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ABSTRACT

The study examined the effects of sensory integration therapy (SIT) on the language development of 15 developmentally delayed preschoolers and the effects of SIT in combination with language therapy. Results of pre- and post-tests using the Sequenced Inventory of Communication Development, and Peabody Picture Vocabulary Test-Revised, and the Mean Length of Utterance; and samples of communicative interactions during free play were analyzed. SIT emphasized tactile discrimination, goal-directed vestibular activities, and reflex integration. Language therapy (LT) stressed expressive and receptive language learning activities equally. Analysis revealed that SIT and its interaction with LT were both generally implicated in language gains made by Ss, and in some cases were statistically significant at moderate levels. (CL)

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REPORT OF RESULTS

Language Therapy and Sensory Integration Therapy In Maximizing Language Gains in Developmentally Delayed Preschool Children

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BACKGROUND AND METHOD

Many investigators of learning in children have stressed the importance of a sensorimotor foundation to development. Piaget (1952) described a period of sensorimotor development from birth to 18 months where children's sensory experiences from and motor interactions with their world form the cognitive substructures that will become the foundation for later perceptual and intellectual development. Kephart (1971) considered a child's ability to weld together data from various senses as crucial to learning. This process he called "intersensory integration". Ayres (1972a) further developed the idea of the relationship between sensory experiences and motor responses as a foundation for learning skills. She defined the process by which sensory information is interpreted and organized in the brain for functional use as "sensory integration". Ayres' sensory integration theory is based on the belief that brain structures are functionally interdependent. Therefore, adequate integration of sensory input (i.e., tactile, vestibular, auditory, proprioceptive, gustatory, visual and olfactory) which is accomplished at the brain stem level, supports and enables the cortical, specialized brain function which we associate with learning to read, speak, write, and so forth. That is, higher cortical organization is influenced by the sensory organization at lower levels of the central nervous system.

The ability to process sensory information may be fundamental to a person's ability to interact effectively and efficiently with his or her environment. Due to central nervous system damage or lack of sensory stimulation, a child may be neurologically unprepared for more advanced sensorimotor and perceptual development (Norton, 1975), thereby affecting intellectual development as described by Piaget. Studies have shown, for example, that handling and sensory stimulation can alter the maturational rate of the brain in rats and human infants (Levine, 1960; Piper, 1963), and a number of researchers (Bates, Camaioni, and Volterra, 1975; Dunst, 1979; Edmonds, 1976; Kahn, 1975; Rodgon, 1976; Zachry, 1979) have found that sensorimotor performance at Piagetian sensorimotor Stage V is generally attained before a child displays emerging oral language skills. Indeed, language, symbolic play, and all aspects of cognition might be viewed as end products of a child's improving ability to process and act on sensory stimuli.

Deficits in sensory integration or the "ability to organize sensory information for use" have been linked to learning delays and disabilities, and to a number of social/behavioral problems (Ottenbacher, Watson, Short, Biderman, 1979; Petri and Anderson, 1980; Ottenbacher, Watson, Short, 1979; Ayres and Tickle, 1980). DeQuiros and Schrager (1979), writing from a primarily medical viewpoint, identified disturbances in vestibular-proprioceptive integration and postural control as the basis of learning and perceptual dysfunction. There has also been consistent documentation over the years supporting a relationship between sensorimotor disorders and speech and language deficits. Bilto (1971) found that children with no speech problems showed better large muscle coordination than children with speech problems. Snyder (1971) suggested that auditory perception is dependent at least in part on intact tactile and kinesthetic systems. DeQuiros (1976) has linked vestibular hyporeflexia to language and learning disorders. Stillwell, Browe, and McCallum (1978) found a statisitically significant frequency of shortened duration postrotary nystagmus (indicative of vestibular system dysfunction) among children with communication disorders. They proposed that the "development of the language center is in some way dependent on previous, as well as on-going, subcortical sensory integration". In dysphasic children, Rider (1974) found a significant number of abnormal postural reflexes. Wetherby (1984) hypothesized that autism, which is characterized by disturbances in language development and use, may be caused by lower brain dysfunction which disrupts the formation of higher cortical regions.

