

The Efficacy of Sensory Integration Procedures*

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The purpose of this paper is to report on the status of research which has been designed to determine the effectiveness of occupational and physical therapy using sensory integration (SI) procedures. Sensory integration efficacy is the extent to which sensory integration procedures have proven to be beneficial. (A reference list of sensory integration efficacy studies is available from Sensory Integration International.) The author(s) of each article in this bibliography stated that they based their treatment on sensory integration theory, although some researchers adapted the actual treatment procedures to meet the developmental level of their clients, and/or to address specific research issues.

What is Sensory Integration?

Before discussing the SI efficacy research, we would like to talk about "What is Sensory Integration?" Although this seems like an obvious question, it is important to define what is and what is not sensory integration as many research studies purport to use SI, yet the modifications of treatment are so substantial as to make one question whether the procedures truly are sensory integrative. Kimball (1988) identified the following as characteristics of sensory integration procedures: (Table 1)

Table 1: Characteristics of Sensory Integration Procedures

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| <ul style="list-style-type: none">• active participation• child directed• individualized treatment• purposeful activity• need for adaptive response³• input varies based on child's response• activity rich in proprioceptive, vestibular and tactile input• implied or stated goal of improving processing and organization of sensation (not the teaching of specific skills)• administered by a trained therapist (OT or PT) |
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Thus, studies which involve pure sensory stimulation such as that of controlled, systematically applied vestibular stimulation (e.g., the work of Kantner) should not be grouped with those of sensory integration. Similarly, perceptual motor programs which tend to be pre-planned, therapist directed, structured programs should be considered separately. The distinction is not always clear-cut since some studies combine sensory integration and perceptual motor procedures. For example, Huff and Harris (1987) in their study with 34 mentally retarded adults utilized sensory integration activities but in a specified sequence. In their study, each treatment session was divided into four areas: CNS normalization (excitation or inhibition), sensory stimulation, reflex inhibition and gross motor activity, and visual motor activity. Thus, treatment was substantially more structured than in sensory integration, and was therapist directed rather than therapist guided.

The article by McKibbin (1973) is another example of this confusion of definition of sensory integration. This article "The effect of additional tactile stimulation in a perceptual-motor treatment program for school children" published in the *American Journal of Occupational Therapy* in 1979 is keyed by the journal as "research in sensory integrative development." Within the article, the author reviews sensory integration literature, and states that she is using Ayres theories. The treatment program is described as a 40 minute "gross motor period including games and relays providing maximum proprioceptive-kinesthetic and vestibular stimulation." However, in order to determine whether additional tactile input vs. eye hand coordination activities would result in greater improvement in motor planning, the authors intentionally omitted tactile stimulation from the gross motor activities. Tactile stimulation is later administered in isolation for a 20 minute period. This separation of input is not consistent with the principles of sensory integration. Furthermore, it appears that activities were administered in a group so that all subjects receive the same program at the same time. This also is not consistent with sensory integration theory which stresses the importance of an individualized child-directed program.

Even among the experts, there is not clear agreement as to what is considered to be sensory integration. In his review of SI research, Ottenbacher (1982) included the studies by DePauw (1978) and by Montgomery and Richter (1977) whereas Clark and Pierce (1986) did not. On the other hand, Clark and Pierce and Ottenbacher include the study by Magrun (1981) in their review of SI research even though the therapy program consisted of 3 'therapist designed' activities from which the client chooses.

An additional issue in research in sensory integration relates to one of the criteria considered essential in good research design - that of sufficient description to enable replication of the study. In terms of sensory integration treatment, this would mean clear elaboration of the treatment procedures. However, in sensory integration, treatment is neither predetermined nor fixed, but rather varies from one individual to the next, and changes in response to the individuals' response to therapy, thus making a concise description of the treatment difficult.

However, despite this problem, the importance of clearly defining Sensory Integration is of particular importance since reviewers of studies of sensory integration effectiveness often have included research studies in which treatment violated so many of the principles of sensory

integration procedures. Although the treatment may have drawn upon SI theory, it was not sensory integration therapy.

Are Sensory Integration Procedures Effective?

The next issue we would like to address deals with what the literature says about the effectiveness of sensory integration procedures. Since 1980, there have been 7 articles which have reviewed the sensory integration effectiveness literature. These are listed in the first part of your bibliography. Examination of these reviews and other related literature indicates that at present, there is not consistent agreement regarding the effectiveness of sensory integration. Clinicians who are using sensory integration procedures are convinced that it is effective.

There are many testimonials from parents of children who have received occupational therapy using sensory integration procedures. However, empirical data is limited, and its interpretation is highly varied. For example, in a review of the SI research with learning disabilities, Henderson (1981) concluded that “the studies ... provide preliminary evidence of the value of sensory integrative therapy for children with learning disabilities.” (p. 45), and that “Certainly they provide sufficient evidence to warrant further investigation of the effects of sensory integrative therapy on academic learning as well as on perceptual and motor skills.” (p. 45).

In 1982, Ottenbacher reviewed the SI effectiveness literature through a meta-analysis, a quantitative review in which the results of a great many studies are synthesized and integrated. Ottenbacher’s (1982) meta-analysis of SI effectiveness studies yielded an overall effect size of $d=.79$ which is considered to be a medium effect size. According to Cohen, a d -index of this magnitude means that the average performance of subjects in the experimental groups receiving sensory integration procedures was better than 78.8% of the subjects in the control groups not receiving sensory integration therapy (see Figure 1). In a summary of his meta-analysis, Ottenbacher (1982) stated that “the meta-analysis of the SI research literature did provide suggestive support for the effects of SI therapy,” (p.3 19). However, the number of studies that met the criteria for inclusion (the research study had to have a control group for example) was only eight, a number which Ottenbacher emphasized is quite small for a meta-analysis.

