PERFORMANCE OF 4-YEAR-OLDS ON A SPATIAL RELATIONSHIP TASK, CORRELATED WITH ASYMMETRICAL TONIC NECK REFLEX BEHAVIOR

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

Teachers and therapists face numerous problems in working with children with learning dysfunction. This study deals with two of these problems.

1) Spatial awareness difficulties are common with children experiencing learning dysfunction. Many books have been written describing remedial activities for use with children who seem to have these spatial awareness problems. Usually these suggested activities do not include information about behavior expected at different age levels. Age expectation information would be invaluable in providing a proper perspective for the therapist or teacher evaluating a child's performance.

2) Those working with children with learning disabilities agree that the earlier remediation efforts are begun, the more effective they are likely to be and the less trauma the child will be exposed to due to failure in school. As yet there is no effective method for early detection of possible learning disorders by means of a quick, simple-to-administer screening device. It has been suggested that examination of primitive postural reflex behavior might be such a device (Rider, 1972, p. 243). Were it to be shown that the presence of asymmetrical tonic neck reflex relates to poor spatial awareness abilities, abilities supposed to be prerequisite to many academic skills, this would lend support to the postulation that certain abnormal postural reflex behavior may be

diagnostic of learning disorder and would suggest an easy-to-administer, quick screening device with which to possibly identify, before they enter school, those children who may experience learning problems.

Spatial Awareness as it Relates to Academic Learning

Various spatial awareness skills have been identified by experts such as Frostig and Horne (1964) and Kephart (1960) as being basic to certain types of academic functioning. Frostig and Horne (1964) have stated:

> ...five visual perceptual abilities...seem to have the greatest relevance to academic development. These five abilities are: (1) perception of position in space, (2) perception of spatial relationships, (3) perceptual constancy, (4) visual-motor coordination, and (5) figure-ground perception (p. 10).

The spatial awareness task used in this study draws heavily upon abilities 1, 2, and 4.

Kephart (1960) stated generally, regarding spatial awareness:

> The observation of relationships is vital to more advanced thinking....The child who has difficulty with space is likely to have similar difficulties in thinking....Unless we can compare the characteristics of different objects, we cannot make the judgment upon which categorization is based....It is...categorization which leads to generalization and abstraction (pp. 94-5).

More specifically, in discussing mathematics, Kephart (1960) stated:

> Mathematics deals with groups of objects and the characteristics of groups and grouping phenomena. If the child has not developed an adequate space world, he will have difficulty in dealing with grouping phenomena, since groups can only exist in space (p. 94).

Research regarding the measuring of spatial awareness abilities, particularly of pre-school children, and studies relating spatial awareness abilities to academic functioning are relatively scarce. Chissom, Collins, and Thomas (1974) have demonstrated that the Frostig Developmental Test of Visual Perception (a pencil and paper task designed to measure perception of position in space, perception of spatial relationships, perceptual constancy, visual-motor coordination, and figure-ground perception) and the Shape-O-Ball test, a three-dimensional task measuring form discrimination, fine eye-hand coordination, and visual-motor match, may be useful in predicting academic readiness. Both of these tests relate to spatial awareness.

The Bender Gestalt test, a paper and pencil test in which the child is required to copy stimulus figures, has been shown to correlate with reading readiness (Smith & Koegh, 1962). Elements of the Bender Gestalt test relate to the spatial awareness task used in this study, for example, rotation of figures, integration of parts into wholes, overlapping of figures; however, the Bender Gestalt test and the spatial awareness task are difficult to compare, the Bender Gestalt test being a far more complex activity than the spatial awareness task (Koppitz, 1958). Koppitz (1958) has, however, identified types of errors on the Bender Gestalt test which relate to learning problems, and among the types identified were the inability to integrate parts into wholes, problems with visual-motor control, and a tendency to rotate figures, all elements important to the execution of the spatial awareness task used in this study.

Spatial Awareness Tasks

Certain aspects of spatial awareness are considered to be basic to academic skills and are considered to be important in the execution of a spatial awareness task used as a diagnostic tool. These include sequencing, position in space, and integration of parts into a whole.

Sequencing

Banus (1971), in discussing visual sequencing, stated:

> Here the child must recognize a spatial-directional ordering of visual stimuli....Material may be positioned in a vertical or horizontal sequence from left to right, in front, behind, beside, or top or bottom. In all cases, there are dimensions of 'beginning' or 'first', 'middle' and 'end' or 'last', denoting sequential progression. Developing an awareness of sequence gives the child a systematic means of organizing, interpreting and transmitting information....If the child has the concept of sequencing, he then knows where to begin and end, and what must occur between the two extremes. This, of course, is basic to reading and writing skills (p. 317).

Banus (1971) also noted that,

> At times it is important that a certain sequence be followed in order to achieve the finished product, in spelling words or dividing numbers, for instance (p. 305).

Other experts have also attested to the importance of visual sequencing in reading readiness activities (Ebersole, Kephart, & Ebersole, 1968; Kaluger & Kolson, 1969; and Vernon, 1971).

Position in Space

Frostig and Horne (1964) defined perception of position in space as, "...perception of the relationship of an object to the observer" (p. 40). This concept of position in space relates to the child's ability to see the difference between 'b' and 'd', for example (Frostig & Horne, 1964). Obviously the ability to distinguish between various orientations in space is an important one.

Integration of Parts into a Whole

Vernon (1971) indicated that the ability of a child to analyze whole patterns and integrate parts into wholes is significant relative to learning to read. As stated above, problems with integrating parts into a whole have been shown to correlate with learning problems (Koppitz, 1958).

Manner of Execution and Time to Complete Task

The way a child completed the spatial awareness task and the time expended in contemplating and completing the task were felt to be of importance in this study. Kephart (1964), in discussing remediation methods stated, "Greater attention to the child's methods of handling the mechanics of our tasks might result in less frustration for us and more learning for the child" (p. 206). Kagan (1965) reported finding a positive correlation between impulsivity and poor reading abilities and admonished those evaluating children with learning disorders to consider more closely factors such as impulsivity rather than too quickly pointing to perceptual problems as the source of the child's learning difficulty.

Primitive Postural Reflexes as They Relate to Academic Learning

Researchers are just beginning to explore the relationship between primitive postural reflex mechanisms and academic abilities. Rider (1972) in a study entitled "Relationship of Postural Reflexes to Learning Disabilities," reported, "...children with learning disorders had significantly more abnormal reflexes than did the normal children..." (p. 242). More specifically, the following relationships were found:

> ...prevalence of abnormal reflex responses correlated highly with spelling achievement ($r. = 68$; $p. < .01$), moderately high with reading ($r. = .20$; $p. < .10$), and did not reach significance in arithmetic achievement ($r. = .23$) (p. 242).

Ayres (1972) has identified neural systems wherein disorder seems to cause a specific constellation of symptoms. She has identified one learning disorder syndrome consisting of learning problems, especially reading problems, and other symptoms, including abnormal degree of residual tonic neck and tonic labyrinthine reflexes. Of particular interest to this study is the statement by Ayres (1972) that, "Children with problems in postural responses tend to have poorer perception of verticality" (p. 87). Verticality is a rather basic element of spatial awareness.

In explaining the importance of postural reflexes in treating learning disorders, Ayres (1972) stated:

> It is not so much the resultant poor coordination that is of concern, but the fact that disorder, when found in conjunction with symptoms such as reading retardation, strongly suggests poor integration in some aspects of brain stem function. It is because some type of sensory integration which occurs in the brain stem appears to be critical to the reading process that postural reactions are important in treating learning disorder (p. 77).

Experts in the field of neurology agree that the brain functions as a total unit, each neural level dependent for optimum function upon the proper functioning of all other levels (Ayres, 1972; Norton, 1972; House & Pansky, 1960).

From a developmental standpoint, the rationale behind relating primitive postural reflex behavior to academic performance is, according to Fiorentino (1963):

> In normal development...primitive spinal and brain stem reflexes gradually diminish in order that higher patterns of righting and equilibrium reactions may become manifested. When inhibiting control of higher centers is disrupted or delayed, primitive patterns dominate to the exclusion of higher, integrated sensorimotor activities (p. 5).

Norton (1972) stated:

> These reflexes and reactions have a specific time for onset and disappearance related to the maturational process....They underlie spontaneous behavior....[and] from the elicited and spontaneous behavior, body image scheme emerges....Body image scheme appears to have a close relationship, to laterality, directionality, and to perceptual-motor development of the pre-school child (p. 138).

In his theory of intellectual development Piaget has stressed the importance of early motor development as a basis for cognitive development.

CHAPTER II

METHOD

Purpose and Hypotheses

The purpose of this study was to 1) examine behavior and develop some normative information about the performance of normal 4-year-old children on an evaluative/training activity of a type sometimes used with children who appear to be experiencing spatial awareness problems, and to 2) determine whether or not a relationship exists between performance on the spatial awareness activity and the degree to which the children have integrated the asymmetrical tonic neck reflex, a primitive reflex mediated at the brain stem level of the central nervous system. The asymmetrical tonic neck reflex was chosen to be used in this study because assessment of the degree to which this reflex has been inhibited is commonly used clinically in evaluating sensory integrative deficits and learning problems (Parmenter, 1975, and Ayres, 1972). It was chosen also because of the ease with which a child wearing street clothes can be screened for presence of this mechanism.

Assessment of an evaluative/training task related to spatial awareness is usually accomplished qualitatively by the clinician. In order to test hypotheses and identify significant relationships among the observed responses it was necessary to quantify the products of the spatial awareness task. Relationships between the quality of the products of the task and the other factors being examined could then be analyzed statistically. Other factors examined included: 1) the manner in which the subjects approached the task, 2) the time it took the subjects to complete the activity, and 3) the latency period, or the time it took the subjects to begin the task after being given the instructions and materials.

In order to compare the various factors of performance on the spatial awareness task and the degree of inhibition of the asymmetrical tonic neck reflex, the following hypotheses were examined:

1) There will be no significant association between the 4-year-old child's level of performance on the spatial awareness task and the degree to which he has inhibited the asymmetrical tonic neck reflex.

2) There will be no significant association between the manner in which the 4-year-old child approaches the spatial awareness task and his finished product.

3) There will be no significant association between the amount of time it takes the 4-year-old child to execute the spatial awareness task and his finished product.

4) There will be no significant association between the time it takes the 4-year-old child to initiate the spatial awareness task (latency time) and his finished product.

Subjects

The subjects for this study were 49 4-year-old children, 23 girls and 26 boys, representing the total population of 4-year-olds enrolled in four pre-school facilities in Stillwater, Oklahoma. Table I shows the distribution by sex and age of the subjects. Any child with suspected or diagnosed motor dysfunction, visual or auditory handicap, or mental retardation was omitted from the sample.

TABLE I

DISTRIBUTION BY AGE AND SEX OF SUBJECTS

Age Years	Age Months	Sex M (N = 26)	Sex F (N = 23)
4	0	1	2
4	1	0	5
4	2	2	0
4	3	2	0
4	4	1	3
4	5	3	3
4	6	3	0
4	7	4	1
4	8	4	3
4	9	4	2
4	10	1	1
4	11	1	3

The sample did not include 3-year-olds for the following reasons:

1) Non-pathological immaturity might be a factor in a 3-year-old's ability to perform on the task (Vernon, 1971).

2) Communication problems relative to the 3-year-old's understanding of 'sameness' might occur (Martin, Gilfoyle, Fischer, & Grueter, 1969).