Therapy to remediate sensory integration or S.I. deficits can be conducted by a specially trained occupational or physical therapist, based on standardized test results on the Southern California Sensory Integration Tests or SCSIT (Ayres 1972b) and/or informal observations and other measures. Such sensory integration techniques have been found to promote gains in such "non-language" areas as academic and fine motor development (Montgomery and Richter, 1977); gross motor development (Montgomery and Richter 1977; Kantner et al, 1976); eye contact (Webb, 1969); purposeful activity, emotional and social responsiveness (Ayres and Tickle, 1980). Other studies have suggested that sensory integration therapy may also have a facilitory effect on language development. Ayres and Mailloux (1981) studied the rate of language growth in four preschool children, three boys diagnosed as "aphasic without other complications" and one girl who was also diagnosed aphasic but who was considered to be slow in all other areas as well. Three of the four children had received either speech and language therapy, special education specific to aphasia, or both, before beginning the study. Baseline data was gathered on both receptive and expressive language and sensory integrative functioning. All children showed sensory integration dysfunction. The results after a year of sensory integration therapy indicated that all the children showed an increase in language comprehension that was greater than previous increases, and two of the four children showed notable gains on expressive language measures. Magrun, Ottenbacher, McCue, and Keefe (1981) found vestibular stimulation to be an effective nonverbal intervention method for facilitating spontaneous language in a group of five primary-age trainable mentally retarded children with a wide range of language abilities, and a group of five developmentally delayed preschoolers who showed severe language delays. Results showed an increase in spontaneous language use for both groups immediately after the vestibular stimulation which was more pronounced in the younger and generally more severely language-handicapped children. In another study, Bailey (1978) found that an eight-week program of sensory integration therapy improved the quality of language in schizophrenic patients. Another language study was conducted by Kantner, Kantner, and Clark (1982) with 30 mentally retarded children aged 5 to 14 years who were enrolled in a speech therapy program and who received special education classes. The purpose of the study was to explore the value of vestibular stimulation as supplemental therapy in improving the language abilities of these children as measured by the Porch Index of Communicative Ability in Children (PICAC). It was hypothesized that a group of children receiving vestibular stimulation in addition to specific speech therapy (Group I) would show greater gains than the control conditions of specific speech therapy alone (Group II) or general speech therapy (Group III). Treatment was conducted over a 6-week period, with Group I receiving vestibular stimulation twice weekly. The results showed that Group I achieved higher mean percentage gains in all areas of the PICAC, especially verbal, except visual and gestural in which Group II showed highest gains. However, analysis of variance indicated these differences between groups were not statistically significant.

To pull together the data on the effects of sensory integration therapy, Ottenbacher (1982) undertook a review of the literature using quantitative methods. He located eight studies with a total of 47 statistical hypothesis tests that evaluated the effectiveness of sensory integration therapy. These studies met the criteria: 1) investigate the effect of sensory integration therapy, 2) include dependent measures of academic achievement, motor or reflex performance, or language, 3) include a comparison between two groups (one that received sensory integration therapy and one that did not), and 4) report quantitative results of the effect of sensory integration therapy. An analysis of these results by quantitative reviewing methods showed that 1) subjects receiving sensory integration therapy performed significantly better than those in control groups who did not;

2) sensory integration therapy had its greatest effect when the dependent measure was some type of motor or reflex evaluation, less of an effect when the dependent measure was academic achievement, and its least effect when the dependent variable was a measure of language function; and 3) sensory integration therapy was most effective for "at risk" or aphasic subjects (also the youngest subjects), less for learning disabled subjects, and the least for the mentally retarded subjects (also the oldest subjects). However, it should be noted that the effect of sensory integration therapy by diagnostic category was possibly confounded with the type of dependent measure, and that this third finding should be interpreted cautiously.

