.52     - -      - -      - -
 spr     - -    0.84      - -      - -
 bmc     - -    0.74      - -      - -
  fi     - -     - -     0.59      - -
```

```
lts      - -      - -     0.39      - -
gra      - -      - -     0.73      - -
ppr      - -      - -      - -     0.73
opr      - -      - -      - -     0.72
prvc     - -      - -      - -     0.64

   GAMMA
        KSI 1
      --------
ETA 1     0.86
ETA 2     0.87
ETA 3     0.90
ETA 4     0.96

   CORRELATION MATRIX OF ETA AND KSI
        ETA 1    ETA 2    ETA 3    ETA 4    KSI 1
      -------- -------- -------- -------- --------
ETA 1     1.00
ETA 2     0.75     1.00
ETA 3     0.77     0.79     1.00
ETA 4     0.82     0.84     0.87     1.00
KSI 1     0.86     0.87     0.90     0.96     1.00

   PSI
        ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
         0.26     0.24     0.18     0.08

   THETA-EPS
           dc      cpr       sv      mfp       fg      spr
      -------- -------- -------- -------- -------- --------
         0.32     0.50     0.59     0.58     0.73     0.29

          bmc       fi      lts      gra      ppr      opr
      -------- -------- -------- -------- -------- --------
         0.46     0.65     0.85     0.46     0.47     0.48

         prvc
      --------
         0.59
```

APPENDIX F

LISREL Output: Modified 4-Factor, Second order Model -LD Group

```
                    WINDOWS  L I S R E L  8.14
                             BY
                   KARL G JORESKOG AND DAG SORBOM

 The following lines were read from file
C:\DATA\CONSULT\MULLIGAN\LISREL\4F_2ND.LS8:
 Mulligan: 4factor 2nd order factor analysis
 !da no=10475 ni=17 ma=cm
 da no=995 ni=17 ma=cm
 label
 *
 sv fg swb dc ppr bmc prvc cpr prn mac spr opr mfp kin fi gra lts
 se
 dc cpr sv mfp fg        ! 1-5
 spr bmc                ! 6-7
 fi lts gra             ! 8-10
 ppr opr prvc /           ! 11-13  THIS IS THE MODIFIED MODEL

 !cm fu file=\data\consult\mulligan\lisrel\cov_aprn.emc  ! FULL SAMPLE
 cm fu file=\data\consult\mulligan\lisrel\cov_ld.emc   ! LD SAMPLE

 mo ne=4 ny=13 ly=fu,fi ps=di,fr te=di,fr        C
 nk=1      ph=sy,fr ga=fu,fr
 free ly 2  1 ly 3  1 ly 4  1 ly 5  1
 free ly 7 2
 free LY 9 3 ly 10 3
 free ly 12 4 ly 13 4
 st 1.0 ly 1  1 ly 6 2 ly 8 3 ly 11 4

 fi ga 1  1
 st 1.0 ga 1  1

 ou ml sc
                  NUMBER OF INPUT VARIABLES 17
                  NUMBER OF Y - VARIABLES  13
                  NUMBER OF X - VARIABLES   0
                  NUMBER OF ETA - VARIABLES  4
                  NUMBER OF KSI - VARIABLES  1
                  NUMBER OF OBSERVATIONS  995
```

```
    COVARIANCE MATRIX TO BE ANALYZED
           dc       cpr       sv      mfp       fg      spr
        -------- -------- -------- -------- -------- --------
   dc     1.03
  cpr     0.65     0.93
   sv     0.55     0.46     0.90
  mfp     0.60     0.51     0.45     1.10
   fg     0.38     0.32     0.28     0.35     1.00
  spr     0.53     0.40     0.39     0.41     0.27     0.94
  bmc     0.50     0.35     0.33     0.35     0.22     0.63
   fi     0.46     0.37     0.33     0.49     0.28     0.41
  lts     0.32     0.26     0.26     0.34     0.20     0.29
  gra     0.57     0.42     0.38     0.49     0.28     0.54
  ppr     0.60     0.50     0.48     0.52     0.30     0.51
  opr     0.52     0.43     0.36     0.46     0.27     0.58
 prvc     0.51     0.44     0.40     0.49     0.24     0.46