Research Instruments

Five instruments were used in the testing of the subjects: 1) the spatial awareness task; 2) an asymmetrical tonic neck screening procedure; 3) a symmetrical tonic neck reflex screening procedure; 4) a tonic labyrinthine reflex (prone) screening procedure; and 5) a tonic labyrinthine reflex (supine) screening procedure. (Appendix B consists of a detailed description of the spatial awareness task, and Appendix C describes the reflex screening procedures used.)

After the testing was completed it was decided that the symmetrical tonic neck reflex and tonic labyrinthine reflex (prone and supine) screening procedures were unsatisfactory for purposes of this study for the following reasons:

1) Subjects had a tendency to lock their elbows during the administration of the symmetrical tonic neck reflex screening procedure, thereby making it difficult to objectively determine if in fact the position of the child's head was influencing muscle tone in his upper extremities.

2) Difficulties encountered during the testing of the 49 subjects led to the conclusion that the procedure used for screening for presence of tonic labyrinthine reflex behavior did not yield conclusive information with this age group, regarding the degree to which the child has inhibited this reflex. For one thing, it was often difficult to accurately observe the child's behavior in cases where, for example, girls wore long dresses or in cases where the child's pantlegs were very loose fitting. In addition the criteria of performance outlined by Ayres (1972) proved to be too non-specific. For example, most of the children bent their knees in the prone position and, of those who bent their knees, most did not lift their knees off the mat. The examiner was

unable to determine whether or not this behavior was indicative of problems in inhibiting the tonic labyrinthine reflex. In a clinical setting other approaches to determining whether or not the child was evincing tonic labyrinthine reflex behavior would have been employed, but these approaches would have been inappropriate or out-of-the-question in terms of space and equipment available for this study. Furthermore, it was felt that this screening method was not a "comfortable" one for some of the children. Despite 100% willing cooperation on the spatial awareness task, five of the 49 subjects refused to try the tonic labyrinthine screening test. It was also an uncomfortable device for the examiner, as it was necessary for the examiner to demonstrate the positions to each child, and these positions are not assumed effortlessly. Not one of the subjects was able to assume the positions after being given only verbal instructions and manual assistance.

Fiorentino's (1971) procedures for screening tonic labyrinthine reflex behavior might have been used, but these screening procedures require that the examiner be able to observe closely muscle tone in the lower extremities. Such observations would have been difficult while the children were wearing street clothes.

The asymmetrical tonic neck reflex screening method seemed to be the only procedure of the four primitive postural reflex screening procedures used in this study that met the criteria of 1) being easy to administer to 4-year-olds in a pre-school setting, and 2) yielding relatively clear results with 4-year-old children. Therefore, it was decided that only data from the spatial awareness task and the asymmetrical tonic neck reflex screening procedure would be analyzed.

Spatial Awareness Task

The spatial awareness task is an adaptation of an activity outlined in The Developmental Therapist, by Banus (1971, p. 313), an activity described as appropriate for evaluating the abilities of a pre-school child to organize forms in space. An adaptation of this activity is also described in Steps to Achievement for the Slow Learner, by Ebersole, Kephart, & Ebersole (1968, p. 132). The adaptation devised for purposes of this study consists of a placing and pasting task whereby the child is required to duplicate a seven-piece sample picture which remains in view during the execution of the task. According to Piaget and Inhelder (1956), children under 6 to 7 years of age do not have a grasp of sequential ordering as a separate element of a group of forms and therefore cannot remember sequence. It was for this reason that the sample picture was not removed from the child's view as he executed the spatial awareness task. Rather than an abstract design, it was decided that the picture should be representational in order to help the child as he organizes the parts into a whole (Banus, 1971).

The task includes as many elements as possible of spatial awareness skills that are often reported to be elementary to reading, writing and arithmetic. Included are elements of sequencing problems such as top-to-bottom, behind-to-front; gradations of orientation in space problems such as "right-side-upness"; the problem of relating parts to a whole, or fabricating a satisfactory whole from given parts.

For purposes of objectively analyzing the performance of the subjects, it was necessary to devise a scoring procedure for the spatial awareness task. No information was found in the literature related to quantifying behavior on a spatial awareness task of the type used in this study. Much experimentation was required to devise the scoring system used in this study.

Initially a scoring procedure was tried giving one point for each correct element contained in the child's completed spatial awareness task and deducting a point for each of certain incorrect elements. The elements were grouped into:

1) A base score portion, which included a point for each of the parts pasted and for orienting the page correctly.

2) A sequencing/orientation in space portion, which included a point for each of the parts that was located in the correct relative position on the page.

3) A general integration/visual-motor portion, which had to do with such things as the parts being appropriately tangent to one another, angulation and overlapping of parts, etc.

Using this scoring system, a perfect paper earned a score of 24, and a poor paper could receive a minus score. A serious problem with this initial scoring procedure was that the total numerical scores earned did not reflect the apparent quality of the children's spatial awareness products. A ranking of the scores and a ranking of the papers by a visual judging of the quality of the finished product did not in any way correlate.

A revised scoring procedure was devised, this time on a "points deducted" basis. A perfect paper would receive a score of zero. Points were deducted for each incorrect element. This time the elements were grouped into two categories, sequencing/orientation in space, and general integration/visual-motor elements.

A weighting of deductions needed to be devised because certain errors seemed of greater consequence than others. For example, many of the children reversed the dog simply because they applied the paste to the wrong side. This did not seem to be as serious a spatial awareness error as pasting the dog on the wrong side of the house, for example. The weighting was assigned using frequency of types of errors made by subjects tested. (See Appendix B for a full description of the spatial awareness task and the scoring procedure.)

Validation of the Procedure Used in Scoring the Spatial Awareness Task. The scoring system arrived at was devised on the basis of the author's opinion of what was a mature imitation of the sample picture, judging from the sequencing and the orientation in space of the parts, and the general integration and visual-motor abilities evinced by the finished product. The points used in the scoring system were identified from the products of the 49 subjects in the study. The scoring system arrived at yielded what appeared to the author to be a gradation of numerical scores which tended to reflect the gradations of maturity evinced in the finished products of the 49 children tested.

Four experts (two professors of special education at Oklahoma State Univeristy, one psychologist at Oklahoma State University, and one kindergarten teacher in Stillwater, Oklahoma) were asked individually to select the best seven pictures and the worst seven (using the sample picture as a criteria for judging). They were told that the task was to measure spatial awareness ability and that therefore the criteria they used in judging the pictures were to relate to elements of spatial awareness. The judges' selections were independent of knowledge of others' selections or the scores on the task. Table II compares the classifications of these four experts with the classification by

TABLE II

EXPERTS' OPINIONS OF SEVEN "BEST" AND SEVEN "WORST" PICTURES COMPARED WITH SEVEN "BEST" AND SEVEN "WORST" SCORES

Subject Nos. of Pictures Selected as "Best" by Experts				Pictures with "Best" Scores		Subject Nos. of Pictures Selected as "Worst" by Experts				Pictures with "Worst Scores	
Exp. I	Exp. II	Exp. III	Exp. IV	Subject No.	Total Score	Exp. I	Exp. II	Exp. III	Exp. IV	Subject No.	Total Score
5	5	5	5	5	2	20	20	20	20	20	65
6		6	6	6	3	21	21	21			
				9	12				23		
	10					24	24	24	24	24	103
13				13	12	26	26	26		26	65
			16			28	28	28	28	28	90
34	34	34	34	34	4	31	31	31	31		
35	35	35	35	35	10	40	40	40	40		
37									41		
		39								42	52
47	47	47	47	47	12						
	48		48								
	49										

numerical scores derived from the scoring system applied to the spatial awareness task.

The classifications (of seven best and seven worst pictures) by each expert were compared individually by means of chi-square with the classification indicated by the scoring system. The four chi-square values obtained from these comparisons were: 54.96, 33.2, 42.6, and 33.2, all significant beyond the .0002 level, indicating that the scoring method provided results that were basically in agreement with the opinions of four experts. In addition to two sub-scores and a total score for the spatial awareness task, each subject was also given scores for latency, time-to-complete, and manner of completion.

Asymmetrical Tonic Neck Reflex Screening Test

The asymmetrical tonic neck reflex is the primitive postural reflex seen normally in infants under age 4 to 6 months, whereby turning of the infant's head to the side is apt to elicit extensor tone in the infant's arm and leg on the face side and flexor tone in the arm and leg on the skull side (Fiorentino, 1963). A detailed description of the screening procedure and scoring system used in this study to test for the presence of the asymmetrical tonic neck reflex is presented in Appendix C.

Validity of Screening Devices

The screening devices used in this study are described in the literature:

1) It was assumed that the asymmetrical tonic neck, symmetrical tonic neck, and tonic labyrinthine reflex screening procedures were valid ones as they are commonly used clinically, as described in Sensory Integration and Learning Disorders by Ayres (1972).

2) Likewise it was assumed that the spatial awareness task used in this study measured elements of spatial awareness, as it is an adaptation of a task commonly recommended for evaluating and training spatial awareness in children (Banus, 1971, and Ebersole, Kephart, & Ebersole, 1968).

Collection of Data

Pilot Study

Before the actual testing, a small pilot study was conducted using six 4-year-olds from one of the laboratory pre-schools on the Oklahoma State University campus. It was determined by this pilot study that it would be necessary to test the children in an area set aside from the regular play area in order to prevent distractions and to prevent the children waiting their turn to be tested from gaining the advantage of having watched another child perform the task. Judging from the results of the pilot study, the examiner felt that the testing procedures were appropriate for use with normal 4-year-old children.

Main Study

All testing was done during the month of May, 1975. Each child was seen individually in a testing area isolated from the other children but in the preschool in which he was enrolled. The testing area was furnished with a small table with two chairs for the spatial awareness task and a mat for the reflex testing.

Regarding the sequencing of the tests, the children were asked as they entered the testing area, "Which would you rather do first, the pasting job or the trick on the mat?" All the children tested were sufficiently intrigued by the "pasting job" that they wanted to do that first. Each child was invited to "practice" pasting with a Pritt glue stick before attempting the "pasting job." During the practice time, the examiner engaged the child in casual conversation in order to put the child at ease as much as possible. By the time the child finished the "pasting job" it was usually the case that he was enough at ease with the examiner that he was willing to try the "trick on the mat", which, of the two activities, seemed to be the more threatening to the children. To ensure cooperation with the reflex testing, the examiner said to the child, as he finished his "pasting job", "Thank you. I am going to keep this good picture. Would you like to make another picture to take home, after you have finished the trick on the mat?" Most of the children responded positively to this approach.

No child was forced into the testing situation. Had any child said he would rather not do the "pasting job" or the "trick on the mat", his wishes would have been respected, and no effort would have been made to convince him to change his mind.

Analysis of Data

Each subject in this study earned the following scores for purposes of statistical analysis: 1) sequencing/orientation-in-space (a sub-score of the spatial awareness task); 2) general integration/visual-motor (a sub-score of the spatial awareness task); 3) spatial awareness task score (total of sequencing/orientation-in-space and general integration/visual-motor sub-scores); 4) latency score (in terms of minutes and seconds); 5) time-to-complete score (in terms of minutes and seconds); 6) manner score; 7) asymmetrical tonic neck reflex (left) score; 8) asymmetrical tonic neck reflex (right) score; 9) asymmetrical tonic neck reflex score (total of left and right scores). Three aspects of the spatial awareness task were recorded for correlation with the above. The three aspects were: 1) whether or not the dog was pasted correctly (facing right); 2) whether or not the house was pasted correctly (with the hinge on the left); and 3) the number of points deducted for angulation of parts. These aspects can be found within the sub-scale scoring and can be extracted for analysis.