In 1986, Florence Clark and Doris Pierce presented a literature review on SI and other relevant treatment effectiveness studies specifically carried out with pediatric populations by occupational therapy researchers. The twenty-six studies found included research with large samples as well as single-subject designs. Thirteen of the studies examined the effectiveness of sensory integration procedures as their independent variable, four examined the effect of systematically applied vestibular stimulation, four of multisensory input, and five of perceptual motor training. Given these numbers of studies, it becomes apparent that occupational therapy efficacy research in this area is progressing, although slowly.

Why and How Does Sensory Integration Work

We would next like to discuss the issue of why and how sensory integration procedures are effective. In sensory integration theory, we hypothesize that we are influencing brain organization and brain change. The idea that the neural organization is actually changing or developing as a result of the sensory input/adaptive response is controversial. Brain change in humans is nonobservable and thus, it is very difficult to establish support for it. In demonstrating the effectiveness of sensory integration, we are primarily limited to observable behaviors. Brain change can be inferred only from indirect observable variables, such as change in a child's performance; it cannot be easily directly observed except, perhaps, through autopsy (Tickle, 1988).

There is some possible support for the effect of sensory integration therapy on change in the nervous system. In a study by Kavar (1973), findings suggested that sensory integration therapy positively influenced hemispheric specialization as measured by a dichotic listening task in a sample of children with learning disabilities.

Ottenbacher (1982) demonstrated change in postrotary nystagmus, as measured by the Southern California Postrotary Nystagmus Test (SCPNT), with multiple measurements of 3 children over a 20-week treatment period. However, as Ottenbacher noted, many factors contribute to postrotary nystagmus (PRN) as tested with the SCPNT, thus it is not clear whether or not the PRN change was due to change in central nervous system physiology or to other factors.

Alternative ways to assess the neural organization influences of sensory integration may be to do on line monitoring of neurophysiological processes (Tickle, 1988). For example, we can ask the question of whether input is being received as would be expected and whether or not the child is processing information in a normal way. The use of PET scans or EEG may, in the future, be used to examine the CNS integration of afferent input whereas the use of EMG may enable the examination of muscle response to induced sensory input. As an example of this type of physiologic research, Mr. Washida, an occupational therapist in Japan, is examining the effect of vestibular stimulation on heart rate with severely retarded individuals. The emergence of new technological advances which allow the non-invasive study of brain-behavior relationships will provide another window to understanding the effects of sensory integration procedures.

Various individuals have criticized sensory integration because the research has not shown why it works (e.g., Arendt, MacLean & Baumeister, 1988). It is clearly very difficult to substantiate why sensory integration is effective through the research tools and methodologies now available, because these aspects are highly theoretical and difficult to observe. However, according to Tickle (1988) "it is not appropriate to conclude on the basis of this difficulty that the theory is not correct" (p. 431). Tickle (1988) states that the purpose of early research in a field, particularly in a practice field, is to demonstrate whether the given treatment is or is not

effective. As the research progresses, researchers start examining factors which influence the effectiveness of therapy, and later, they examine why therapy works.

Factors Influencing the Effectiveness of Therapy

In sensory integration research, a significant amount of effort has been devoted to trying to identify which children will respond to SI procedures. Much attention has been directed toward examining factors related to qualities of the patient or client, for example the child's age (Ayres & Mailloux, 1983), the diagnosis (Ayres, 1976, 1978), the degree of responsiveness to certain kinds of sensory input (Ayres, 1978; Ayres & Tickle, 1980). For example, learning disabled children who show a shortened duration of postrotary nystagmus appear to improve to a greater degree from SI treatment than those children who do not show this type of dysfunction (Ayres, 1978). Table 2 presents some of the variables which may influence a child's response to therapy. These can be categorized as treatment variables, patient variables, and therapist variables.

Table 2: Variables Which May Influence Response to Therapy

<p><u>Treatment variables</u>: sequence of kinds of sensory input; therapist induced vs. child induced stimulation</p>
<p><u>Patient variables</u>: age, sex, diagnosis, severity</p>
<p><u>Therapist variables</u>: sex, personality, expectations</p>

Variables which influence the response to therapy can be examined in a number of ways :1) through observation of treatment, 2) through theory, and 3) through controlled testing. Let us take the example using the variable of the child's age. Through working with children of a variety of ages, we may clinically observe through treatment that children that make the most rapid gains in therapy are children who have not yet entered school, thus primarily children under 6. We may draw upon theories of brain plasticity which would indicate that the younger the child, the more plastic the brain, and since we feel we are influencing brain function, we may hypothesize that SI would be most effective with younger children. Finally, we may carry out controlled testing specifically to examine age effects, or, we may review the literature, in a meta-analysis, and examine the effect of age on outcome.

Outcome Measures: What Are They? What Should They Be?