In the population of developmentally handicapped children, the incidence of speech and language disorders is high, and the literature suggests that sensory integration dysfunction is also frequent among such children. It has been argued that classical academic and behavior modification techniques have assumed a level of sensory integration and neural and motor development which are higher than that actually present in the developmentally delayed child (Montgomery and Richter, 1977; Kinnealey, 1973). For speech and language therapy, based on behavior modification techniques, this latter point is particularly crucial. Especially in the very young, sensory integration deficient child, the traditional speech and language therapy approach requiring a certain level of body awareness (particularly oral), eye contact, auditory processing, and so forth may be inadequate or even inappropriate. As suggested in the study by Kantner, Kantner, and Clark (1982), and less directly by the other studies cited, sensory integration therapy or modified sensory integration techniques might be combined effectively with speech and language therapy to maximize speech and language gains in the developmentally delayed child. And, as suggested by the Magrun et al (1981) study, this might be particularly so in the preschool child.

The purpose of this study was to determine whether sensory integration therapy alone could have a facilitory effect on language development and whether, combined with language therapy, sensory integration therapy could further enhance language development in the developmentally delayed, sensory integration deficient preschooler.

Method

Subjects: Fifteen children were chosen as subjects for this study, from a population of developmentally delayed preschool children. All children served as experimental subjects, with five of those children also serving as control subjects, before beginning experimental treatment. Therefore, in terms of the data, there were 20 subjects. The children ranged in age from 3 to 5 years.

To qualify for participation in this research, each child was to be developmentally delayed, show an expressive and receptive language delay of at least 25% on the Sequenced Inventory of Communication Development (SICD) (Hedrick, Prather and Tobin, 1975), have significant deficits in sensory integration relative to age-level peers, and not have a diagnosis of a primary physical handicap such as cerebral palsy. All children met these criteria with the exception of one child who was diagnosed as having mild cerebral palsy at the completion of the study. The data for this child is included nonetheless, as his physical impairment was mild and was one of a number of physical/neurological signs indicating what we were calling sensory integration impairment. All children were enrolled at the Wabash Center preschool for developmentally delayed children. The therapies and testing performed as a part of this study were conducted at Wabash Center in appropriate rooms and by qualified professionals. The professionals testing the children were different from those providing treatment to the children. The children were taken from their classrooms for experimental and control treatment in a way that would maintain approximate equivalence in areas and amounts of classroom and other stimulation. The subjects received no other language or sensory integration therapy during the study, but had received varying amounts of such therapy (ies) up to two weeks before the study began. Tests: As mentioned above, the SICD was used to establish whether a child was an appropriate candidate for the study in terms of language delay. An informal screening test for sensory integration dysfunction was used to establish whether a sensory integration problem was present (Smith, 1980). Because the children's young ages and developmental delays precluded their taking the standardized SCSIT which has norms only for children aged 4;0 and above, each child's sensory integration functioning was examined in six areas that have been identified in the literature as indicative of sensory integration dysfunction. These are: ocular pursuits, eye dominance, Schilder's arm extension test, flexion in supine position, prone extension posture, and postrotary nystagmus. The test administrator gathered baseline performance data on 40 normal children from two to five years of age on this instrument. Potential subjects falling below a cut-off score in sensory integration as compared to age-level peers were considered to show sensory integration problems. Comparison was made to age-level peers rather than mental-age matched children because it was felt that children without sensory integration problems should show age-level physical/neurological maturation whether or not other factors, such as cognitive delay, were present.