          bmc       fi      lts      gra      ppr      opr
        -------- -------- -------- -------- -------- --------
  bmc     1.06
   fi     0.35     1.10
  lts     0.29     0.38     1.07
  gra     0.50     0.55     0.39     1.15
  ppr     0.52     0.47     0.36     0.54     1.13
  opr     0.59     0.51     0.37     0.61     0.72     1.18
 prvc     0.39     0.35     0.30     0.42     0.51     0.46

         prvc
        --------
 prvc     1.05

PARAMETER SPECIFICATIONS
    LAMBDA-Y
         ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
   dc       0        0        0        0
  cpr       1        0        0        0
   sv       2        0        0        0
  mfp       3        0        0        0
   fg       4        0        0        0
  spr       0        0        0        0
  bmc       0        5        0        0
   fi       0        0        0        0
  lts       0        0        6        0
```

```
    gra       0     0     7     0
     ppr      0     0     0     0
     opr      0     0     0     8
    prvc      0     0     0     9

     GAMMA
          KSI 1
        --------
   ETA 1       0
   ETA 2      10
   ETA 3      11
   ETA 4      12

     PHI
          KSI 1
        --------
            13

     PSI
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
            14       15       16       17

     THETA-EPS
            dc      cpr       sv      mfp       fg      spr
        -------- -------- -------- -------- -------- --------
            18       19       20       21       22       23

           bmc       fi      lts      gra      ppr      opr
        -------- -------- -------- -------- -------- --------
            24       25       26       27       28       29

          prvc
        --------
            30

 Number of Iterations = 25

 LISREL ESTIMATES (MAXIMUM LIKELIHOOD)
     LAMBDA-Y
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
      dc    1.00      - -      - -      - -
```

```
cpr     0.83     - -      - -      - -
       (0.03)
        26.18

 sv     0.73     - -      - -      - -
       (0.03)
        22.60

mfp     0.82     - -      - -      - -
       (0.04)
        23.05

 fg     0.51     - -      - -      - -
       (0.04)
        13.96

spr      - -     1.00     - -      - -

bmc      - -     0.94     - -      - -
                (0.04)
                 22.79

 fi      - -      - -     1.00     - -

lts      - -      - -     0.74     - -
                         (0.06)
                          13.09

gra      - -      - -     1.19     - -
                         (0.06)
                          18.34

ppr      - -      - -      - -     1.00

opr      - -      - -      - -     0.99
                                  (0.04)
                                   23.70

prvc     - -      - -      - -     0.77
                                  (0.04)
                                   19.08

   GAMMA
       KSI 1
```

```
        --------
ETA 1     1.00

ETA 2     0.93
        (0.04)
         21.42

ETA 3     0.83
        (0.05)
         17.53

ETA 4     1.07
        (0.05)
         21.96

   COVARIANCE MATRIX OF ETA AND KSI
        ETA 1    ETA 2    ETA 3    ETA 4    KSI 1
      -------- -------- -------- -------- --------
ETA 1     0.76
ETA 2     0.52     0.67
ETA 3     0.46     0.43     0.46
ETA 4     0.59     0.55     0.49     0.68
KSI 1     0.55     0.52     0.46     0.59     0.55

   PHI
        KSI 1
      --------
         0.55
       (0.04)
        12.89
   PSI
        ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
         0.20     0.18     0.09     0.05
       (0.02)   (0.02)   (0.02)   (0.02)
         9.36     7.57     4.62     2.52

   SQUARED MULTIPLE CORRELATIONS FOR STRUCTURAL EQUATIONS
        ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
         0.73     0.72     0.81     0.93

   THETA-EPS
           dc      cpr      sv      mfp      fg      spr
```

```
   --------  --------  --------  --------  --------  --------
     0.27      0.41      0.50      0.59      0.80      0.27
    (0.02)    (0.02)    (0.03)    (0.03)    (0.04)    (0.02)
    13.83     18.37     19.84     19.70     21.56     10.90
THETA-EPS

      bmc        fi       lts       gra       ppr       opr
   --------  --------  --------  --------  --------  --------
     0.46      0.64      0.81      0.50      0.45      0.50
    (0.03)    (0.03)    (0.04)    (0.03)    (0.03)    (0.03)
    16.24     18.48     20.72     14.68     16.50     17.25

     prvc
   --------
     0.64
    (0.03)
    20.08


SQUARED MULTIPLE CORRELATIONS FOR Y - VARIABLES
      dc        cpr        sv       mfp        fg       spr
   --------  --------  --------  --------  --------  --------
     0.73      0.56      0.45      0.46      0.20      0.71