In a review of the effectiveness studies, Ottenbacher (1982) categorized the outcome measures of the effects of sensory integration procedures into 3 groups: academic achieve-

ment, language, and motor performance. Ottenbacher found that SI had its greatest effect when the dependent measure was some type of motor or reflex evaluation and its least effect when the dependent variable was some type of language measure. On the other hand, Clarke and Pierce (1986) also reviewed the sensory integration literature according to type of outcome and concluded that "results of these studies suggest that sensory integrative procedures seem to produce language or language related gains in both learning disabled and mentally retarded children, that they may promote eye-hand coordination, and that their effects on nystagmus duration are unclear."

In compiling the bibliography, we analyzed the type of outcome measures used in the SI effectiveness studies. In addition to the categories of measures and behavior noted by Ottenbacher (1982), additional measures included duration of postrotary nystagmus and frequency of self injurious or stereotyped behavior.

Table 3 presents the percentage of studies that measured each type of outcome. The percentages add up to more than 100% since many studies measured more than one category of outcome.

Table 3: Percentage of SI Efficacy Studies Using Each Category of Outcome Variable

Outcome Measure	Percentage of Studies
Academic	20%
Language	45%
Motor	45%
Postrotary Nystagmus	20%
Self-stimulation	5%
Behavior	5%
Other	10%

In the area of outcome of treatment, two types of documentation were reported in SI effectiveness studies - approximately 50% used standardized instruments whereas 50% did not. Research studies with the learning disabled child tended to use standardized instruments whereas research with the mentally retarded and autistic tended to use nonstandardized instruments. No single instrument was used with high frequency. These findings illustrate a factor complicating the comparison of SI studies, namely the wide variety and type of dependent measures used and the difficulty of drawing inferences from results of nonstandardized tests.

Research in occupational therapy is greatly hampered by the lack of good measures of treatment effectiveness. Measurement of change in handicapped children is especially difficult because the effects of maturation must be taken into account. The unsatisfactory status of measurement as well as the lack of knowledge as to what to measure is illustrated by the fact that few measures are used in more than one study. Good and widely used measures are

much needed for the documentation of both short term and long term changes. The inconclusive nature of the results of many studies may be a function of the fact that measures are not sufficiently discrete for the detection of small changes in behavior. Considerable attention must be given to the development of clinical evaluation measures that can be reliably used to demonstrate change with therapy.

We would like to propose consideration of the expansion of assessment areas in order to permit the documentation of progress in domains not measured by traditional tests and measures. Applicable domains in which change in response to SI therapy may be demonstrated include organization, learning rate, attention, affect, exploratory behavior, biologic rhythm (sleep-wake cycle), sensory responsivity, play skills, self-esteem, peer interaction, and family adjustment.

Models of Sensory Integration Efficacy

Much of our intervention research has examined change over time using a pre-test post-test model. That is, the child has been involved in a program of sensory integration for six or nine months and the change over time has been measured. Yet, how often, after a child has left the occupational therapy clinic and returned to class, has the teacher said "Johnny seems so much better organized now. He seems so much better able to focus and attend to his work." Comments like these make one think that there is an immediate, or perhaps a very short term effect of sensory integration procedures.

Only a few studies of sensory integration have examined the immediate effects, looking what sensory integration does in the here and now, during the moment of treatment delivery. For example, Reilly, Nelson and Bundy (1983) examined the quality and quantity of spontaneous vocalizations during treatment. Clinical observation has indicated that treatment affects factors such as the child's attention and organization. These parameters could perhaps be studied by having the child perform continuous performance tasks or paired associate learning before and after an individual therapy session.

Criticisms of Sensory Integration Efficacy

Recently, there has been a rising debate of the value of sensory integration. Sensory integration has come under attack from a number of sources including physicians, psychologists, and educators. These professionals point out that sensory integration procedures have not been conclusively demonstrated to be effective, and some have recommended that sensory integration procedures be applied only in a research context. Criticisms of sensory integration can be analyzed from both a philosophical and a research design perspective. Each area will be addressed.

Philosophical Orientation: Skills vs. Foundation. In order to better understand why SI

has been critiqued so heavily, it is helpful to examine the philosophical orientation of SI and how this relates to current popular views of intervention. Within pediatric occupational therapy, we can identify two different philosophical orientations. One is the focus on underlying ability, and is identified in approaches such as neurodevelopmental therapy and sensory integration procedures that focus on influencing the processing and organization of the nervous system. The second approach is skill development, including both the teaching of specific skills and the design of, and training in the use of equipment and adaptations to the environment.

These two orientations can also be found in education, medicine and psychology. However, currently in the United States the philosophical thrust in these other professions has swung far toward the skill development approach and toward rejection of neurophysiologic approaches. For example, behavior modification to reinforce specific desired behaviors is a frequently used approach in both psychology and education. Kinsbourne highlights the skills development viewpoint in discussing treatment for the child with learning disabilities. When discussing the merits of therapy, "If the skill itself is of some use in everyday life or could serve as a morale booster, and if the program succeeds in inculcating the skill, then the exercise does have merit. But it has to be kept clearly in mind that the benefit achieved will not generalize beyond the specific skill acquired." (Kinsbourne & Caplan, 1979, p. 200).

The theoretical orientation of most physicians is maturational. The assumption is that maturational changes in development, especially in motor development, will occur as part of the natural history of the disease. This common theoretical orientation was strongly stated by Taft in 1972. In an editorial in *Developmental Medicine and Child Neurology*, Taft wrote, "There is no hard evidence to indicate that treatment programs which attempt to modify or inhibit abnormal movement patterns are ever successfully incorporated into the maturing nervous system with resulting improvement in motor function." (Taft, 1972). In respect to the mild motor dysfunction as found in developmental delay and dyspraxia, physicians are citing reports that high risk infants with abnormal motor patterns show a spontaneous recovery (e.g., Denhoff, 1981). Recently, the Committee on Children with Disabilities (1985) concluded that "The motor disabilities of the dyspraxic child will generally improve over time without a specific treatment program."