Throughout the remainder of this thesis the following abbreviations refer to:

ATNR = total asymmetrical tonic neck reflex score

ATNR(L) = asymmetrical tonic neck reflex score for the left

ATNR(R) = asymmetrical tonic neck reflex score for the right

TTC = total time to complete the spatial awareness task

Latency = latency time score

Ang. = total points deducted for anguation of parts

Total = total spatial awareness task score (V-M plus Seq.)

V-M = general integration/visual-motor sub-score of the spatial awareness task

Seq. = sequencing/orientation-in-space sub-score of the spatial awareness task

Manner = classification of how the child approached the spatial awareness task

Dog = refers to the aspect in the spatial awareness task of having pasted the dog correctly (facing right)

House = refers to the aspect in the spatial awareness task of having pasted the house correctly (hinge on left)

The scores were analyzed to determine whether there were significant differences between: 1) the performance of boys and of girls on all of the above-mentioned scores or aspects; and 2) performance by age (grouped by 4-month intervals) on all of the above-mentioned scores or aspects. In addition, all of the above-mentioned scores and aspects were compared statistically with one another. The chi-square test, one-way analysis of variance, and correlation coefficients were used in analyzing the data.

CHAPTER III

RESULTS

Chi-square, one-way analysis of variance, and correlation coefficient were used in comparing and examining relationships among the following variables: 1) age, 2) sex, 3) sequencing/orientation-in-space sub-score, 4) general integration/visual-motor sub-score, 5) total spatial awareness task score, 6) manner score, 7) latency time, 8) time to complete, 9) points deducted for angulation of parts, 10) dog pasted correctly (facing right), 11) house pasted correctly (with hinge on left), 12) asymmetrical tonic neck reflex (left) sub-score, 13) asymmetrical tonic neck reflex (right) sub-score, 14) asymmetrical tonic neck reflex total score. This chapter discusses the results of these analyses and describes the responses of a general population of normal 4-year-old children to the testing procedures used in this study. Table VIII in Appendix A gives descriptive data and scores for each subject; Tables IX and X in Appendix A and Table V, p. 27, indicate the statistical tests run on the data and the levels of significance obtained.

Performance of 4-Year-Olds on the Spatial Awareness Task

Sex Differences

Differences in performance on the spatial awareness task between the boys and the girls were analyzed by means of the chi-square test relative to 1) Manner, 2) House, and 3) Dog. No statistically significant difference was noted relative to the above three variables.

The aspects of 1) Latency, 2) TTC, 3) Ang., 4) Seq., 5) V-M, and 6) Total were analyzed relative to sex, by means of analysis of variance. As seen on Table III, the means for the girls' sub-scores on Seq., V-M, Total, and Ang. were lower than the means of the boys. (Zero is a perfect score, and the lower the numerical score, the better the score.) However, only the difference between girls and boys relative to V-M sub-score was statistically significant ($p < .04$).

As shown in Table III the girls averaged less latency time than the boys; however, the mean time to complete the spatial awareness task for girls was more than for boys. Neither of these differences, however, was statistically significant. Although the mean difference in latency time between boys and girls appears to be relatively large, the fact that there was a great deal of variability in the latency times accounts for the lack of significance ($p < .26$) of the difference.

Age Differences

For purposes of statistical analysis, the subjects were divided into three age groups: Group I consisted of those subjects of age 4 years, 0 months through 4 years, 3 months; Group II consisted of subjects of age 4 years, 4 months through 4 years, 7 months; Group III consisted of those subjects of age 4 years, 8 months through 4 years, 11 months. Refer to Table I for distribution of ages of subjects.

TABLE III

MEANS OF SELECTED VARIABLES BY SEX, AND LEVELS OF SIGNIFICANCE OF F RATIOS

		Variables					
Sex	No.	Seq.	V-M	Total	Ang.	Latency	TTC
F	23	4.09	20.00	24.09	3.39	3.70	362.13
M	26	5.19	29.54	34.03	4.81	8.50	315.58
Level of Significance of F Ratio		.51	.04	.06	.51	.26	.59

Note: See Table X, Appendix A for listing of analysis of variance statistics relative to comparison of sexes on the above variables.

Chi-square was used to determine whether or not age was a factor related to: 1) Dog, 2) House, and 3) Manner. No statistically significant differences between age groups on the above three variables were noted.

Analysis of variance was used to compare the age groups in regard to the mean Seq. sub-score, V-M sub-score, and the Total score, as well as the mean Ang., Latency, and TTC. Table X, Appendix A presents the results of the analysis of variance, and Table IV lists the means of age groups relative to the above factors.

TABLE IV

MEANS OF SELECTED VARIABLES BY AGE GROUP, AND LEVELS OF SIGNIFICANCE OF F RATIOS

Age Group	No.	Variable Seq.	V-M	Total	Ang.	Latency	TTC
I	12	6.5	28.0	34.5	4.5	14.1	337.3
II	18	5.8	29.1	34.9	5.7	4.2	334.0
III	19	2.4	19.4	21.8	2.4	3.2	340.8
Level of Significance of F Ratio		.08	.16	.09	.51	.10	.995

Note: See Table X, Appendix A for listing of analysis of variance statistics relative to comparison of age groups on the above factors.

The comparison between age groups relative to Seq. sub-scores approaches significance ($\underline{p} < .08$) as does the comparison relative to Latency ($\underline{p} < .10$). The comparison between age groups relative to Total reaches a significance level of .09; however, as the sub-score on Seq. is a part of the Total score on the spatial awareness task, this significance is to be expected.

Time Element Relative to Spatial Awareness Task

The time subjects took to complete the spatial awareness task ranged from 2 minutes, 10 seconds to 14 minutes, 50 seconds. The mean time to complete the task was 5 minutes, 37 seconds.

No latency time was observed for 34 children, that is they began the task immediately after having been given the parts. Latency times ranged from 2 seconds to 1 minute, 10 seconds; the mean latency time was 6 seconds.

Analysis of variance was computed to determine whether or not: 1) Dog, 2) House, and 3) Manner differed according to Latency or TTC. None of the F ratios approached statistical significance at the .05 level. Table X, Appendix A presents statistical values and levels of significance obtained.

The presence or absence of linear intercorrelations among the following variables: 1) Seq., 2) V-M, 3) Total, 4) Ang., 5) Latency, and 6) TTC was examined by means of coefficients of correlations, $\underline{r}$. The values for $\underline{r}$ and levels of significance are presented in Table V. Regarding the latency time, it was noted that there is a significant correlation with: 1) Seq. sub-score ($\underline{p} < .01$), 2) V-M sub-score ($\underline{p} < .003$), and 3) Total score ($\underline{p} < .002$), indicating a trend toward higher latency time scores being associated with higher (poorer) Seq., V-M, and Total scores. Among this group of subjects there was no observed relationship between Latency and Ang. or TTC.

Regarding the time to complete, no correlation was found with Seq. nor with Ang.; however, there was a significant negative correlation with V-M sub-score ($\underline{p} < .04$) and, as would be expected, with the Total score ($\underline{p} < .04$). The more time taken to complete the task, the lower (better) the V-M sub-score among this group of 4-year-old subjects.

TABLE V

INTERCORRELATION AMONG SELECTED VARIABLES

Variable		Seq.	V-M	Total	Ang.	Latency
Seq.	(correlation)	1.00				
	(significance)	.00				
V-M		.58				
		.0001				
Total		.75	.97			
		.0001	.0001			
Ang.		.42	.65	.65		
		.003	.0001	.0001		
Latency		.35	.42	.44	.14	
		.01	.003	.002	.67	
TTC		-.18	-.30	-.29	-.08	-.17
		.20	.04	.04	.60	.24

Manner Score Relative to Spatial Awareness Task

The manner score was distributed as follows: 15 subjects completed the spatial awareness task in the most systematic, efficient manner possible, receiving a score of zero; 26 subjects completed the task in what was considered a reasonably systematic manner (see Appendix B for manner scoring criteria), receiving a manner score of one; five subjects completed the task in a manner which was considered to be between "reasonably systematic" and random placing of parts, receiving a manner score of two. Three subjects completed the task in what was considered a random fashion and received a manner score of three.

Chi-square was used to determine whether or not the manner in which the child completed the spatial awareness task was related to: 1) House and 2) Dog. Only the probability of the chi-square for the aspect of having pasted the dog facing correctly, compared with the manner score, approached significance ($p < .07$).

By means of analysis of variance, groups categorized on the basis of the manner scores were compared in regard to: 1) Seq., 2) V-M, 3) Total, 4) Ang., 5) Latency, and 6) TTC. Table VI presents the group means for the above variables.

Significant differences ($p < .01$) between manner score groups on Seq. sub-scores indicated that a systematic, efficient approach to the spatial awareness task tended to be related to good Seq. sub-scores. The high level of significance ($p < .03$) for differences between manner score groups on Total scores is a reflection of the differences associated with Seq. sub-scores, a part of the Total.

There appears also to be a relationship between the manner in which the subject completed the spatial awareness task and Ang. ($p < .01$). Unfortunately, one subject had 45 points deducted for angulation of parts. The closest score to that was 18 points deducted, therefore, the one score of 45 deduction points is bound to bias the result. Angulation points are a part of the V-M sub-score. In examining the data through use of an analysis of variance it may be noted that the means of the V-M sub-scores grouped by manner score were <u>not</u> significantly different. This lends support to the suspicion that the significant differences between manner groups on the angulation score were spuriously high due to the influence of one extremely deviant score.

TABLE VI

MEANS OF SELECTED VARIABLES BY MANNER CLASSIFICATION, AND LEVELS OF SIGNIFICANCE OF F RATIOS

Manner Score	Variable					
	Seq.	V-M	Total	Ang.	Latency	TTC
0	3.8	24.1	27.0	4.2	7.6	378.0
1	4.8	23.8	28.6	2.7	7.2	317.8
2	1.0	21.0	22.0	4.4	0.0	306.0
3	14.3	47.3	61.7	16.0	1.7	356.7
Level of Significance of F Ratio	.008	.11	.03	.01	.77	.79

Note: See Table X, Appendix A, for listing of analysis of variance statistics relative to comparison of manner score groups on the above variables.

Suspected Significant Factors Within the Spatial Awareness Task

Due to clinical impressions of the examiner, it was decided that three aspects of the spatial awareness task would be included in the statistical analysis to determine any possible relationships between these factors, as separate entities, and the other variables being analyzed. The three factors are: 1) pasting of the dog correctly (facing right); 2) pasting of the house correctly (with hinge on left); and 3) the number of points deducted because of angulation of parts. These three factors have already been discussed relative to sex and age differences, Latency, TTC, and Manner.

As seen in Table V, there seems to be a linear correlation between Ang. and Seq. sub-scores ($\underline{p} < .003$), V-M sub-scores ($\underline{p} < .0001$), and Total ($\underline{p} < .0001$). The factor of angulation of parts was included in the V-M sub-score. This was a rather arbitrary decision on the part of the author, because angulation of parts could also be considered related to orientation of parts in space as well as a factor of the child's visual-motor skills. Because deduction of points for angulation of parts is included in the V-M sub-score, and the V-M sub-score is part of the Total score, the probability levels are less meaningful than they appear.