      bmc        fi       lts       gra       ppr       opr
   --------  --------  --------  --------  --------  --------
     0.56      0.42      0.24      0.57      0.60      0.57

     prvc
   --------
     0.39


                 GOODNESS OF FIT STATISTICS
    CHI-SQUARE WITH 61 DEGREES OF FREEDOM = 231.77 (P = 0.0)
      ESTIMATED NON-CENTRALITY PARAMETER (NCP) = 170.77
             MINIMUM FIT FUNCTION VALUE = 0.23
      POPULATION DISCREPANCY FUNCTION VALUE (F0) = 0.17
    ROOT MEAN SQUARE ERROR OF APPROXIMATION (RMSEA) = 0.053
         EXPECTED CROSS-VALIDATION INDEX (ECVI) = 0.29
              ECVI FOR SATURATED MODEL = 0.18
             ECVI FOR INDEPENDENCE MODEL = 5.52
  CHI-SQUARE FOR INDEPENDENCE MODEL WITH 78 DEGREES OF
FREEDOM = 5463.54
```

```
        INDEPENDENCE AIC = 5489.54
              MODEL AIC = 291.77
          SATURATED AIC = 182.00
      INDEPENDENCE CAIC = 5566.28
             MODEL CAIC = 468.85
         SATURATED CAIC = 719.15
ROOT MEAN SQUARE RESIDUAL (RMR) = 0.035
         STANDARDIZED RMR = 0.033
    GOODNESS OF FIT INDEX (GFI) = 0.97
 ADJUSTED GOODNESS OF FIT INDEX (AGFI) = 0.95
PARSIMONY GOODNESS OF FIT INDEX (PGFI) = 0.65
     NORMED FIT INDEX (NFI) = 0.96
   NON-NORMED FIT INDEX (NNFI) = 0.96
 PARSIMONY NORMED FIT INDEX (PNFI) = 0.75
   COMPARATIVE FIT INDEX (CFI) = 0.97
   INCREMENTAL FIT INDEX (IFI) = 0.97
     RELATIVE FIT INDEX (RFI) = 0.95
         CRITICAL N (CN) = 385.24

 CONFIDENCE LIMITS COULD NOT BE COMPUTED DUE TO TOO SMALL
P-VALUE FOR CHI-SQUARE

 SUMMARY STATISTICS FOR FITTED RESIDUALS
 SMALLEST FITTED RESIDUAL =  -0.07
   MEDIAN FITTED RESIDUAL =   0.00
  LARGEST FITTED RESIDUAL =   0.11

 STEMLEAF PLOT
 - 6|321
 - 4|943183
 - 2|5500998754110
 - 0|97663311088443211000000000000000
   0|123445589901239
   2|0124890033449
   4|6617
   6|3502
   8|
  10|04

 SUMMARY STATISTICS FOR STANDARDIZED RESIDUALS
 SMALLEST STANDARDIZED RESIDUAL =  -5.53
   MEDIAN STANDARDIZED RESIDUAL =   0.00
  LARGEST STANDARDIZED RESIDUAL =   5.26
```

```
STEMLEAF PLOT
 - 4|5220
 - 2|82185500
 - 0|65553322221109987666443211000000000000000
   0|11223334666779113445788
   2|02344500666
   4|6993
 LARGEST NEGATIVE STANDARDIZED RESIDUALS
 RESIDUAL FOR     bmc AND     cpr  -3.17
 RESIDUAL FOR      fi AND    bmc  -2.76
 RESIDUAL FOR     ppr AND     spr  -4.21
 RESIDUAL FOR     ppr AND     gra  -3.08
 RESIDUAL FOR     opr AND      dc  -5.53
 RESIDUAL FOR     opr AND     cpr  -3.79
 RESIDUAL FOR     opr AND      sv  -4.03
 RESIDUAL FOR    prvc AND     opr  -4.21
 LARGEST POSITIVE STANDARDIZED RESIDUALS
 RESIDUAL FOR     cpr AND      dc   3.05
 RESIDUAL FOR      fi AND    mfp   4.92
 RESIDUAL FOR     ppr AND      sv   3.00
 RESIDUAL FOR     opr AND     bmc   4.59
 RESIDUAL FOR     opr AND     ppr   4.89
 RESIDUAL FOR    prvc AND      dc   3.61
 RESIDUAL FOR    prvc AND     cpr   3.56
 RESIDUAL FOR    prvc AND      sv   3.61
 RESIDUAL FOR    prvc AND     mfp   5.26