Changes from pre to post testing in language development were measured by use of three formal tests and two informal measures. Receptive and expressive language were measured by the Sequenced Inventory of Communication Development (SICD). Vocabulary comprehension was measured by the Peabody Picture Vocabulary Test - Revised (PPVT-R) (Dunn and Dunn, 1981). Mean Length of Utterance (Brown, 1973), or M.L.U. , was used to assess sentence length and complexity development. From 10 minutes of free-play with an adult, a sample of communicative interactions was recorded and examined for the number of instances of certain types of communicative intents based on categories developed by Dore (1978). Four categories were chosen as being most likely to show benefits from increased "organization" in the child and least likely to be influenced by the responses given to the child by the adult present. These were: Request for Information, Self-Report, Description, and Play. An informal measure of comprehension was developed from a scale for analyzing dialogues in preschoolers by Blank and Franklin (1980) which we have referred to as "Comprehension by Complexity". This assessed the quality of a child's responses to increasingly complex questions and commands. The subjects were also reexamined after experimental or control treatment with the sensory integration measure described previously. This was done primarily in a descriptive way, (e.g., Was a change in functioning seen? Did it show improvement or decrease in sensory integration abilities? In what area were changes seen?). Description was used because the scoring system for that test was most useful for indicating presence of dysfunction rather than describing change in functioning.

Conditions: The study had four conditions, to which the subjects were randomly assigned. After a child had participated in the control condition, he was again randomly assigned, to one of the three experimental conditions, in order to conserve subjects and provide therapy for those children. The three experimental conditions were sensory integration therapy, language therapy, and both sensory integration and language therapy. There were five subjects for each of the four conditions. Each subject received an average of two hours of treatment per week for 12 weeks, for a total of 24 treatment sessions. In the condition of both sensory integration and language therapy, one hour per week was a language therapy session, and one hour per week was a sensory integration therapy session. The language therapy consisted of roughly equal amounts of time spent on expressive and receptive language learning activities, in the areas of need for each individual child. The sensory integration therapy also targeted individual needs, but with emphasis on tactile discrimination, goal-directed vestibular activities, and reflex integration. The control subjects received individual attention from an adult equal to that received by the experimental subjects, without receiving specific sensory integration or language stimulation.

STATISTICAL ANALYSIS

Because this study involved the use of a small number of subjects, it was considered important to discover and highlight any trends in the data. Therefore, the traditional approach of setting significance levels such as .10 or .05 was not used. Rather, for the factors of interest in each test, the significance level was allowed to "float" so that the reader might see not only whether a traditionally chosen significance level such as those mentioned above was met, but also how near to such levels the data came in each instance. With our limited number of subjects, this appeared to be the most meaningful way to treat the data, and seemed to conserve much information.

The experimental design used for this study was a 2^2 factorial design with additional blocking factors. The two factors of interest, SENSORY INTEGRATION THERAPY (SIT) and LANGUAGE THERAPY (LT), and their interaction effect, (SIT) X (LT), were tested for significance according to standard ANOVA procedures. Each of these factors had two levels: not present, indicated by 0, and present, indicated by 1.

A third factor, REPLICATIONS (R), not of interest to the experimenter, was included in the statistical models used for analysis to account for any possible variation in the responses between the three separate groups of subjects used in the experiment. Each of these groups was represented by a specific level of the factor R. The variation between groups of subjects would be included in the general error term used to test for the significance of the factors of interest if R were not included in the model. Thus, inclusion of R reduces the general error estimate, which in turn results in more sensitive F-tests for the significance of SIT, LT, and (SIT) X (LT). The factor R is a blocking factor having no interaction effect with either SIT or LT.

The responses for each subject consisted of six different test scores recorded before and after the experimental treatments were administered. This situation allowed the analysis to be conducted using two different models. A schematic of the design is given below:

REPLICATIONS

1

		LT 0	LT 1
SIT	0	4 subjects	2
	1	2	2

2

		LT 0	LT 1
SIT	0	1	2
	1	2	2

3

		LT 0	LT 1
SIT	0	0	1
	1	1	1

One of the two models used for analysis was:

1) $Y_{ijkl} = \mu + \gamma_i + \alpha_j + \beta_k + \alpha\beta_{jk} + \delta X_{ijkl} + \varepsilon_{ijkl}$

$i = 1, \ldots, 3$

$j = 1, 2$

$k = 1, 2$

$l = 1, \ldots, 4$

where

μ = overall mean

γ_i = effect of i'th replicate

β_k = effect of k'th level of LT

α_j = effect of j'th level of SIT

δ = coefficient of concomitant variable

$\alpha\beta_{jk}$ = effect of interaction of j'th level of SIT with k'th level of LT.