Analysis of variance was used to compare groups classified according to: 1) Dog and 2) House relative to Seq. sub-scores, V-M sub-scores, and Total. Statistical values and levels of significance may be found in Table X, Appendix A. It would appear that both Dog and House were significantly associated with the Seq. sub-score; however, since Dog and House are a part of the Seq. sub-score, the significance levels (Dog, $\underline{p} < .003$ and House, $\underline{p} < .03$) are not particularly meaningful. It may be noted that the dog pasted incorrectly (not facing right) was given two deduction points according to the scoring system, while the house pasted incorrectly (with hinge not on left) was given three deduction points. Therefore, one might expect that the relationship between these sub-scale scores and positioning the house would be stronger than the relationship between the sub-scale scores and positioning the dog. However, it appears that the dog being pasted incorrectly is more closely related to a poor Seq. sub-score than is the house being pasted incorrectly.

Child's Verbalized Perception of His Finished Product

As part of the total testing procedure, each child was asked, as he finished the spatial awareness task, "Does your picture look the same as 'this' picture?" (referring to the sample picture). All of the children, with the exception of three, responded to this question positively. Nine children qualified their "yes" answer with a response to the effect that "such-and-such" was pasted backwards, etc., but they would then characteristically add something like, "But that's OK, isn't it?" Only one child gave a flat "no" response, and his picture was a good imitation of the sample picture. It is suspected that he did not fully understand the question. It is possible, for example, that this child had not yet developed an understanding of the concept "sameness" which he could apply to an item composed of a number of parts. The other two children who did not respond positively said, "The window is twisted," and, "Kind of".

Results of Primitive Postural Reflex Screening

As mentioned in Chapter III, only the results of the asymmetrical tonic neck reflex (ATNR) screening were considered suitable, for purposes of this study, for statistical analysis. This section, then, will deal only with the results of the ATNR screening.

The total ATNR score was made up of a sub-score reflecting the degree to which the ATNR seemed to affect the muscle tone in the left arm (ATNR-L sub-score), i.e., when the child's head was turned toward the right; and a sub-score reflecting the degree to which the ATNR seemed to affect the muscle tone of the right arm (ATNR-R sub-score), i.e., when the child's head was turned toward the left. A full description of testing and scoring procedures may be found in Appendix C. As with the spatial awareness task, a score of zero is the best possible score, indicating no ATNR was observed. A score of one is a questionable score, meaning either that only a very slight change in muscle tone was noted or that the examiner was in doubt about whether or not there was a change in muscle tone. A score of two indicated definite presence of increased flexor tone in the arm opposite the direction to which the head was turned. Table VII shows the distribution of ATNR reflex score. Only 10 of the 49 subjects did not evince some degree of ATNR behavior, and ATNR-R was elicited significantly more often than was ATNR-L ($\underline{X}^2 = 22.19$, 4 d.f., $\underline{p}$ .0002). (Table IX).

Age and Sex Differences

Differences between age groups and sex groups on ATNR scores, ATNR-L sub-scores, and ATNR-R sub-scores were analyzed using chi-square. No association was shown between age and ATNR screening results. Table IX, Appendix A, presents chi-square values and levels of significance.

Although the chi-square value only approached significance ($\underline{p} < .10$), there seemed to be a tendency for girls to evince better integrated ATNR. Tables XII, XIII, and XIV, Appendix E present chi-square analysis data and frequencies of ATNR scores by sex, ATNR-L sub-scores by sex, and

ATNR-R sub-scores by sex. It may be noted that in comparing ATNR scores by sex a chi-square value of 7.87 with d.f. = 4 was obtained (p .10). It should be noted that this level of significance appears to be coming more strongly from the comparison of ATNR-R sub-scores than ATNR-L sub-scores, as the former comparison yields a chi-square significant at the .09 level and the latter, a chi-square at only the .19 level.

TABLE VII

DISTRIBUTION OF ATNR SCREENING RESULTS

Instances of:	
ATNR-L, 0; ATNR-R, 0 (no ATNR)	10
ATNR-L, 1; ATNR-R, 1 (ATNR questionable on both sides)	6
ATNR-L, 2; ATNR-R, 2 (ATNR affecting both arms strongly)	14
ATNR-L, 1; ATNR-R, 0 (questionable on left)	3
ATNR-L, 0; ATNR-R, 1 (questionable on right)	3
ATNR-L, 0; ATNR-R, 2 (ATNR affecting right arm only)	6
ATNR-L, 2; ATNR-R, 0 (ATNR affecting left arm only)	0
ATNR-L, 1; ATNR-R, 2 (right arm more strongly affected than left)	7
ATNR-L 2; ATNR-R, 1 (left arm more strongly affected than right)	0

Spatial Awareness Task Aspects Related to ATNR

ATNR scores, ATNR-L sub-scores, and ATNR-R sub-scores were compared for groups categorized according to the following spatial awareness task components: 1) House, 2) Dog, and 3) Manner, through the use of chi-square. Analysis of variance was used to determine whether or not ATNR scores, ATNR-L sub-scores, ATNR-R sub-scores were associated with: 1) Seq. sub-scores, 2) V-M sub-scores, 3) Total, 4) Ang., 5) Latency, and 6) TTC. Only the differences between ATNR groups relative to angulation points were statistically significant ($\underline{p} < .01$). Again, the presence of one subject who had 45 points deducted for angulation of parts confuses the statistical analysis. A graphic representation of the reflex scores and angulation scores did not seem to reflect any sort of linear correlation between the two factors.

Summary of Statistically Significant Findings

Relative to performance on the spatial awareness task, the difference in performance between girls and boys on the general integration/visual-motor portion of the spatial awareness task was statistically significant, the girls tending to perform better than the boys ($\underline{p} < .04$). Judging from the asymmetrical tonic neck reflex scores, girls tended to evince less asymmetrical tonic neck reflex behavior than did the boys, although the probability level only approached statistical significance ($\underline{p} < .10$).

Relative to performance on the spatial awareness task, it was shown that the sequencing/orientation-in-space sub-scores increased with the age of the children, the probability level approaching statistical significance ($\underline{p} < .08$). No age difference was shown relative to asymmetrical tonic neck reflex scores.

A definite relationship was shown between the manner in which the children approached the spatial awareness task and the sequencing/ orientation-in-space sub-score. This association was significant at the .01 level.

A significant linear correlation was shown to exist between the general intergration/visual-motor sub-score and the amount of time the children spent completing the spatial awareness task ($p < .04$). More time spent was related to better general integration/visual-motor quality.

Regarding the latency time, there was found to be a significant linear correlation between the latency time and the sequencing/orienta-ion-in-space and general integration/visual-motor aspects of the spatial awareness task ($p < .01$ and $p < .003$). The greater the latency time, the larger (poorer) the spatial awareness task score which was obtained.

Placement of the dog and manner score were associated at a level approaching significance ($p < .07$). The points deducted for angulation of parts correlated significantly with the sequencing/orientation-in-space sub-score of the spatial awareness task ($p < .003$), as well as the general integration/visual-motor portion of the spatial awareness task ($p < .0001$).

No statistically significant association between ATNR scores and spatial awareness task scores was demonstrated. Specifically, the p values ranged between .998 and .08. ATNR-R was elicited significantly more often than was ATNR-L ($p < .0002$).

CHAPTER IV

DISCUSSION AND IMPLICATIONS

Discussion of Significant Findings

Spatial Awareness Task Findings

Despite a rather wide range of quality of finished spatial awareness tasks completed by the subjects, all the children tested evinced great interest in the task, and without exception they seemed particularly delighted with the door that opened to reveal a person. Each child wanted to make an identical picture to take home and was allowed to do so. It would seem that the seven-piece placing and pasting task is at an appropriate level for normal 4-year-olds, judging from the challenge it appeared to present and the delight with which it was received.

Sex Differences. The girls did significantly better than the boys ($p < .04$) on the general integration/visual-motor portion of the spatial awareness task. As shown in Table III, the means for the girls' scores on the spatial awareness task without exception reflect a better performance than do the means for the boys' scores (at least relative to the scoring criteria set forth in this study). Even though the mean time to complete the task for the girls was greater than for the boys in this sample, the difference was not significant and no inferences are justified regarding maturation, impulsivity on the part of the boys, or better concentration on the part of the girls.

Age Difference. There appears to be a difference approaching statistical significance between age groups, relative to the sequencing/orientation-in-space portion of the spatial awareness task. As shown on Table IV, the scores of the oldest one-third of the subjects are almost three times better than those of the youngest. Although the comparison of the sequencing/orientation-in-space sub-scores of the three age groups only approaches statistical significance ($p < .08$), it is felt that the difference between the oldest and youngest groups of these 4-year-old children is notable. This is a critical time in children's development of spatial relations concepts, and awareness of this has teaching implications.

Latency Times. Kagan (1965) investigated reflection-impulsivity behavior in first graders and felt that during response latency periods to a visual matching task the children were mentally considering alternatives, and that, "Response latency was a faithful index of decision time" (p. 627). He acknowledged that, "Long response latencies could reflect merely a strong inhibition in offering any response, perhaps arising out of fear of responding with a strange adult" (Kagan, 1965, p. 627). It appeared to the researcher of this study that Kagan's latter hypothesis applied best to the 4-year-old subjects studied here and with this particular spatial awareness task. It was felt that response latency periods observed seemed to reflect uncertainty and confusion and some difficulty with initiating the task.

Somewhat supportive of this impression is the fact that a significant linear correlation was demonstrated between latency time and sequencing/orientation-in-space sub-scores ($p < .01$) and general integration/visual-motor sub-scores ($p < .003$), the higher latency times tending to occur with the higher sub-scores (high sub-scores reflecting "poorer" quality of finished spatial awareness task).

As seen in Table III, the average performance on the spatial awareness task of the girls was better than that of the boys ($p < .06$), and their average latency time was less than one half of that of the boys ($p < .26$) Table IV shows that the youngest subjects averaged over four times the latency time of the oldest subjects; however, the significance level for latency time versus age group is only $p < .10$. These findings may perhaps indicate that with these young subjects, latency time is in part a reflection of level of maturity rather than a more advanced cognitive style as suggested in Kagan's (1965) study with older children.

The fact that the comparison between ATNR-R and latency scores approached significance ($p < .08$) may also be an indication that immaturity is in some way involved with latency time evinced at age four. The less mature a child is neurologically the more likelihood of his evincing primitive postural reflex behavior.

Time-to-Complete. A significant linear correlation was found between time-to-complete and general integration/visual-motor portion of the spatial awareness task ($p < .04$). This may suggest that "time-to-complete" implies "how-careful-child-was" rather than "length-of-time-child-required-to-complete-task."

Manner in Which Subjects Approached Task. Analysis of results of testing strongly indicated that a child who uses an efficient approach to the spatial awareness task scores significantly better on the sequencing/orientation-in-space portion of the task than does the child who uses a random approach ($p < .01$). The manner in which the child approached the task was shown to be related to the number of points deducted from his general integration/visual-motor sub-score for angulation of parts ($p < .01$). However, the fact that one subject received 45 deduction points, while the next largest number of points deducted for angulation of parts was only 18, may be greatly distorting the statistics relative to angulation of parts.