 MODIFICATION INDICES AND EXPECTED CHANGE
       MODIFICATION INDICES FOR LAMBDA-Y
            ETA 1     ETA 2     ETA 3     ETA 4
          --------  --------  --------  --------
     dc       - -      3.63      0.03      0.48
    cpr       - -      9.72     10.09      4.20
     sv       - -      0.02      0.18      0.26
    mfp       - -      0.07     19.57      8.67
     fg       - -      0.05      0.34      0.23
    spr      0.54       - -      0.63      1.97
    bmc      5.85       - -      0.86      9.28
     fi      1.80      6.25       - -      0.75
    lts      0.05      1.98       - -      0.00
    gra      0.22      9.34       - -      0.01
    ppr      5.19     14.46     12.37       - -
    opr     57.63     17.28      6.13       - -
   prvc     42.16      2.29      0.10       - -
```

```
 EXPECTED CHANGE FOR LAMBDA-Y
        ETA 1    ETA 2    ETA 3    ETA 4
       -------- -------- -------- --------
 dc       - -     0.11     0.01    -0.06
 cpr      - -    -0.18    -0.26    -0.16
 sv       - -     0.01    -0.04     0.04
 mfp      - -    -0.02     0.41     0.25
 fg       - -    -0.02     0.06    -0.04
 spr     0.06      - -     0.13    -0.45
 bmc    -0.20      - -    -0.16     1.05
 fi      0.11    -0.24      - -    -0.18
 lts    -0.02    -0.13      - -     0.01
 gra     0.04     0.29      - -    -0.03
 ppr     0.19    -0.36    -0.60      - -
 opr    -0.66     0.40     0.43      - -
 prvc    0.54     0.14    -0.05      - -

 STANDARDIZED EXPECTED CHANGE FOR LAMBDA-Y
        ETA 1    ETA 2    ETA 3    ETA 4
       -------- -------- -------- --------
 dc       - -     0.09     0.01    -0.05
 cpr      - -    -0.14    -0.18    -0.13
 sv       - -     0.01    -0.02     0.03
 mfp      - -    -0.01     0.28     0.21
 fg       - -    -0.01     0.04    -0.04
 spr     0.05      - -     0.09    -0.37
 bmc    -0.18      - -    -0.11     0.87
 fi      0.10    -0.19      - -    -0.15
 lts    -0.02    -0.10      - -     0.01
 gra     0.04     0.24      - -    -0.02
 ppr     0.17    -0.29    -0.41      - -
 opr    -0.58     0.33     0.29      - -
 prvc    0.47     0.12    -0.04      - -

 COMPLETELY STANDARDIZED EXPECTED CHANGE FOR LAMBDA-Y
        ETA 1    ETA 2    ETA 3    ETA 4
       -------- -------- -------- --------
 dc       - -     0.09     0.01    -0.05
 cpr      - -    -0.15    -0.18    -0.13
 sv       - -     0.01    -0.03     0.03
 mfp      - -    -0.01     0.27     0.20
 fg       - -    -0.01     0.04    -0.04
 spr     0.05      - -     0.09    -0.38
 bmc    -0.17      - -    -0.11     0.84
```

```
 fi     0.09   -0.18     - -    -0.14
 lts   -0.02   -0.10     - -     0.01
 gra    0.03    0.22     - -    -0.02
 ppr    0.16   -0.27   -0.39     - -
 opr   -0.53    0.30    0.27     - -
 prvc   0.46    0.11   -0.03     - -

NO NON-ZERO MODIFICATION INDICES FOR GAMMA
NO NON-ZERO MODIFICATION INDICES FOR PHI

   MODIFICATION INDICES FOR PSI
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
 ETA 1     - -
 ETA 2    2.28      - -
 ETA 3    2.28     0.00      - -
 ETA 4    0.00     2.28     2.28      - -

   EXPECTED CHANGE FOR PSI
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
 ETA 1     - -
 ETA 2   -0.03      - -
 ETA 3    0.02     0.00      - -
 ETA 4    0.00     0.03    -0.02      - -

   STANDARDIZED EXPECTED CHANGE FOR PSI
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
 ETA 1     - -
 ETA 2   -0.04      - -
 ETA 3    0.04     0.00      - -
 ETA 4    0.00     0.04    -0.04      - -