Similarly, Kinsbourne stated that "irrational methods" of remediation "share the goal of helping.. children's brains to develop by training them in activities that have no self evident relationship to reading, writing, or arithmetic but which are alleged to be prerequisites for readiness to acquire those skills" (Kinsbourne & Caplan, 1979, p. 196). He further states that "If the irrational methodology in question is continued for long enough, then spontaneous cerebral maturation might occur coincidentally, and the child might acquire additional mental skills regardless of - or even in spite of - the training procedures." (Kinsbourne & Caplan, 1979, p. 200).

Research Design Issues. The second reason why SI has been so heavily criticized relates to criticism of the SI effectiveness research. The concern about the quality of research design in intervention studies of handicapped children including but not limited to research in sensory integration has lead reviewers to conduct descriptive reviews of design elements of

the studies. These reviews critique characteristics of research designs such as use of control groups, random assignment to groups, multiple baselines, use of reliable and standardized assessment tools. Table 4 presents a list of some of the criticisms of SI efficacy research.

Table 4: Flaws in SI Efficacy Research

Subject Characteristics

- Lack of clear definition of subject population
- Lack of stringent sampling
- Lack of operational definition of sensory integration dysfunction and LD

Design

- Maturation not controlled
- Lack of control/contrast group
- Non-equivalence of groups at pretest
- Lack of control for tester bias
- Treatment procedures not specified and/or not specifically SI

Instrumentation

- Relevant info re: reliability/validity of instruments not reported or inadequate
- Lack of good measures of treatment effectiveness

Data Analysis

- Inappropriate analysis

Many of those who criticize the design of intervention studies conclude that we can know nothing about the effectiveness of intervention until good quality studies are conducted. For example, in discussing research on the efficacy of early intervention for biologically impaired children, Duntz and Rheingrover (1981) analyzed 49 studies and reported that the majority of the studies have severe flaws in design that make the interpretation of the results “fundamentally uninterpretable.”

Schaffer (1984) leveled a similar criticism at research in sensory integration efficacy. After critiquing the SI efficacy literature for threats to internal and external validity, she states “one is forced to conclude that SI therapy remains a promising but virtually unresearched tool.”

Arendt, MacLean & Baumeister (1988) take an even more extreme position. On the basis of their review of SI theory and effectiveness articles with the mentally retarded, they ask “Considering its flawed methods, what conclusions can be drawn from research on this therapy? (p.408) They answer this question by stating that “It is our position that until the therapeutic effectiveness of sensory integration therapy with the mentally retarded is demonstrated, there exists no convincing empirical or theoretical support for the continued use of this therapy with that population outside of a research context.” (p. 409)

A Critique of the Critiques - Perspective on SI Efficacy

Although the SI efficacy research studies have been criticized for methodological flaws, according to Ottenbacher (1988), the “process of discrediting the collective findings of multiple studies based on design and analysis factors is almost always judgmental and done post hoc.” This is illustrated in the article by Arendt, MacLean, and Baumeister (1988). They dismissed the collective positive results of sensory integration research studies on the basis of inadequate methodology. Because the empirical findings were dismissed, the authors then questioned the validity of the theory and concluded “there exists no convincing empirical or theoretical support for the continued use of sensory integration therapy with that population

Ottenbacher states that there are a number of problems with the ad hoc impeachment of studies based on predetermined design and statistical considerations. One difficulty is deciding what constitutes a good design. Glass (1976) has observed that a common practice in critically evaluating several studies “is to carp on the design and analysis deficiencies of all but a few studies -- those remaining frequently being one’s own work or that of one’s students and friends--and then advance the one or two acceptable studies as the truth of the matter” (Ottenbacher, 1988). Ottenbacher emphasizes that in evaluating the sensory integration effectiveness studies, it is important to remember that all applied research exists on a continuum of control of the design considerations. Ottenbacher (1988) pointed out the “although each of the studies reviewed by Arendt et al. (1988) had some design or analysis weakness, the bottom line is that seven of the eight studies revealed positive results.” (p.42ti) He suggested that given the overall positive findings, the obvious conclusion would be to call for an aggressive empirical effort to establish the credibility of these initial findings.” (p. 426)

In a commentary to the article by Arendt et al., Burns, (1988) a physiotherapist from Australia stated “Rather than suggest, as Arendt, MacLean and Baumeister have done, that clinicians should refrain from using an apparently successful program, those with research abilities should work with clinicians in undertaking approximately designed studies to evaluate the influence of many variables that need to be considered.” She further states “In an attempt to demonstrate the validity of therapeutic interventions,” it would be counter productive to” throw the baby out with the bathwater.” (p. 412)

In considering the critiques of sensory integration, it is critical to keep our perspective. We must keep the status of sensory integration efficacy research in perspective with the status of all efficacy research with children. There is very little in medicine, education, or therapy for children with chronic disorders for which there is scientific evidence for efficacy (Henderson, 1981). All professionals concerned in intervention are in the same situation. In a comment on neurodevelopmental therapy Pearson (1982) pointed out that “The state of the art in much of developmental behavioral medicine, education, and early developmental education programs is no better.”