It may be noted that angulation of parts and sequencing/orientation-in-space sub-score were significantly related as seen in Table V ($p < .003$). Were it not for the fact of the one highly unusual angulation score which may be distorting the statistics, one might infer that it is possible that these three factors (manner score, sequencing/orientation-in-space sub-score, and angulation score) may be dependent upon some ability basic to all three.

Manner score was not significantly associated with age of subject, so one would assume that the common factor here is probably not maturity. It may be that a style of cognitive approach to organization in time and space is what is being measured by these three scores (manner score, sequencing/orientation-in-space sub-score, and perhaps angulation score). This ability also seems to be independent of time-to-complete the task, as neither manner score, sequencing/orientation-in-space sub-score, or the angulation of parts aspect was associated significantly with the time-to-complete.

Banus's (1971) statement quoted earlier regarding visual sequencing certainly implies a relationship between sequencing ability and the child's ability to organize a task:

> Here the child must recognize a spatial-directional ordering....Material may be positioned in a vertical or horizontal sequence from left to right, in front, behind, beside, or

> top or bottom. In all cases, there are dimensions of 'beginning' or 'first', 'middle' and 'end' or 'last', denoting sequential progression. Developing an awareness of sequence gives the child a systematic means of organizing, interpreting and transmitting information....If the child has the concept of sequencing, he then knows where to begin and end, and what must occur between the two extremes (p. 317).

Verbalization. As previously noted, all but three of the children tested, when asked if their picture looked the same as the sample picture, replied, "yes". It is felt that there is a strong possibility that the children did not completely understand the question. According to Martin, *et al.* (1969),

> ...three and four year old children do not consistently have the concept of same or different. While these children [can] motorically match similarities, they do not grasp this concept verbally (p. 394).

Reliability. Regarding the reliability of the spatial awareness task, it was informally noted that the picture each child made to take home (completed after the formal testing) was remarkably similar to that he made during the formal testing. In other words, it can be stated subjectively that the children did respond in the same way on a second chance at the spatial awareness task that they did on the first chance at it. The examiner was a stranger to all the children tested, and it cannot be stated that this did not have an effect upon the response of the children to the spatial awareness task. It can, however, be stated subjectively that the children all seemed to be at ease with the examiner, at least by the end of the "practice period", therefore it seems unlikely that shyness on the part of any subjects adversely affected their performances.

Regarding examiner reliability relative to the scoring of the spatial awareness task, subjective impressions were not called for in this scoring system. All the factors were objectively measureable.

Reflex Test Findings

Although the probability level only approached significance, ($p < .10$), a tendency for girls to evince better integrated ATNR than boys was observed. This sort of age difference was noted by Rider (1972), who found, in testing normal second grade children, that the boys, "...exhibited significantly more abnormal reflex responses than did the girls in the same group" (p. 241). The level of significance for this association was .05. Rider's study involved reflex screening at the spinal, brain stem, midbrain, and cortical levels of the central nervous system. A study by Parmenter (1975) involving only the screening of ATNR behavior showed a sex difference identical to that found in this study: "The mean score of females was higher than that of males but the difference did not meet the .05 level of significance ($F = 2.89$, df 1, 60, $p < .10$)" (p. 467). Parmenter's study and this study both suggest that normal subjects commonly evince some degree of ATNR when screened in the quadruped position, their heads rotated laterally.

Table VII shows that ATNR-R was more frequently elicited in the subjects of this study than was the ATNR-L. Ayres (1972) states that, "As a general rule, the side of the body showing the greater manifestation of the TNR is reflecting the lesser degree of integration in the contralateral part of the brain" (p. 107). On the other hand, Parmenter (1975) found, when screening normal first and third grade children for presence of ATNR that, "The data comparing right and left lateral rotations of the head revealed a highly significant difference, the right scoring the higher ($F = 20.53$, df 1,60, $p < .001$)" (p. 267). Parmenter's finding with normal children, then, are consistent with the findings of this study on normal children that ATNR-R appears to be more commonly elicited than ATNR-L ($p < .0002$). No significant associations were found between ATNR behavior and performance on the spatial awareness task.

Regarding the reliability of the children's responses to the asymmetrical tonic neck reflex screening, the responses were supposedly reflex in nature. Therefore, it probably can be assumed that the fact that the examiner was a stranger had little or no affect on the responses. It cannot positively be stated that each child would respond in the same way upon retest at another time. Examiner reliability was not formally established. The examiner has used the ATNR screening procedure clinically in the past and is proficient in this area.

Implications for Future Study

Expanding this study into a longitudinal one and/or one including a wider age range of subjects would be desirable. It would, of course, be extremely meaningful if one could establish whether or not the children with poor spatial awareness task scores at age four, or poor reflex scores, tend to subsequently be identified as children with learning disabilities. The range of scores in this study may be totally within normal limits. To determine this, one would need to use the same measurements with children who have been diagnosed as having learning disabilities, and it is not easy to find such subjects at age four.

Valuable information may have been excluded from this study because results from the tonic labyrinthine reflex and symmetrical tonic neck reflex screenings were not analyzed. It is felt that future research relative to this topic, if conducted in a clinical setting, should include more conclusive tonic labyrinthine and symmetrical tonic neck reflex screening procedures and should include reflex screening at the midbrain level, as Rider's (1972) findings with children with learning disabilities have indicated "...a much higher incidence of abnormal responses [to reflex testing] at the midbrain level than at any other CNS level" (p. 243).

CHAPTER V

SUMMARY

The purpose of this study was to 1) examine behavior and develop some normative information about the performance of normal 4-year-old children on an evaluative/training activity of a type sometimes used with children who appear to be experiencing spatial awareness problems, and to 2) determine whether or not a relationship exists between the normal 4-year-old's ability to perform the spatial awareness task and the degree to which he has integrated the asymmetrical tonic neck reflex. The following hypotheses were examined:

1) There will be no significant assocation between the 4-year-old child's level of performance on the spatial awareness task and the degree to which he has inhibited the asymmetrical tonic neck reflex.

2) There will be no significant assocation between the manner in which the 4-year-old child approaches the spatial awareness task and his finished product.

3) There will be no significant association between the amount of time it takes the 4-year-old child to execute the spatial awareness task and his finished product.

4) There will be no significant association between the time it takes the 4-year-old child to initiate the spatial awareness task (latency time) and his finished product.

The sample was composed of 49 normal 4-year-old children, 23 girls and 26 boys. All were attending pre-school facilities in Stillwater, Oklahoma.

Measuring devices were:

1) A placing and pasting activity which was scored as to sequencing/ orientation-in-space quality, the general integration/visual-motor quality, the manner in which the task was completed, the response latency time, and the time taken to complete the task.

2) A procedure commonly used clinically in the evaluation of presence of asymmetrical tonic neck reflex behavior, for which a simple scoring system was devised.

As a result of statistical analysis of the data, hypothesis 1 was not rejected at the $\underline{p} = .05$ level, and hypotheses 2, 3, and 4 were rejected. In general girls did score better on the spatial awareness task than the boys, and there was a notable difference between the performance of the oldest and youngest one/third of the subjects on the spatial awareness task.

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APPENDIX A

TABLE VIII

DESCRIPTIVE DATA AND TEST SCORES OF SUBJECTS PARTICIPATING IN THIS STUDY

			Scores											
Subject No.	Sex	Age (Mo.)	Seq.	V-M	Manner	Dog	House	Ang.	Latency (Min.)	(Sec.)	Time-to-Complete (Min.)	(Sec.)	ATNR(L)	ATNR(R)
01	M	9	2	17	2	0	1	5	0	0	7	30	2	2
02	M	6	1	14	1	1	1	2	0	0	16	15	2	2
03	M	7	3	13	1	1	0	0	0	0	3	7	1	1
04	M	5	10	33	3	0	0	3	0	0	8	0	0	2
05	F	8	0	2	0	1	1	1	0	0	12	45	0	2
06	F	8	0	3	1	1	1	1	0	0	2	30	0	0
07	M	5	3	11	1	1	0	2	0	0	4	15	1	2
08	M	11	2	12	1	0	1	1	0	0	6	30	1	2
09	F	8	6	6	1	0	0	1	0	0	14	50	1	2
10	M	8	0	19	0	1	1	3	0	0	9	30	2	2
11	M	7	4	15	0	1	1	3	0	0	5	30	1	1
12	F	0	15	33	0	1	0	4	0	0	4	15	0	0
13	F	0	3	9	1	0	1	0	0	9	6	29	1	1
14	F	1	6	16	1	0	0	5	0	0	3	50	0	0
15	M	8	6	17	1	0	1	1	0	5	3	25	2	2
16	F	4	0	17	2	1	1	1	0	0	3	15	1	1
17	F	11	1	20	1	1	1	3	0	0	4	40	2	2
18	F	1	0	24	1	1	1	6	0	0	2	10	1	0
19	M	10	0	17	0	1	1	3	0	0	3	55	1	1
20	M	3	22	43	1	0	1	0	0	7	4	8	2	2

TABLE VIII (Continued)

Subject No.	Sex	Age (Mo.)	Scores: Seq.	V-M	Manner	Dog	House	Ang.	Latency (Min.)	Latency (Sec.)	Time-to-Complete (Min.)	Time-to-Complete (Sec.)	ATNR(L)	ATNR(R)
21	F	10	14	19	0	1	1	7	0	7	4	0	0	0
22	M	9	2	24	1	0	1	2	0	2	2	50	1	1
23	F	4	11	28	3	0	1	0	0	5	4	45	0	0
24	M	6	22	81	3	0	0	45	0	0	5	05	1	0
25	F	11	6	37	1	0	0	11	0	0	4	30	0	1
26	M	2	17	48	1	0	1	6	1	10	4	30	2	2
27	F	11	5	36	0	0	0	1	0	30	2	10	2	2
28	M	4	13	77	1	1	1	7	0	30	2	30	1	2
29	F	1	00	18	0	1	1	3	0	0	12	35	2	2
30	M	8	1	34	1	1	1	0	0	0	4	30	0	0
31	M	0	4	53	0	1	1	18	1	0	4	00	1	2
32	M	7	2	32	1	0	1	5	0	0	3	15	2	2
33	F	6	DROPPED FROM STUDY											
34	F	5	1	3	1	1	1	0	0	3	9	30	1	2
35	M	8	0	10	2	1	1	1	0	0	5	30	2	2
36	M	6	3	24	2	0	1	3	0	0	4	30	0	2
37	F	5	3	16	0	0	1	7	0	0	6	30	1	0
38	F	9	1	30	1	1	1	3	0	0	7	45	0	1
39	M	9	0	21	0	1	1	1	0	17	6	15	1	2
40	M	5	10	26	1	0	1	4	0	30	5	00	0	2

TABLE VIII (Continued)

Subject No.	Sex	Age (Mo.)	Scores											
			Seq.	V-M	Manner	Dog	House	Ang.	Latency (Min.)	(Sec.)	Time-to-Complete (Min.)	(Sec.)	ATNR(L)	ATNR(R)
41	F	4	8	14	1	1	0	1	0	8	3	15	2	2
42	M	7	4	48	0	1	0	2	0	0	5	45	0	0
43	M	9	0	33	1	1	1	1	0	0	2	30	0	0
44	F	5	0	37	2	1	1	12	0	0	4	45	0	2
45	M	3	0	34	1	1	1	7	0	0	6	0	2	2
46	M	2	4	12	1	1	0	0	0	0	2	30	0	2
47	F	9	0	12	0	1	1	0	0	0	2	20	0	0
48	F	1	6	28	1	1	1	1	0	23	7	0	2	2
49	F	1	1	18	0	1	1	4	0	0	10	0	0	0
50	F	7	7	34	0	0	1	6	0	0	5	0	0	1