   MODIFICATION INDICES FOR THETA-EPS
            dc       cpr      sv       mfp      fg       spr
        -------- -------- -------- -------- -------- --------
  dc       - -
  cpr     9.28      - -
  sv      0.10     0.06      - -
  mfp     6.46     0.73     0.00      - -
  fg      0.54     0.01     0.04     2.00      - -
  spr     0.55     0.72     1.55     0.57     0.54      - -
  bmc     4.33     2.92     2.22     6.27     1.20      - -
```

```
 fi     0.54     0.53     0.34    17.50     2.78     0.10
 lts    3.86     0.25     0.69     4.42     1.13     2.35
 gra    3.87     2.99     1.77     0.37     0.05     3.96
 ppr    0.05     1.03     9.73     0.08     0.39    16.66
 opr   10.40     1.40    10.36     0.45     0.23     1.23
 prvc   0.73     4.92     3.92    10.32     0.38     4.39

MODIFICATION INDICES FOR THETA-EPS

          bmc      fi       lts      gra      ppr      opr
        -------- -------- -------- -------- -------- --------
 bmc      - -
 fi     5.91       - -
 lts    0.01     3.06       - -
 gra    0.75     0.19     1.15       - -
 ppr    1.08     0.32     0.24     8.25       - -
 opr   14.07     1.78     0.00     4.73    23.94       - -
 prvc   3.01     1.75     1.01     3.15     1.11    17.76
          prvc
        --------
 prvc     - -

   EXPECTED CHANGE FOR THETA-EPS
          dc       cpr      sv       mfp      fg       spr
        -------- -------- -------- -------- -------- --------
 dc       - -
 cpr    0.06       - -
 sv    -0.01     0.00       - -
 mfp   -0.05    -0.02     0.00       - -
 fg    -0.01     0.00     0.00     0.03       - -
 spr    0.01    -0.01     0.02    -0.01     0.01       - -
 bmc    0.03    -0.03    -0.03    -0.05    -0.02       - -
 fi    -0.01    -0.01    -0.01     0.09     0.04    -0.01
 lts   -0.04    -0.01     0.02     0.05     0.03    -0.03
 gra    0.03    -0.03    -0.03     0.01    -0.01     0.04
 ppr    0.00     0.02     0.06     0.01    -0.01    -0.07
 opr   -0.05    -0.02    -0.06    -0.01    -0.01     0.02
 prvc   0.01     0.04     0.04     0.07    -0.01     0.04

   EXPECTED CHANGE FOR THETA-EPS
          bmc      fi       lts      gra      ppr      opr
        -------- -------- -------- -------- -------- --------
 bmc      - -
```

```
 fi    -0.05     - -
 lts    0.00     0.05    - -
 gra    0.02    -0.02   -0.03    - -
 ppr    0.02    -0.01    0.01   -0.06    - -
 opr    0.07     0.03    0.00    0.05    0.14    - -
 prvc  -0.04    -0.03    0.03   -0.04   -0.02   -0.10
          prvc
       --------
 prvc     - -
   COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-EPS
          dc      cpr      sv      mfp      fg      spr
       -------- -------- -------- -------- -------- --------
 dc       - -
 cpr    0.06     - -
 sv    -0.01    0.00     - -
 mfp   -0.05   -0.02    0.00     - -
 fg    -0.01    0.00    0.00    0.03     - -
 spr    0.01   -0.01    0.02   -0.01    0.01     - -
 bmc    0.03   -0.03   -0.03   -0.05   -0.02     - -
 fi    -0.01   -0.01   -0.01    0.08    0.04   -0.01
 lts   -0.04   -0.01    0.02    0.05    0.03   -0.03
 gra    0.03   -0.03   -0.02    0.01    0.00    0.03
 ppr    0.00    0.02    0.05    0.00   -0.01   -0.07
 opr   -0.05   -0.02   -0.06   -0.01   -0.01    0.02
 prvc   0.01    0.04    0.04    0.06   -0.01    0.04