Pearson (1982) suggests that all concerned professionals have failed to confront a very real dilemma. As professionals we must believe in the therapeutic merit of what we do

and we must support the demand for services. Simultaneously, we are faced with a responsibility to acknowledge the lack of scientific evidence that these services make a significant difference in outcomes. As therapists, we must sustain our belief in the efficacy of what we do. At the same time we must be open to the possibility that some of these beliefs will be altered. Finally, we must value research as an integral part of our clinical practice and accept the responsibility for furthering research development.

Through many replications of studies by various investigators, the use of carefully planned control conditions, and the evaluation of variables that influence a client's response to therapy, a picture will emerge regarding the effectiveness of sensory integration: whether or not sensory integration treatment is more effective than no treatment, than other types of less costly treatments (including special education classes), than individualized attention, or than fun and novel situations (Tickle, 1988). Only an accumulation of research can determine whether the treatment is effective or ineffective.

Ayres (1978), Henderson (1981), Ottenbacher (1982), Ayres and Tickle (1981), and Clark and Pierce (1986) have all emphasized that some children respond to sensory integration therapy while others do not. Thus it is important to explore and define the dimensions of learning disabilities and other diagnostic groups in order that better categorization of children can increase the precision of therapy.

The knowledge that there is some support for what we do is encouraging and we should share this knowledge with colleagues in other professions, recognizing that the research to date is just a beginning and that the findings are not sufficiently specific to diagnosis and degree of handicap. We need to recognize that much of the current research on intervention research is not sufficiently stringent, and that we do not have sufficient data to specifically support much of what we do. The lack of research support for the effectiveness of therapy does not mean that sensory integration procedures are not clinically valid. However, efficacy research must be done and must be done well.

Conclusions

1. Researchers have come to premature conclusions about sensory integration theory and sensory integration procedures.
2. The development of meta-analysis as a statistical tool can be a great stimulus to efficacy research. A major limitation to intervention research is obtaining adequate sample size. With meta-analysis, well designed small studies become additive. The results of the initial meta-analysis on SI effectiveness (Ottenbacher, 1982) are encouraging.
3. We need studies of the relative efficacy of sensory integration procedures for children with differing diagnoses, differing degrees of disabilities, and different ages.
4. We need to develop models to examine of sensory integration treatment effectiveness. This

needs to include an examination of the immediate effect of sensory integration procedures as well as a model of examining change over time.

5. We must be clinical accountable. Part of that clinical accountability should be for functionally significant changes. We must be sure that the outcome measures include areas of behavior of significance to occupational therapy.

References

Sensory Integration Treatment Effectiveness

Compiled by Sharon Cermak EdD, OTR (1990)

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II. Research Studies

LEARNING DISABILITIES

Ayres, A.J. (1972) . Improving academic scores through sensory integration. *Journal of Learning Disabilities*, 24-28.

Subjects: 148 LD Ss from which the following groups were formed: 30 Experimental and 30 Control Ss with generalized exclusively auditory language problems. (Average age of groups — 8 years)

Design/Treatment:: Experimental design. Experimental group received SI for 25-40 minutes per day, 5 days a week for 5-6 months.

Outcome Measures: Academic: Wide Range Achievement Tests Slosson Oral Reading Test; Language: Illinois Test of Psycholinguistic Abilities; Other: SCSIT

Results: Both Experimental groups show improvement in academic and language variables. Some measures show trend, some reach significance.

Comments: Possibility of Hawthorne effect-control group received only additional classroom time, rather than new alternative form of therapy.

Ayres, A.J. (1977). Effect of sensory integrative therapy on the coordination of children with choreoathetoid movements. *American Journal of Occupational Therapy*, 31, 291-293.

Subjects: Sample of 54 LD Ss with a mild choreoathetosis (from Ayres 1978 study). Ss divided into 2 groups - 31 Ss in Experimental group, 23 Ss in Control group. Mean age 8 years.

Design/Treatment:: Children in Experimental group seen individually or in pairs for SI therapy 1/2 hour per day, 5 times a week for 6 months. Control Ss stay in classroom.

Outcome Measures: Eye—hand coordination (MAC) Results: Therapy group shows greater improvement than classroom control ($p < .06$)

Ayres, A.J. (1978). Learning disabilities and the vestibular system. *Journal of Learning Disabilities*, 11, 30 -41.

Subjects: 128 LD Ss ages 6-10 from which 2 groups were drawn: 46 Experimental, 46 Control (Mean age — 8 years)

Design/Treatment:: Experimental group received SI for 1/2 hour per day, 5 days a week for 5 months. Control Ss stay in classroom.

Outcome Measures: Academic: Wide Range Achievement Tests, Slosson Oral Reading Test; Auditory Language: Flowers Costello Test of Central Auditory Abilities; Other: MAC and DC of SCSIT, SCPNT

Results: Hyporeactivity to rotation (PRN duration) predictive of academic success (WRAT scores)

Comments: Assignment to Experimental and Control groups by classroom - not randomly matched pairs (attempt to control this by alternating schools for Experimental and Control group in 2nd year) ; Experimental group with hypo-responsive nystagmus was more intelligent than Experimental group without hypo-responsive PRN which might have accounted for some of the

Carte, E., Morrison, D., Sublett, J., Tiemura, A., Setrakian, W. (1984) . Sensory integration therapy: A trial of a specific neurodevelopmental therapy for the remediation of learning disabilities. *Journal of Developmental Behavioral Pediatrics*, 5, 139-194.