X_{ijkl} = concomitant variable (pre-test scores)

ε_{ijkl} = error term

Y_{ijkl} = l'th response from ijk'th treatment combination

This design was unbalanced in that $l \neq 4$ for all ijk treatment combinations. This fact somewhat clouds the interpretation of the resulting ANOVA tests though general conclusions can still be reached as long as the unbalanced nature of the design is kept in mind. The response of interest for each of the six test scores recorded consisted of the post-test score. The pre-test score was considered the concomitant variable and its influence or effect was regressed out of the post-test responses Y_{ijkl} by the term δX_{ijkl}. Thus, for this analysis of covariance case, the residual post-test scores were used to conduct the ANOVA tests. These tests were performed on a computer using the SPSS package. The results for the ANOVA tests for each of the six test scores recorded are given in tables 1-6.

Recognizing that the significance tests given in these tables are approximate, a general trend seems to be indicated by the results of all six tables considered together. In particular, the SIT X LT interaction term does seem to be present in the model though its effect does not seem to be great in relative magnitude compared to the other factors, as indicated by the relatively low significance levels for SIT X LT. However, given the small sample sizes for the treatment combinations, these results take on greater importance.

The second model considered for analysis was:

$$2)\quad Y_{ijklm} = \mu + \gamma_i + \rho_j + \alpha_k + \beta_l + \alpha\beta_{kl} + \varepsilon_{ijklm} \qquad \begin{array}{l} i = 1, \ldots, 3 \\ j = 1, 2 \\ k = 1, 2 \\ l = 1, 2 \\ m = 1, \ldots, 4 \end{array}$$

where μ = overall mean

γ_i = effect of i'th replicate

ρ_j = effect of j'th block/score

α_k = effect of k'th level of SIT

β_l = effect of l'th level of LT

$\alpha\beta_{kl}$ = effect of interation of kth level of SIT with l'th level of LT

ε_{ijklm} = error term

Y_{ijklm} = m'th response from ijkl'th treatment combination

TABLE #1. Mean Length of Utterance (M.L.U.)

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	17.366	1	17.366	62.843	.001
PRE	17.366	1	17.366	62.843	.001
MAIN EFFECTS	.881	4	.220	.797	.556
SI	.019	1	.019	.063	.794
LANG	.001	1	.001	.003	.957
REP	.788	2	.394	1.426	.290
2 WAY INTERACTIONS	1.590	5	.318	1.150	.402
SI LANG	.678	1	.678	2.453	.152
SI REP	.207	2	.103	.374	.699
LANG REP	.256	2	.128	.464	.643
EXPLAINED	19.837	10	1.984	7.178	.003
RESIDUAL	2.487	9	.276		
TOTAL	22.324	19	1.175		

TABLE #2. Peabody Picture Vocabulary Test - Revised (PPVT-R)

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	348.981	1	348.981	2.396	.156
PRE	348.981	1	348.981	2.396	.156
MAIN EFFECTS	94.501	4	23.625	.162	.952
SI	62.900	1	62.900	.432	.528
LANG	27.839	1	27.839	.191	.672
REP	3.525	2	1.763	.012	.988
2-WAY INTERACTIONS	307.241	5	61.448	.422	.823
SI LANG	150.166	1	150.166	1.031	.336
SI REP	206.696	2	103.348	.709	.517
LANG REP	61.806	2	30.903	.212	.813
EXPLAINED	750.723	10	75.072	.515	.842
RESIDUAL	1311.027	9	145.670		
TOTAL	2061.750	19	108.513		

TABLE #3. Sequenced Inventory of Communication Development - Receptive (SICD-R)