   COMPLETELY STANDARDIZED EXPECTED CHANGE FOR THETA-EPS
          bmc      fi      lts      gra      ppr      opr
       -------- -------- -------- -------- -------- --------
 bmc      - -
 fi    -0.05     - -
 lts    0.00    0.04     - -
 gra    0.02   -0.01   -0.03     - -
 ppr    0.02   -0.01    0.01   -0.05     - -
 opr    0.07    0.03    0.00    0.04    0.12     - -
 prvc  -0.03   -0.03    0.02   -0.04   -0.02   -0.09

          prvc
       --------
 prvc     - -

 MAXIMUM MODIFICATION INDEX IS   57.63 FOR ELEMENT (12, 1) OF
LAMBDA-Y
```

```
STANDARDIZED SOLUTION
    LAMBDA-Y
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
   dc     0.87      --       --       --
   cpr    0.72      --       --       --
   sv     0.64      --       --       --
   mfp    0.71      --       --       --
   fg     0.45      --       --       --
   spr     --      0.82      --       --
   bmc     --      0.77      --       --
   fi      --       --      0.68      --
   lts     --       --      0.51      --
   gra     --       --      0.81      --
   ppr     --       --       --      0.83
   opr     --       --       --      0.82
   prvc    --       --       --      0.64

    GAMMA
          KSI 1
        --------
  ETA 1   0.85
  ETA 2   0.85
  ETA 3   0.90
  ETA 4   0.96

    CORRELATION MATRIX OF ETA AND KSI
          ETA 1    ETA 2    ETA 3    ETA 4    KSI 1
        -------- -------- -------- -------- --------
  ETA 1   1.00
  ETA 2   0.73     1.00
  ETA 3   0.77     0.77     1.00
  ETA 4   0.82     0.82     0.87     1.00
  KSI 1   0.85     0.85     0.90     0.96     1.00

    PSI
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
          0.27     0.28     0.19     0.07

COMPLETELY STANDARDIZED SOLUTION
    LAMBDA-Y
          ETA 1    ETA 2    ETA 3    ETA 4
        -------- -------- -------- --------
```

```
   dc     0.86     - -      - -      - -
   cpr     0.75     - -      - -      - -
   sv     0.67     - -      - -      - -
   mfp     0.68     - -      - -      - -
   fg     0.45     - -      - -      - -
   spr     - -    0.84      - -      - -
   bmc     - -    0.75      - -      - -
   fi     - -     - -     0.65      - -
   lts     - -     - -     0.49      - -
   gra     - -     - -     0.75      - -
   ppr     - -     - -      - -     0.78
   opr     - -     - -      - -     0.76
   prvc    - -     - -      - -     0.62

    GAMMA
       KSI 1
      --------
  ETA 1     0.85
  ETA 2     0.85
  ETA 3     0.90
  ETA 4     0.96
    CORRELATION MATRIX OF ETA AND KSI
       ETA 1    ETA 2    ETA 3    ETA 4    KSI 1
      -------- -------- -------- -------- --------
  ETA 1     1.00
  ETA 2     0.73     1.00
  ETA 3     0.77     0.77     1.00
  ETA 4     0.82     0.82     0.87·    1.00
  KSI 1    0.85     0.85     0.90     0.96     1.00
    PSI
       ETA 1    ETA 2    ETA 3    ETA 4
      -------- -------- -------- --------
        0.27     0.28     0.19     0.07
THETA-EPS
         dc      cpr      sv      mfp      fg      spr
      -------- -------- -------- -------- -------- --------
        0.27     0.44     0.55     0.54     0.80     0.29