Subjects: 18 LD: 14 NC (no LD) ages 5 to 10 matched by age and sex

Subjects: 87 LD Ss ages 6-11

years, mean age 8 1/2, divided into Experimental and Control groups using a matched pair design (Subsample of children with hyporesponsive PRN were identified)

Design/Treatment:: Experimental group received three 45 minute SI sessions per week for 9 months. Control Ss remain in classroom.

Outcome Measures: Academic: Wide Range Achievement Tests, Gates MacGinitie Reading Comprehension; Other: Target Test —visual tracking, attention, immediate memory; Underlining Test - rapid visual perceptual analysis; Postrotary nystagmus

Results: The only statistical difference was a between group difference in PRN duration at post-test, with therapy group showing more normal duration. There was no difference between Experimental and Control groups on academic or perceptual measures.

Comments: Authors attempted to replicate Ayres (1978) study however used different criteria for subject selection.

Danner, P. (1983) . Effectiveness of sensory integrative procedures on four Finnish preschoolers with minimal brain dysfunction. Unpublished Master's thesis, University of Southern California, Los Angeles.

Subjects: 4 children with MBD (ages 3-6) and 4 normal Controls (age and sex matched)

Design/Treatment:: Modified multiple baseline A-B. MBD children received SI for two SD minute sessions per week for 8 months. Control Ss receive no intervention.

Outcome Measures: Language: Peabody Picture Vocabulary Test; Perceptual/Motor: Beery Buktenica Test of Visual-Motor Integration; SV and MAC of SCSIT, Bruininks Oseretsky Test of Motor Proficiency; Behavior: Burks Behavior Rating Scale.

Results: Visual inspection of data indicates all 4 MBD Ss show treatment effects in language, perceptual and behavioral areas. Gains in eye—hand coordination and visual motor integration were less consistent.

Comments: Matched Ss are “normal”, not dysfunctional children. Score changes for dysfunctional Ss may be “regression to the mean”

Mawar, M. (1972). The effects of sensorimotor therapy dichotic listening in children with learning disabilities.. *American Journal of Occupational Therapy* 27, 226 -231.

Design/Treatment:: Pre-test, treatment, Post-test. LD Ss receive 1 hour weekly SI sessions. Range of 10 to 40 sessions per child.

Outcome Measures: Dichotic listening.

Results: LD initially showed smaller R ear effect (lack of L hemisphere specialization for language) than control. After 1 year of therapy, R ear performance of LD comparable to control.

Comments: No LD Control. Maturation may explain effects.

McKibbin, E.H. (1973). The effect of additional tactile stimulation in a perceptual—motor treatment program for school children. *American Journal of Occupational Therapy*, 27, 191-197.

Subjects: 27 Kindergarten and elementary children identified by teachers as having difficulties in coordination (and LD).

Design/Treatment:: Both experimental and control groups receive SI. Experimental group gets extra tactile stimulation. Control group gets eye-hand coordination activities. Three one hour sessions weekly for 16 weeks. Outcome Measures: Tactile and perceptual—motor tests from SCSIT.

Results: Both groups make gains on motor accuracy, tactile localization, and finger identification. Gains maintained 2-3 months later.

Comments: Sufficient violations to SI so as not to justify classification as SI even though it is categorized as such by the journal.

Ottenbacher, K. (1982). Patterns of postrotary nystagmus in three learning disabled children. *American Journal of Occupational Therapy*, 36 657-663.

Subjects: 3 LD Ss, 2 with shortened PRN duration, 1 with normal PRN duration.

Design/Treatment:: Single case design. Ss receive three 50 minute sessions employing vestibular stimulation activities weekly for 20 weeks.

Outcome Measures: PRN duration.

Results: Changes in PRN duration occurred for 2 of 3 Ss.

Ottenbacher, K., Short, M.A., & Watson, P.J. (1979). Nystagmus duration changes of learning disabled children during sensory integrative therapy, *Perceptual Motor Skills*, 48 1159-1164.

Subjects: 43 LD subjects, 4 to 10 years, categorized into 3 groups according to pretest duration of PRN (shortened, normal, prolonged); relatively short duration, others for relatively longer duration.

Outcome Measures: PRN duration

Results: Children with initial shortened duration of PRN show increase in duration while other subjects show decreases. Changes more apparent following relatively long than relatively short duration of therapy.

Comments: Authors discuss major threats to validity such as maturation's, regression to the mean, etc.

White, M. (1979). A first-grade intervention program for children at risk for reading failure. *Journal of Learning Disabilities*, 12, 26-32.

Subjects: 21 at risk for reading failure (based on Satz' test battery) children, ages 5-6, in

normal first grade classes. Randomly divided into Experimental (n = 11) and Control group (n=10)

Design/Treatment: Pretest, treatment, post-test. Children in Experimental group received two 30 minutes per week individual therapy for 6 months. Control group stayed in regular class.

Outcome Measures: Reading test. Teachers ratings of reading competence.

Results: At end of first grade, Experimental group achieved significantly higher reading level than Control. One and two years later, with no further intervention, reading scores of Experimental group were still significantly higher than Control group.

Comments: Groups not compared on reading scores prior to start of therapy, thus may have been different.

DEVELOPMENTAL DELAY

Brody, J.F., Thomas, J.A., Brody, D.M., & Kucherawy, D.A. (1977). Comparison of sensory integration and operant methods for production of vocalization in profoundly retarded adults. *Perceptual and Motor Skills* 44 1283—1296.