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	135512.519		1135512.519	25.033	.001
PRE	135512.519		1135512.519	25.033	.001
MAIN EFFECTS	15020.939	4	3755.235	.694	.615
SI	133.542	1	133.542	.025	.879
LANG	851.088	1	851.088	.157	.701
REP	8327.015	2	4163.507	.769	.492
2-WAY INTERACTIONS	9857.356	5	1971.471	.364	.861
SI LANG	866.676	1	866.676	.160	.698
SI REP	9608.851	2	4804.425	.888	.445
LANG REP	697.902	2	348.951	.064	.938
EXPLAINED	160390.815	10	16039.081	2.963	.059
RESIDUAL	48719.985	9	5413.332		
TOTAL	209110.800	19	11005.832		

TABLE #4 Sequenced Inventory of Communication Development - Expressive (SICD-E)

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES		298960.660	1	298960.660	139.983	.001
PRE		298960.660	1	298960.660	139.983	.001
MAIN EFFECTS		5661.967	4	1415.492	.663	.633
SI		4449.217	1	4449.217	2.083	.183
LANG		1349.527	1	1349.527	.632	.447
REP		1398.199	2	699.099	.327	.729
2-WAY INTERACTIONS		14307.852	5	2861.570	1.340	.331
SI	LANG	7670.128	1	7670.128	3.591	.091
SI	REP	7946.286	2	3973.143	1.860	.211
LANG	REP	3726.554	2	1863.277	.872	.450
EXPLAINED		318930.478	10	31893.048	14.933	.001
RESIDUAL		19221.272	9	2135.697		
TOTAL		338151.750	19	17797.461		

TABLE #5 "Comprehension by Complexity"

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES		27958.578	1	27958.578	18.734	.002
PRE		27958.578	1	27958.578	18.734	.002
MAIN EFFECTS		2535.340	4	633.835	.425	.787
SI		1805.377	1	1805.377	1.210	.300
LANG		285.007	1	285.007	.191	.672
REP		249.125	2	124.563	.083	.921
2-WAY INTERACTIONS		8184.272	5	1636.854	1.097	.425
SI	LANG	3843.077	1	3843.077	2.575	.143
SI	REP	5869.499	2	2934.749	1.966	.196
LANG	REP	460.269	2	230.134	.154	.859
EXPLAINED		38678.190	10	3867.819	2.592	.084
RESIDUAL		13431.560	9	1492.396		
TOTAL		52109.750	19	2742.618		

TABLE #6 Communicative Intents

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES		1655.123	1	1655.123	6.889	.028
PRE		1655.123	1	1655.123	6.889	.028
MAIN EFFECTS		1134.522	4	283.630	1.180	.382
SI		32.790	1	32.790	.136	.720
LANG		236.188	1	236.188	.983	.347
REP		716.116	2	358.058	1.490	.276
2-WAY INTERACTIONS		560.755	5	112.151	.467	.792
SI	LANG	40.325	1	40.325	.168	.692
SI	REP	551.923	2	275.962	1.149	.360
LANG	REP	162.285	2	81.143	.338	.722
EXPLAINED		3350.400	10	335.040	1.394	.314
RESIDUAL		2162.400	9	240.267		
TOTAL		5512.800	19	290.147		

Here the pre-test and post-test scores are considered as responses from levels one and two respectively of a blocking variable. Again, the design remains unbalanced, thus making interpretation of results less clear. The inclusion of the pre and post test blocking factor is done for the purpose of further reducing the general error term. The results for the ANOVA tests for each of the six test scores recorded are given in Tables 7-12.

Again, keeping in mind the approximating nature of the significance tests in tables 7 through 12 one can still draw general conclusions based on the aggregate of the six test score results. This model focuses more on testing the significance of the main effects, SIT and LT, than the first model presented. Tables 7 through 12 indicate clearly that both SIT and LT have significant effects on the test scores, though the level of significance would be expected to improve with larger sample sizes. Some of the tables indicate that the interaction term (SIT) X (LT) is also significant. The general trend established in the tables for both methods taken together indicates that there is an effect on the test scores due to SIT, LT, and (SIT) X (LT).