        bmc       fi      lts      gra      ppr      opr
      -------- -------- -------- -------- -------- --------
        0.44     0.58     0.76     0.43     0.40     0.43
        prvc
      --------
        0.61
```

January 1997

CURRICULUM VITAE

Shelley Elizabeth Mulligan
83 Garrity Rd., Lee, NH 03824
(603)868-6093

EDUCATION

1992-present Doctorate of Philosophy Candidate, Special Education, University of Washington, Seattle, WA, expected completion of Ph.D., May 1997.
Dissertation: Sensory integration: Patterns of dysfunction and clinical application with children with mild disabilities.

1990 Master of Science, Occupational Therapy, Colorado State University, Fort Collins, CO.

1985 Bachelor of Science, Occupational Therapy, University of Western Ontario, London, Ontario, CAN.

Other Professional Development

1991 Combined Sensory Integration and Neurodevelopmental Treatment for Children Birth Through Three, Seattle, WA
1990 Neurodevelopmental Introductory Treatment Course, St. Catharines, Ont.
1990 Grant Writing Workshop, Colorado State Univ., Fort Collins, CO
1989 Sensory Integration and Praxis Tests Certification, Denver, CO
1988 Ontario Health Assoc. Management Certification, Mississauga, Ont.

PROFESSIONAL EXPERIENCE

8/96-present	Assistant professor, University of New Hampshire, School of Health and Human Services, Occupational Therapy Dept., Durham, NH.
1/96 -5/96	Clinical Faculty, part-time University of Washington, Dept. of Rehabilitation Medicine, Seattle, WA
9/95 - 2/96	Occupational therapist, Nova Care, Seattle, WA
5/91- 9/95	Occupational therapist, part time, pediatric private practice, Seattle, WA
9/93- 6/95	Occupational therapist, Federal Way School District, Federal Way, WA
9/91-10/93	Technical assistance coordinator, Program Development Services, Experimental Education Unit, University of Washington, Seattle, WA
1991-92	Occupational therapist, Experimental Education Unit, University of Washington, Seattle, WA.
1990	Assistant director, Occupational Therapy Dept., Niagara Peninsula Children's Center, St. Catharines, Ont. CAN.
1989-90	Teacher's assistant, Occupational Therapy Dept., Colorado State University, Fort Collins, CO.
1989-90	Occupational therapist, Weld County School District RE -4, Windsor, CO.
1986-88	Occupational therapist, adult rehabilitation and pediatrics, The Credit Valley

Hospital, Mississauga, Ontario, CAN.
1985-86 Occupational therapist, adult neurology, University Hospital, London, Ontario.

RESEARCH EXPERIENCE

1993 - present Ph.D. program research projects, University of Washington:
An analysis of score patterns of children with attention disorders on the Sensory Integration and Praxis Tests.
Transdisciplinary Teaming: Implications for school-based occupational therapy services.
Parent perceptions of the attention deficit hyperactivity disorder label.

1990 Master's Research, Colorado State University:
The effectiveness of sensory stimulation in the treatment of children with severe head injuries.

1985 Bachelor's Research, University of Western Ontario, Ontario, CAN :
A description of the pediatric population treated by occupational therapy at one facility.

RESEARCH INTERESTS

Occupational therapy service delivery models
Interpretation of the Sensory Integration and Praxis Tests
Evaluation of educational and therapy programming for children and adults with attention deficit disorders
Program Evaluation

PUBLICATIONS

Mulligan, S. & Hanzlik, J. (1991). The effectiveness of sensory stimulation in the treatment of children with severe head injuries. The Occupational Therapy Journal of Research, 11(4), 213-226.
Mulligan, S. (1996). An analysis of score patterns of children with attention disorders on the Sensory Integration and Praxis Tests, American Journal of Occupational Therapy, 50(8), 647-654.

CONFERENCE PRESENTATIONS

6/95 "Programming considerations for students who are medically fragile", M-First Summer Institute, Olympia, WA.
4/95 "An analysis of score patterns of children with attention disorders on the Sensory Integration and Praxis Tests" , AOTF research poster session, American Occupational Therapy Association national conference, Denver, CO.
6/94 "Transdisciplinary Teaming: Implications for pediatric physical therapy services", National American and Canadian Physical Therapy Conference, Toronto, Ontario.

3/93 " Project NIC: A Transdisciplinary Approach to Serving Children with Profound Disabilities," Seminar Presentation, Conference '93, Council for Exceptional Children, Seattle, WA.

1992/93 " Transdisciplinary Approach to Assessment and Programming for Children with Severe Disabilities", 10 days of training, sponsored by Program Development Services, University of WA, in Vancouver, WA, '92, Sumner, WA, '93.

7 /90 " The Effectiveness of Sensory Stimulation in the Treatment of Children with Severe Head Injuries", Poster presentation, 18th Annual Sensorimotor Symposium, San Diego, CA.

AWARDS AND SCHOLARSHIPS

1994 University of Washington, recipient of Grant No. HO29D20081, Preparing Leadership Personnel: Careers in Personnel Training and Research for Occupational Therapists, US Department of Education, including tuition costs and stipend.

1993 Scholarship from the American Occupational Therapy Foundation; $1,000 towards doctoral studies at The University of Washington, Seattle, WA.

1988-1990 Colorado State University, recipient of Sarah Durning Award, and funding under a personnel preparation grant related to preparing leaders in the area of technology, including tuition costs and stipend.

PROFESSIONAL AFFILIATIONS

American Occupational Therapy Association
Sensory Integration International
State of New Hampshire Occupational Therapy License