TABLE IX

CHI-SQUARE TEST RESULTS

Variables	d.f.	X^2	*p*
Manner - House	3	4.75	.19
ATNR - House	4	1.27	.87
ATNR(L) - House	2	1.31	.53
ATNR(R) - House	2	.38	.83
ATNR(L) - ATNR(R)	4	22.19	.0002
ATNR - Manner	12	11.03	.53
ATNR(L) - Manner	6	3.36	.76
ATNR(R) - Manner	6	6.92	.33
Manner - Dog	3	7.10	.07
House - Dog	1	.84	.36
ATNR - Dog	4	3.90	.42
ATNR(L) - Dog	2	.14	.92
ATNR(R) - Dog	2	.52	.78
Manner - age	6	8.48	.20
House - age	2	1.54	.47
Dog - age	2	.42	.81
ATNR - age	8	6.18	.63
ATNR(L) - age	4	3.03	.55
ATNR(R) - age	4	1.26	.87
Manner - sex	3	1.57	.67
House - sex	1	.06	.79
Dog - sex	1	.29	.60
ATNR - sex	4	7.87	.10
ATNR(L) - sex	2	3.29	.19
ATNR(R) - sex	2	4.87	.09

TABLE X

SUMMARY OF ONE-WAY ANALYSIS OF VARIANCE STATISTICS

Dependent Variable		Classification Variable	d.f.	Mean Square (Error)	F	p
TTC	-	ATNR	4, 44	37970.00	.86	.50
Latency	-	ATNR	4, 44	204.10	1.75	.15
Ang.	-	ATNR	4, 44	39.70	3.48	.01
Total	-	ATNR	4, 44	412.05	1.09	.37
V-M	-	ATNR	4, 44	268.32	1.21	.32
Seq.	-	ATNR	4, 44	34.00	.37	.83
TTC	-	ATNR(R)	2, 46	35643.20	2.26	.11
Latency	-	ATNR(R)	2, 46	202.90	2.66	.08
Ang.	-	ATNR(R)	2, 46	48.19	.86	.57
Total	-	ATNR(R)	2, 46	422.96	.56	.58
V-M	-	ATNR(R)	2, 46	280.09	.39	.68
Seq.	-	ATNR(R)	2, 46	32.56	.75	.52
TTC	-	ATNR(L)	2, 46	38171.54	.58	.57
Latency	-	ATNR(L)	2, 46	214.25	1.30	.28
Ang.	-	ATNR(L)	2, 46	48.00	.96	.61
Total	-	ATNR(L)	2, 46	432.97	.01	.99
V-M	-	ATNR(L)	2, 46	284.83	.001	.998
Seq.	-	ATNR(L)	2, 46	33.47	.11	.90
TTC	-	House	1, 47	38010.07	.37	.55
Latency	-	House	1, 47	218.35	.69	.58
Ang.	-	House	1, 47	47.43	1.49	.23
Total	-	House	1, 47	410.72	1.52	.22
V-M	-	House	1, 47	275.16	.62	.56
Seq.	-	House	1, 47	29.88	4.76	.03
TTC	-	Dog	1, 47	38200.55	.13	.72
Latency	-	Dog	1, 47	218.72	.61	.55
Ang.	-	Dog	1, 47	47.57	1.35	.25
Total	-	Dog	1, 47	398.07	3.06	.08
V-M	-	Dog	1, 47	271.56	1.25	.27
Seq.	-	Dog	1, 47	27.13	10.01	.003

TABLE X (Continued)

Dependent Variable		Classification Variable	d.f.	Mean Square (Error)	F	p
TTC	-	Manner	3, 45	39107.56	.35	.79
Latency	-	Manner	3, 45	224.54	.46	.72
Ang.	-	Manner	3, 45	40.51	3.92	.01
Total	-	Manner	3, 45	366.32	3.13	.03
V-M	-	Manner	3, 45	255.09	2.12	.11
Seq.	-	Manner	3, 45	26.39	4.54	.01
TTC	-	age	2, 46	39133.12	.01	.99
Latency	-	age	2, 46	204.94	2.41	.10
Ang.	-	age	2, 46	47.77	1.08	.35
Total	-	age	2, 46	391.16	2.47	.09
V-M	-	age	2, 46	263.21	1.89	.16
Seq.	-	age	2, 46	30.13	2.67	.08
TTC	-	sex	1, 47	37746.83	.70	.59
Latency	-	sex	1, 47	215.56	1.31	.26
Ang.	-	sex	1, 47	48.42	.51	.51
Total	-	sex	1, 47	394.57	3.50	.06
V-M	-	sex	1, 47	255.16	4.35	.04
Seq.	-	sex	1, 47	32.59	.46	.51

APPENDIX B

SPATIAL AWARENESS TASK

The child is shown a picture which has been constructed by pasting seven colored forms onto a 9 by 12 inch piece of construction paper. (See Figure 1, page 57.) The forms are representative of the following, proceeding from the left to right on the page:

1) stylized tree consisting of (1) a green circle representing the leaf mass and (2) a long, slender, black rectangle representing the tree's trunk and connecting the circle with the bottom of the page.

2) house represented by (3) an orange rectangle into which is cut a flap which represents a door that can be opened to reveal the form of (4) a yellow person with facial features outlined. The roof of the house is represented by (5) a red triangle onto which is pasted (6) a blue rectangular "window".

3) the figure of (7) a black dog, facing right. The figure of the dog has no features outlined on it.

The examiner asks the child to describe what is in the picture in order to establish whether or not the child can perceive two-dimensional representations. As, according to the Denver Developmental Screening Test (Frankenburg & Dobbs, 1969), this ability is usually well established by age 2½, it was assumed for purposes of this study that any 4-year-old child who cannot describe the picture is not a "normal" 4-year-old, and therefore would not be included in the testing sample.

After determining that the child recognizes the representations in the picture, the examiner says, "I want you to make a picture the same

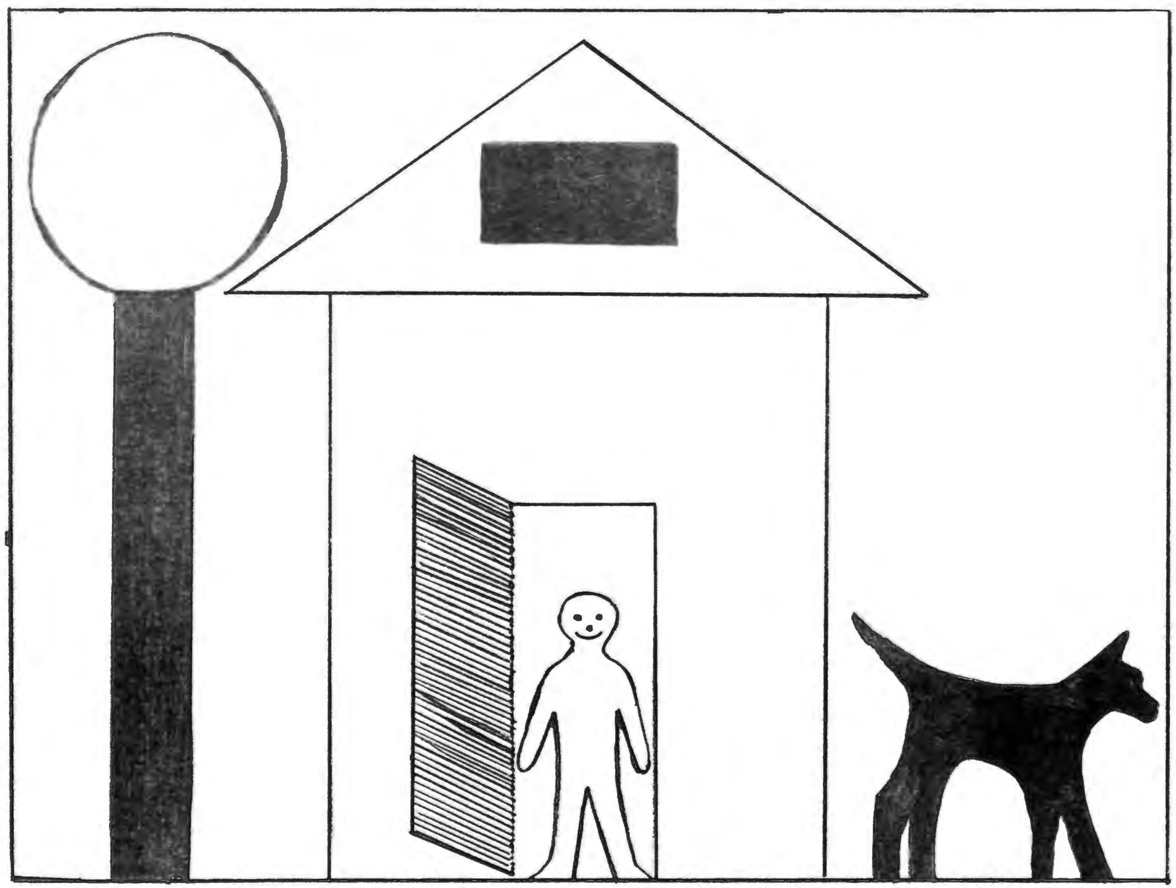

Figure 1. Spatial Awareness Task (one-half scale)

as 'this' picture. Here is the paper and the pieces." The examiner gives the child a piece of paper and shows him an envelope containing the pieces. The examiner then dumps the pieces out onto the table so that the child can see all the pieces simultaneously. This manner of presenting the child with the pieces was used for the following reasons: 1) If the child were given the envelope and allowed to take the forms out himself, too much time might be expended in this process, thereby possibly causing a distraction from the spatial awareness task itself. Furthermore, the order in which the child happened to randomly pull the pieces from the envelope might affect the order in which he pasted the pieces. 2) It was felt that a system of placing the pieces in a certain order next to the child's blank piece of paper might also affect the child's order of pasting. 3) A system of pre-arranging the pieces for the child was attempted during the pilot testing, and it was determined that this system afforded the child too much assistance. In other words, the system of the examiner dumping the pieces onto the table next to the child's blank piece of paper proved to provide the child with the fewest cues relative to order of pasting.

The order in which the child pastes the forms is recorded. Judging from the order, the relative efficiency of the child's approach to the task may then be determined (manner score).

The examiner times how long it takes the child to actually begin working at the task, i.e., the period between the time the examiner dumps the pieces onto the table and the time the child picks up the first piece (latency score). Also the examiner times how long it takes the child to finish the task after he has once begun working at it (time-to-complete score).

When the child finishes the task, the examiner asks if the child's picture looks the same as the sample picture. The child's answer to this question is recorded.

Scoring the Spatial Awareness Task

As described in Chapter III, numerous trials were required before a satisfactory scoring system was affected. The following system was devised which produces a numerical score that seems to reflect the overall quality of the finished product, including sequencing and orientation of parts in space, visual-motor accuracy, and general integration of parts into a whole.

Sequencing/Orientation-in-Space Sub-Score

1) One point is deducted[1] if the door is pasted. (On the sample, the door is free to open.)

2) Two points are deducted if the dog is not pasted facing to the right.