Clark, F.A., Miller, L.R., Thomas, J.A., Kucherawy, D.A., & Azen, S.P. (1978) . A comparison of operant and sensory integrative methods on developmental parameters in profoundly retarded adults. *American Journal of Occupational Therapy*, 32, 86—92.

Subjects: 27 profoundly mentally retarded institutionalized adults, age range 23—62 years.

Design/Treatment: Pre—test, post-test design. Three treatment groups, SI, Operant and Combined 9 Ss per group, randomly assigned. 4 sessions per week for 6 months.

Outcome Measures: Eye contact frequency; Rate of vocalizations; Bayley Scales-Mental; Verbal Language; Developmental Scale Vocal and Motor Imitation; Quality of postural adaptation.

Results: Significant gains in frequency of eye contact,(between-group different not significant)

Comments: Possibility of Hawthorne effect. SI procedures modified to be applicable for this group. (Note: Both Brody et al. (1977) and Clark et al. (1978) report results of the same study although the data is analyzed differently).

Huff, D.M., & Harris, S.C. (1987). Using sensorimotor integrative treatments with mentally retarded adults. *The American Journal of Occupational Therapy*, 41, 227—231.

Subjects: 34 mentally retarded institutionalized adults. 25 Ss in sensorimotor integrative group, 9 Ss in Control group.

Design/Treatment:: Experimental group received sensori-motor integrative group treatment in a group for five 45 minute sessions per week for 12 months.

Outcome Measures: Sensorimotor development: The Sensorimotor Performance Analysis.

Results: No significant between group differences.

Comments: Modified SI: Group treatment, specified sequence

Jenkins, J.R., Fewell, R., & Harris, S.R. (1983). Comparison of sensory integrative therapy and motor programming. *American Journal of Mental Deficiency*, 88, 221-224.

Subjects: 44 preschool children with mild to moderate delays.

Design/Treatment:: Two treatment groups (random assignment): sensorimotor integrative (individual treatment) 2 times per week and Motor developmental program (small group treatment) 4 times per week. All sessions 25 minutes. Duration of treatment is 17 weeks.

Outcome Measures: Peabody Developmental Motor Scales - Gross Motor; DeGangi Assessment of Sensorimotor Integration in Preschool Children (Modified).

Results: Gains for both groups on both measures. No significant between group difference.

Magrun, M., Ottenbacher, K., McCue, S., & Keefe, R. (1981). Effects of vestibular stimulation on spontaneous use of verbal language in developmentally delayed children. *American Journal of Occupational Therapy*, 2, 101-104.

Subjects: 5 mentally retarded preschoolers with severe language delay (age 3—6), 5 trainable mentally retarded (ages 6-10)

Design/Treatment:: Single subject ABAB design. Each treatment (Phase B) consisted of 10 minutes per day for 5 days of vestibular stimulation activities (3 activities from which subject chose).

Outcome Measures: Verbal responses recorded each day during a 5 minute free play situation (following treatment).

Results: Eight of 10 participants showed an increase in frequency of verbal response from baseline 1 to treatment 1. Nine of ten participants showed increase from baseline 2 to treatment 2. Decrease in verbal responses seen in treatment withdrawal phase.

Montgomery, P., & Richter, E. (1977). Effect of sensory integrative therapy on the neuromotor development of retarded children. *Physical Therapy*, 799-806.

Subjects: 75 mentally retarded preschool children divided into 3 groups.

Design/Treatment: Effectiveness of sensory-motor integrative program compared to a developmental physical education program and a recreational program with ADL and arts and crafts -9 months therapy.

Outcome Measures: Test batteries for gross motor (60 items) fine motor (35 items), reflex integration (17 items).

Results: Sensory-motor program is more effective than physical education for motor gross motor and reflex integration. No difference in fine motor.

Comments: Not pure SI - used in conjunction with other forms of sensory motor procedures.

Sandler, A., & Coren, A. (1980). Relative effectiveness of sensory integrative therapy and overcorrection in the treatment of stereotyped behavior: An exploratory study. *Training Quarterly on Developmental Disabilities*, 17-24.

Subjects: 1 child

Design/Treatment: Single-case experimental design. Sensory integration therapy in first condition then overcorrection.

Outcome Measures: Frequency and duration of specific stereotyped behaviors during 10 minute period following treatment sessions.

Results: Frequency and duration of specific stereotyped behaviors decreased slightly but duration increased during both treatment phases.

Comments: Unable to locate this article thus information is from Arendt et al. (1988).

Wells, M.E., & Smith, D.W. (1983). Reduction of self-injurious behavior of mentally retarded persons using sensory integrative techniques. *American Journal of Mental Deficiency*, p2, 664—666.

Subjects: 4 profoundly retarded multiply handicapped institutionalized adults.

Design/Treatment: Single case experimental AB design. 4 weeks baseline observation treatment. Five 30 minute SI sessions per week.

Outcome Measures: Frequency of self-injurious behavior (head slapping, hitting and biting hands, etc.).

Results: Frequency of self injurious behavior, as documented by direct—care staff members throughout the day, decreased significantly for all subjects.

Comments: SI adapted for use with profoundly involved clients. Staff members collecting data were aware of the nature of the program; reliability in observations not obtained.

AUTISM AND CHILDHOOD SCHIZOPHRENIA

Ayres, A.J., Tickle, L.S. (1980). Hyper-responsivity to touch and vestibular stimuli as a predictor of positive response to sensory integration procedures by autistic children. *American Journal of Occupational Therapy*, 34, 375-381.