TABLE #7 Mean Length of Utterance (M.L.U.)

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS		12.090	5	2.418	2.595	.051
SI		3.625	1	3.625	3.890	.060
LANG		6.021	1	6.021	6.461	.019
BLOCK		2.525	1	2.525	2.709	.112
REP		.442	2	.221	.237	.791
2-WAY INTERACTIONS		7.255	9	.806	.865	.567
SI	LANG	.088	1	.088	.094	.762
SI	BLOCK	.009	1	.009	.010	.921
SI	REP	2.236	2	1.118	1.199	.318
LANG	BLOCK	.001	1	.001	.001	.973
LANG	REP	4.594	2	2.297	2.465	.105
BLOCK	REP	.410	2	.205	.220	.804
EXPLAINED		19.345	14	1.382	1.483	.189
RESIDUAL		23.299	25	.932		
TOTAL		42.644	39	1.093		

TABLE #8 Peabody Picture Vocabulary Test - Revised (PPVT-R)

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS		354.386	5	70.877	.678	.644
SI		10.426	1	10.426	.100	.755
LANG		148.523	1	148.523	1.422	.244
BLOCK		.100	1	.100	.001	.976
REP		171.786	2	85.893	.822	.451
2-WAY INTERACTIONS		894.379	9	99.375	.951	.501
SI	LANG	159.953	1	159.953	1.531	.227
SI	BLOCK	40.982	1	40.982	.392	.537
SI	REP	217.848	2	108.924	1.043	.367
LANG	BLOCK	87.461	1	87.461	.837	.369
LANG	REP	121.693	2	60.846	.582	.566
BLOCK	REP	22.647	2	11.324	.108	.898
EXPLAINED		1248.765	14	89.197	.854	.611
RESIDUAL		2611.635	25	104.465		
TOTAL		3860.400	39	98.985		

TABLE #9 Sequenced Inventory of Communication Development - Receptive (SICD-R)

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS		231724.370	5	46344.874	4.370	.005
SI		50429.036	1	50429.036	4.755	.039
LANG		96755.649	1	96755.649	9.123	.006
BLOCK		71656.225	1	71656.225	6.757	.015
REP		50878.095	2	25439.048	2.399	.111
2-WAY INTERACTIONS		89441.506	9	9937.945	.937	.511
SI	LANG	1018.592	1	1018.592	.096	.759
SI	BLOCK	889.078	1	889.078	.084	.775
SI	REP	10169.046	2	5084.523	.479	.625
LANG	BLOCK	781.987	1	781.987	.074	.788
LANG	REP	48262.101	2	24131.051	2.275	.124
BLOCK	REP	15818.706	2	7909.353	.746	.485
EXPLAINED		321165.877	14	22940.420	2.163	.045
RESIDUAL		265128.098	25	10605.124		
TOTAL		586293.975	39	15033.179		

TABLE #10 Sequenced Inventory of Communication Development-Expressive (SICD-E)

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS		160550.719	5	32110.144	2.101	.099
SI		82627.752	1	82627.752	5.407	.028
LANG		41258.191	1	41258.191	2.700	.113
BLOCK		38316.100	1	33316.100	2.507	.125
REP		9136.119	2	4568.059	.299	.744
2-WAY INTERACTIONS		174161.348	9	19351.261	1.266	.303
SI	LANG	29442.706	1	29442.706	1.927	.177
SI	BLOCK	2569.443	1	2569.443	.168	.685
SI	REP	5793.868	2	2896.934	.190	.828
LANG	BLOCK	690.990	1	690.990	.045	.833
LANG	REP	141076.471	2	70533.235	4.616	.020
BLOCK	REP	691.346	2	345.673	.023	.978
EXPLAINED		334712.067	14	23908.005	1.565	.160
RESIDUAL		382034.333	25	15281.373		
TOTAL		716746.400	39	18378.113		