3) Three points are deducted if the house is pasted so that the door hinges on the right instead of on the left side.

4) Four points are deducted if the tree is not on the left side of the house.

5) Five points are deducted if the window is not in front of the roof.

---

[1]The term "deducted" is used in a negative sense; a score of zero is considered perfect. A score of ten, then, for example, would refer to ten points removed from being perfect. The larger the numerical score, the less accurately the finished product imitates the sample picture.

6) Five points are deducted if the dog is not on the right side of the house.

7) Six points are deducted if the dog is not pasted with his feet downward.

8) Seven points are deducted if the house is not pasted with the door located at the bottom.

9) Eight points are deducted if the person is not behind the door (or at least more than one half of the person is not situated behind the door).

10) Eight points are deducted if the page is oriented vertically rather than horizontally.

11) Eight points are deducted if the roof is not on top of the house.

12) Nine points are deducted for each piece omitted.

13) Nine points are deducted if the leaf mass is not on top of the trunk.

14) Nine points are deducted if the person is not pasted face up.

15) Nine points are deducted if the person is pasted feet upwards.

The weighting of these scores was assigned according to frequency of occurrence in the sample population. Those items occurring least frequently have been assigned the largest deduction; those items occurring most frequently have been assigned the smallest deduction. Table XI shows the frequency of occurrence of the identified errors among the group being studied and the assigned scores based on this distribution.

TABLE IX

ASSIGNMENT OF DEDUCTION POINTS ACCORDING TO FREQUENCY OF OCCURRENCE OF ERROR

Error	Frequency	Assigned Deduction Points
Door pasted	20	1
Dog not facing to right	16	2
Door not hinging on left	13	3
Tree not to left of house	8	4
Window not in front of roof	5	5
Dog not to right of house	5	5
Dog's feet not downward	3	6
Door not at bottom of house	2	7
Person not behind door	1	8
Page oriented vertically	1	8
Roof not on top of house	1	8
Piece omitted	0	9
Leaf mass not on top of trunk	0	9
Person not face up	0	9
Person's feet not downward	0	9

General Integration/Visual-Motor Sub-Score

1) One point is deducted if the leaf mass is not tangent to the trunk. The trunk may lie partially under the leaf mass, but may not protrude beyond the leaf mass. (See Figure 2.)

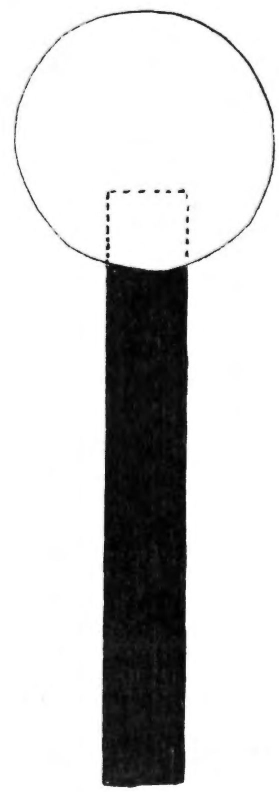

Figure 2. Sketch Illustrating Trunk Lying Partially Under Leaf Mass (This placement is considered as "tangent" if the trunk does not protrude beyond leaf mass.)

2) One point is deducted if roof is not tangent to house. Again, the house may lie partially under the roof, but may not protrude beyond

the roof.

3) One point is deducted for the first five degrees of angulation of: a) the roof, b) the window, c) the tree, d) the house, e) the dog, and f) the person. Two points are deducted for each additional five degrees of angulation or part thereof that any of those six parts angulates over the initial five degrees.

When a piece angulates more than 90 degrees, it is no longer treated as a mere angulation. It is thought to have been pasted up-side-down. The point of reference relative to determining the degrees of angulation then becomes the top of the page. (Points of deduction for a piece being pasted up-side-down are covered in the Sequencing/Orientation-in-Space sub-score.)

4) The window is permitted to be 1/4-inch off center relative to the center of the roof. However, beyond that 1/4-inch one point is deducted for each 1/4-inch unit (or part thereof beyond 1/16-inch) that the window is off center of the roof horizontally. Regarding the vertical dimension, one point is deducted if the window touches the edge of the roof or is closer than 1/16-inch at the closest point.

5) The leaf mass is allowed to be 1/4-inch off center relative to the center of the trunk (measuring vertically through the trunk). However, beyond that 1/4-inch one point is deducted for each 1/4-inch (or part thereof beyond 1/16-inch) that the leaf mass is off center of the trunk.

6) The roof is allowed to be 1/4-inch off center relative to the center of the house; however, beyond that 1/4-inch one point is deducted for each 1/4-inch (or part thereof beyond 1/16-inch) that the roof is off center of the house.

7) The roof may be as far as 1/4-inch from the house with no deduction taken other than that already taken for the roof not being tangent to the house. However, beyond the 1/4-inch one point is deducted for each 1/4-inch unit (or part thereof beyond 1/16-inch) that the roof is from the top edge of the house at the closest point.

8) The leaf mass may be as far as 1/4-inch from the trunk with no deduction taken other than that already taken for the leaf mass not being tangent to the trunk; however, beyond that 1/4-inch one point is deducted for each 1/4-inch unit (or part thereof beyond 1/16-inch) that the leaf mass is beyond the top edge of the trunk.

9) One point is deducted for each point at which one part touches another incorrectly. In addition, beyond that initial "touch" deduction (which includes anything from a "touch" to 1/4-inch of overlap) one point is deducted for each 1/4-inch unit (or part thereof beyond 1/16-inch) that a part overlaps beyond 1/4-inch.

For example, if the dog's tail touched the house or overlapped the house 1/4-inch, one point would be deducted. If the dog's tail overlapped the house 3/8-inch instead, two points would then be deducted for the error of the dog overlapping the house.

A special instance arises in the case of the person overlapping the door frame in two directions, top and side. (See Figure 3.) In this case both directions are measured and totaled.

In the instance illustrated in Figure 4 where the roof overlaps the house to the extent that a part of the house protrudes from behind the roof, only that portion protruding is measured and scored accordingly. The same principle also applies to measuring a trunk which protrudes from behind the leaf mass.

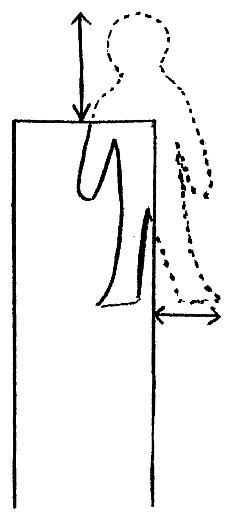

Figure 3. Sketch Illustrating Person Overlapping Door Frame in Two Directions

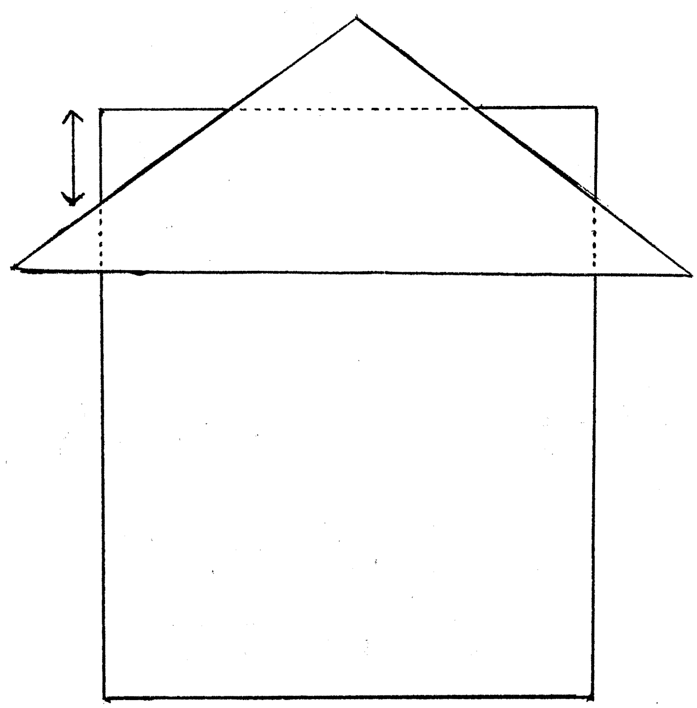

Figure 4. Sketch Illustrating Roof Overlapping House so that Part of the House Protrudes from Behind Roof

The window being pasted on the house rather than on the roof is another special instance. (See Figure 5.) Such positioning is considered an overlap, and the distance from the lower edge of the roof to the most distant edge of the window is measured and scored accordingly.

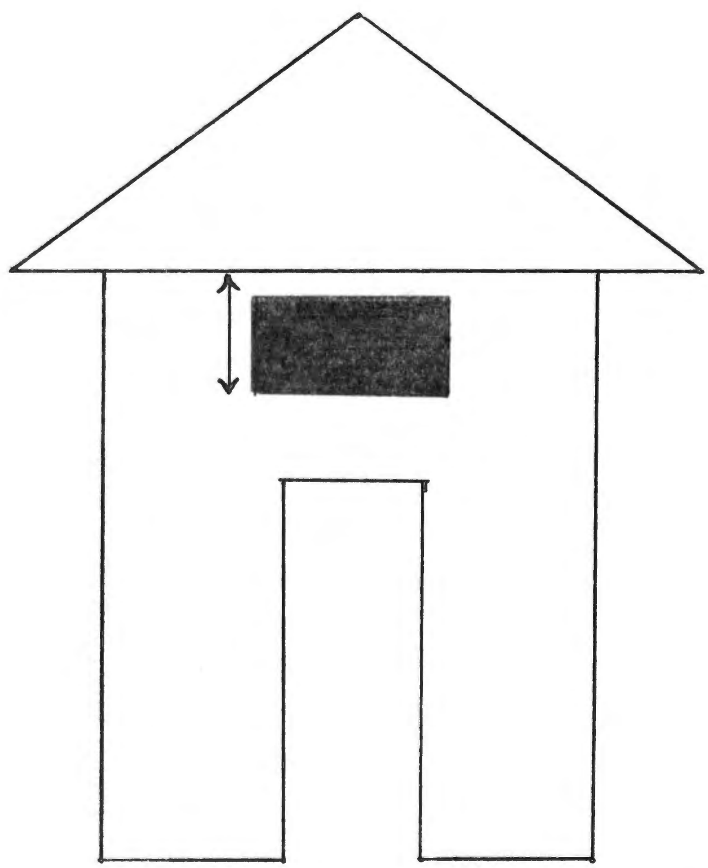

Figure 5. Sketch Illustrating Window Misplacement and the Correct Measurement for Determining Points Deducted

In the case where two parts of a figure, such as the dog's tail and a leg, overlap another form, such as the house, in one direction only, the measurement is taken at the largest overlapping distance, and only that measurement is used in determining the deduction. (See Figure 6.)