Subjects: 10 autistic children, ages 3 1/2 to 13 years evaluated as to their responsiveness to sensory stimuli in a number of modalities.

Design/Treatment: Attempt to identify predictors of response to therapy. All subjects received SI individually 2 times per week for 1 year.

Outcome Measures: Therapeutic progress was judged qualitatively and quantitatively for each child. Five areas judged: language, environmental awareness, engagement in purposeful activity, self-stimulation, social-emotional. Subjects ranked for response to therapy, six best and 4 poorest respondees identified.

Results: Discriminant analysis indicated that good responders to therapy registered sensory input but failed to modulate it. Children who failed to respond to sensory input were poorer respondees to therapy.

Ayres, A.J., & Mailloux, Z.K. (1983). Possible pubertal effect on therapeutic gains in an autistic girl. *American Journal of Occupational Therapy*, 37, 535-540.

Subject: A deaf, partially sighted, severely retarded autistic girl, age 11 1/2 years.

Design/Treatment: Combines descriptive case study with single subject design. Child receives 2 years of sensory integration, two 50-minute sessions per week.

Outcome Measures: Reduction of self stimulation. Recorded through videotaped time samples.

Results: Consistent reduction in amount of stereotypes noted from time of starting therapy to interruption for vacation and surgery for scoliosis. On returning to therapy after a 9 week break, self stimulation was markedly increased and did not return to pre-surgery level even with additional therapy. An increase in self stimulation; as linked to onset of menarche.

Comments: Limited baseline data.

Reilly, C., Nelson, D., & Bundy, A. (1983). Sensorimotor versus fine motor activities in eliciting vocalizations in autistic children. *Occupational Therapy Journal of Research*, 3 199 -212.

Subjects: 18 autistic children, age range 6 to 11 years.

Design/Treatment: Each child served as own control, receiving both therapies, Sensory integration and fine motor. Each subject received four 30-minute sessions, two of each type of therapy.

Outcome Measures: 7 aspects of quantity and quality of spontaneous vocalizations (The sample of Vocal Behavior, a Planning)

Results: There were no between-treatment differences in 4 of the 7 vocalization variables. There were significant differences of 3 of the 7 vocalization variables in favor of the fine motor sessions.

Comments: SI modified: predetermined fixed order of activity.

Slavik, B.A., Kitsuwa-Lowe, J., Danner, P.T., Green, J. & Ayres, A.J. (1984) Vestibular stimulation and eye contact in autistic boys. *Neuropediatrics*, 15, 33 -36.

Wolkowicz, R., Fish, J., & Schaffer R. (1977) Sensory integration with autistic children. *Canadian Journal of Occupational Therapy*, 44 171-175.

BEHAVIORAL DISORDERS

Madsen, P.S. & Conte, J.R. (1980). Single subject research in occupational therapy: A case illustration. *American Journal of Occupational Therapy*, 35 101-104.

Subjects: 3 male behaviorally disordered children, ages 11-13 enrolled in a therapeutic and educational day program. Ss selected as appropriate SI candidates based on low PRN and poor prone extension. Treatment: Multiple baseline-across-subjects design. Ss attended three individual 30 minute SI sessions per week. Length of baseline and treatment varied from S to S as staggered entry into the SI program took place. Treatment ranged from 10 -18 sessions per subject. During baseline and at the end of each treatment session Ss did 10 minutes of math problems; time attending to task was recorded.

Outcome Measure: Time attending to an academic task of independently completing a set of math problems.

Results: Baseline very unstable for all Ss thus difficult to interpret results.

Comments: This study illustrates importance of baseline in single subject design research.

DYSPHASIC

Ayres, A.J., Mailloux, Z. (1981). Influence of sensory integration procedures on language development. *American Journal of Occupational Therapy*, 35 383-390.

Subjects: 4 Aphasic preschool children, age 4 and 5

Design/Treatment: Single case experimental design A-B. Ss receive SI for a year.

Outcome Measures: Receptive Language: (Test of Auditory Comprehension of Language by Carrow); Expressive Language: (Carrow Elicited Language Inventory); Informal language assessments; Weiss Articulation Test (used with 1 subject).

Results: Consistent increase in rate of growth in language comprehension. Two

children with hyporesponsive PRN made gains in expressive language.

Comments: Operational definition for diagnosis of aphasia not given. Effect of SI not isolated since other types of therapy started during this time. Maturation not controlled. For two Ss different measures of language comprehension used from pre to post-test.

DePauw, P. (1978) . Enhancing the sensory integration of aphasic students. *Journal of Learning Disabilities*, 11, 142 -146.

Subjects: 23 preschool aphasic children from 3 classrooms. Experimental Group, n =11; Physical education group, (Control 1), n = 6, No extra intervention, (Control 2), n = 5.

Design/Treatment: Children diagnosed as having SI dysfunction received 7 months daily 20 minutes SI therapy compared to control group receiving remedial physical education and control group with no extra programming.

Outcome Measures: SCSIT.

Results: Trend towards improved sensory integration after a sensorimotor program.

Comments: Interpretation limited by small sample size and lack of data on age and IQ. Each classroom served as a different group.

Additional References

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Dunst, C.J., & Rheingrover, A.M. (1981). An analysis of the efficacy of infant intervention programs with handicapped children. Evaluation and Program Planning, 4, 287-323.

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