TABLE #11 "Comprehension by Complexity"

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS		35112.746	5	7022.549	2.866	.035
SI		9692.461	1	9692.461	3.956	.058
LANG		1916.272	1	1916.272	.782	.385
BLOCK		8179.600	1	8179.600	3.339	.080
REP		10840.646	2	5420.323	2.212	.130
2 WAY INTERACTIONS		7330.547	9	814.505	.332	.956
SI	LANG	2432.234	1	2432.234	.993	.329
SI	BLOCK	491.098	1	491.098	.200	.658
SI	REP	3364.238	2	1682.119	.687	.513
LANG	BLOCK	58.408	1	58.408	.024	.879
LANG	REP	3183.297	2	1591.648	.650	.531
BLOCK	REP	783.703	2	391.851	.160	.853
EXPLAINED		42443.294	14	3031.664	1.237	.311
RESIDUAL		61250.606	25	2450.024		
TOTAL		103693.900	39	2658.818		

TABLE #12 COMMUNICATIVE INTENTS

SOURCE OF VARIATION		SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS		1923.445	5	384.689	1.692	.173
SI		698.060	1	698.060	3.070	.092
LANG		964.370	1	964.370	4.242	.050
BLOCK		308.025	1	308.025	1.355	.255
REP		192.970	2	96.485	.424	.659
2-WAY INTERACTIONS		4164.329	9	462.703	2.035	.078
SI	LANG	71.668	1	71.668	.315	.579
SI	BLOCK	6.037	1	6.037	.027	.872
SI	REP	1397.793	2	698.896	3.074	.064
LANG	BLOCK	27.725	1	27.725	.122	.730
LANG	REP	2614.723	2	1307.362	5.750	.009
BLOCK	REP	639.805	2	319.903	1.407	.264
EXPLAINED		6087.773	14	434.841	1.913	.075
RESIDUAL		5684.002	25	227.360		
TOTAL		11771.775	39	301.840		

DISCUSSION

Both statistical models for analyzing the data showed similar patterns emerging. Specifically, in terms of the questions asked at the outset of this research project, sensory integration therapy and its interaction with language therapy were both generally implicated in language gains made by the subjects and in some cases were statistically significant at moderate levels. These results are impressive given the small number of subjects and the fact that particular children were highly variable in their test-taking performance. For example, a few children showed poorer post test performance on some language tests than on the pre test, ostensibly because of internal or external distractions causing them to have a "bad day" when being post tested. The results of the data analysis are further strengthened by the fact that the trends appeared in both models used for analyzing the data. Yet another factor contributing to our ability to attribute importance to the trends seen was the experimental design. The design was particularly strong in the handling of control subjects. These subjects received the individual attention of an adult as the experimental subjects did, and the controls showed maturation gains on the language tests.

This study suggests that sensory integration techniques may be useful in aiding language growth for developmentally delayed preschoolers who have sensory integration problems. This is important information for speech and language pathologists working with such children, and supports a team approach to their language problems. Further research is needed to delineate precisely what areas of language learning may be most enhanced by a child's receiving an appropriate sensory integration program, and what type of child is most likely to benefit. A larger number of subjects and a longer treatment period would help to answer such questions.

More research is needed in many areas of development with regard to sensory integration. The review of literature by Ottenbacher (1982) showed clearly that there are relatively few well-designed studies on the effects of sensory integration techniques. Furthermore, in the limited number of studies which report findings that can be analyzed quantitatively, broad conclusions and generalizations are difficult to reach because of the few subjects typically involved; their diversity in age and disabilities; the variance of sensory integration techniques used; and the variety of areas in which effects are looked for. What appears to be needed are well-designed studies which can quantitatively evaluate the effects of sensory integration techniques on a given population across many areas of development. The relative changes made among individuals of that population in each area of development would lend much insight into the potential uses of such techniques as a tool for enhancing the development of disabled children.

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