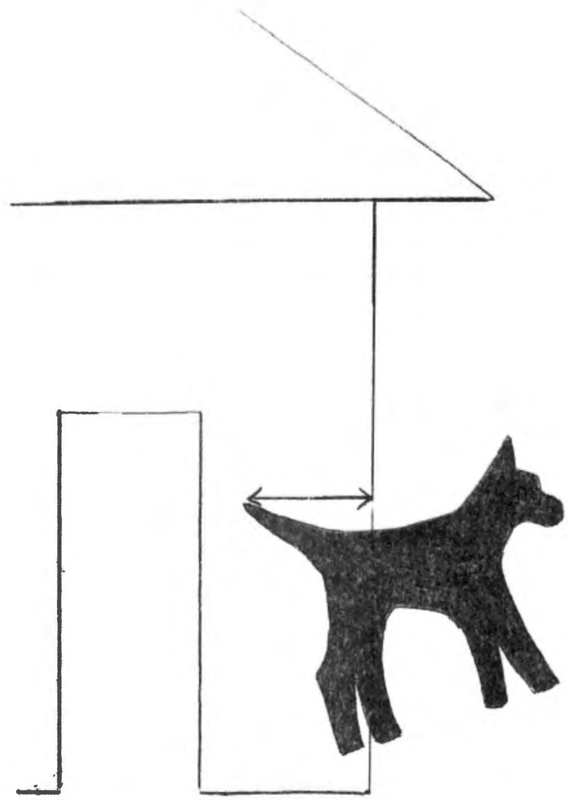

Figure 6. Sketch Illustrating Overlapping of Two Aspects of One Piece and the Correct Measurement for Determining Points Deducted

10) One point is deducted for each 1/4-inch unit (or part thereof beyond 1/16-inch) that parts extend beyond the edge of the page. In the case that a part extends beyond two edges, both dimensions are measured and scored accordingly. (See Figure 7.)

11) If at least one piece touches the bottom of the page, deduct one point for each 1/4-inch unit (or part thereof beyond 1/16-inch) that

the following pieces are from the bottom of the page: a) the house, b) the trunk, c) the dog.

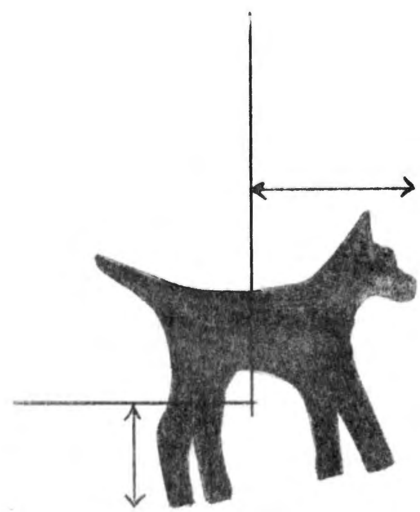

Figure 7. Sketch Illustrating One Part Extending Beyond Two Edges of the Paper and Measurement for Determining Points Deducted

12) If no piece is tangent to the bottom of the page, a line is drawn parallel to the bottom of the page, tangent with the largest piece (the house). If no other piece is more than 1/2-inch from that line, then one may substitute that line for the bottom of the page and deduct one point for each 1/4-inch unit (or part thereof beyond 1/16-inch) that the trunk and/or dog are from that line. In addition, one point is deducted for each 1/4-inch unit (or part thereof beyond 1/16-inch) that the line is from the bottom of the page. Through this system for establishing a base line, credit is given to those individuals who, though

their pieces are not tangent to the bottom of the page, have managed to align the pieces with one another.

13) One point is deducted for every 1/4-inch unit (or part thereof beyond 1/16-inch) that the person is pasted from an imaginary line forming the bottom of the door frame.

Again, a perfect general integration/visual-motor sub-score would be zero. The numerical score indicates points away from perfect. Chapter II describes the validation of this scoring system.

Scoring the Manner in Which the Child Pastes the Parts

As the spatial awareness task picture can be reduced to three basic units, a center part (house, roof, window, and person), a left side (trunk and leaf mass), and a right side (dog), any approach whereby the child works on and finishes one of the three basic units, progresses to and finishes another of the three units, and then finishes the third unit can probably be considered a well-organized, efficient or systematic approach to the task, in other words, a three-unit approach.

If, instead, the child pastes the tree unit, all of the house unit except the window, then the dog, and finally the window, he has used a four-unit approach to the task, or in other words, has used one extra step beyond the most efficient three-unit approach. A child who pastes the trunk, the house unit except for the person, the dog, then the leaf mass, and finally the person has included two steps beyond the efficient three-unit approach.

Using this line of reasoning, the following method of scoring was devised:

(units)

3 _____ (optimum, or 0 points)

4 _____ (one extra step, or one point)

5 _____ (two extra steps, or two points)

6 _____ (three extra steps, or three points)

An approach which by the criteria set forth in this reasoning is thought to be well-organized, efficient, and/or systematic would be given a score of zero. An approach which, again using the criteria set forth in this reasoning, seems random would be given three points, that is, three points away from optimum.

Spatial Awareness Task Score Sheet

In order to facilitate recording the scores, a score sheet was developed for recording data for each subject. A sample score sheet may be found in Appendix D.

APPENDIX C

PRIMITIVE POSTURAL REFLEX TESTING

For purposes of this study, methods of testing for presence of tonic neck and tonic labyrinthine reflexes outlined by A. Jean Ayres (1972) in Sensory Integration and Learning Disorders were used. During the testing it developed that the asymmetrical tonic neck reflex screening procedure proved to be the only screening procedure, of the four listed below, that was appropriate and/or sufficient for purposes of this study. Although all four screening procedures were used, whenever possible, with each subject in the study, only the data from the asymmetrical tonic neck reflex screening procedure was ultimately used in the analysis of data.

Following is a description[1] of the asymmetrical tonic neck reflex test used:

> The change in muscle tone elicited by the TNR [tonic neck reflex] can be observed by turning the child's head while he is in the quadruped position. The turning may be performed passively by the examiner. It is appropriate for the child's eyes to be closed. The elbows should be slightly flexed before the head is turned, for a locked elbow will prevent the observation of the slight movements that indicate changes in tone. Flexion of the arm contralateral to the side toward which the jaw has been rotated is considered indicative of the TNR influence. Resistance to passive turning of the head is believed to be a function of the child's attempt to avoid the disorganizing influence of eliciting the TNR (Ayres, 1972, p. 102).

The asymmetrical tonic neck reflex test (head turned to the left and to the right) was scored as follows:

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[1] Reflex testing procedures outlined in Sensory Integration and Learning Disorders are reprinted by Permission. © 1972, 1972. Western Psychological Services. (Per letter dated August 7, 1975.)

	Left	Right
Zero points were given if no asymmetrical TNR reaction was observed.		
One point was given if slight evidence of asymmetrical TNR reaction was observed (or examiner was in doubt about reaction).		
Two points were given if definite asymmetrical TNR reaction was observed (definite flexion of arm contralateral to side toward which head was turned or definite resistance to turning of head, or both).		

Following is a description of the symmetrical tonic neck reflex test used:

> The influence of the symmetrical TNR on the musculature [may] also be observed...when the child is in the quadruped position....When the head is held in mid-position (as opposed to rotated) and flexed, the TNR increases flexor tone in the arms. When the head is extended, i.e., dorsiflexed or chin raised, extensor tone is increased in the arms (Ayres, 1972, p. 102).

The symmetrical tonic neck reflex test was scored as follows:

	Flexion	Extension
Zero points were given if no symmetrical tonic neck reflex reaction was observed.		
One point was given if slight evidence of symmetrical TNR reaction was observed (or if examiner was in doubt about reaction).		
Two points were given if definite symmetrical TNR reaction was observed (definite flexion of arms on forward flexion of head, or definite increase in extensor tone in arms when head was dorsiflexed).		

Following is a description of the tonic labyrinthine reflex (prone) test used:

> ...a test which has provided a fairly objective and quantifiable means of detecting the degree of influence of the TLR [tonic labyrinthine reflex] in the prone position is performed by

observing how well the child can assume a position in which the extensor muscles must hold the head and extremities up in spite of the increased tone in the flexor muscles brought about by the reflex. The child is asked to assume a prone position with arms flexed at the elbows and the elbows placed about four inches from the body. The child is first helped to know what is expected of him by passively placing him in a prone extensor position with head, shoulder, and arms raised and legs held straight and hyperextended at the hip.... The child being prepared for the test of the TLR should be held in this position only long enough to allow him to get the idea, for the posture is fatiguing and fatigue will reduce the effectiveness of his response on the test proper.

After the child knows what is expected of him, he is asked if he can assume and hold the position for thirty seconds, while counting aloud up to thirty. The child's motivation can be increased by watching the stopwatch that is timing him and counting with the therapist, who times his counting to the number of seconds. The child's counting aloud helps to keep him from holding his breath, only to have to let it out and collapse before reaching the goal of thirty seconds....

Neuromuscularly and orthopedically normal children ages six and above can usually--but not invariably--hold the position for twenty to thirty seconds, depending upon age, with moderate exertion. A lesser time should be expected of children under six years, not only because of lower endurance and motivation but also because the reflex is probably less well integrated at younger ages.

The quality of the response is as important an index as is the ability to maintain a prone extensor posture for a half minute. The well integrated child can lift both ends of the body simultaneously in a smoothly coordinated manner without an excessive amount of effort or instruction but may release it to rest before the end of the test period because there is inadequate reason, from his point of view, to maintain such a difficult posture....On the other hand, some children with poor neurological organization, knowing their limitations and the importance of performance, will clumsily assume the position, often as though each limb acted independently of the rest of the body, rather than as a coordinated whole, and will hold the posture for the thirty-second period with great expenditure of effort and will power. This type of response does not deserve a grade of 'normal' (Ayres, 1972, pp. 98-100).

Following is a description of the tonic labyrinthine reflex (supine) test used:

> Using the same neurophysiological prinicple, the TLR in the supine position can be tested by observing how well the child can hold his head, arms, and legs flexed so that they are off the surface on which his body's weight is resting. The child is asked to 'curl up' without giving himself the advantage of clasping his arms around his knees for a mechanical as opposed to muscular hold (Ayres, 1972, p. 101).

For purposes of this study, the 4-year-old subjects were asked to hold the above positions for 15 seconds while the examiner counted out loud for them. Without exception the subjects of this study required a demonstration of the position in order to understand what was being required of them.

The tonic labyrinthine reflex tests were scored as follows:

	Prone	Supine
Zero points were given if child assumed position easily and held it for 10-15 seconds.	____	____
One point was given if child assumed position with difficulty and held it for 10-15 seconds.	____	____
One point was given if child assumed position but was not able to hold it for even 5 seconds.	____	____
Two points were given if child could not assume position.	____	____

APPENDIX D

Name:______________________________ Date of Birth:________ Age:_____

SPATIAL AWARENESS TASK

Order of pasting:

trunk	___	roof	___
leaf mass	___	window	___
dog	___	house	___
		person	___

Manner Score (units)

3	___	(optimum - 0)
4	___	(one extra - 1)
5	___	(two extra - 2)
6	___	(three extra -3)

Sequencing/Orientation-in-Space Sub-score

___ (one point) door pasted
___ (two points) dog not facing right
___ (three points) hinge not on left
___ (four points) tree not on left
___ (five points) window not in front of roof
___ (five points) dog not on right
___ (six points) dog's feet not downward
___ (seven points) door not at bottom of house
___ (eight points) person not behind door
___ (eight points) page oriented vertically
___ (eight points) roof not on top of house
___ (nine points) for each piece omitted
___ (nine points) leaf mass not on top of trunk
___ (nine points) person not pasted face up
___ (nine points) person pasted feet upwards

=== Sequencing/Orientation-in-Space Sub-score

General Integration/Visual-Motor Sub-score (one point each unless stated otherwise)

___ leaf mass not tangent to trunk
___ roof not tangent to house
one point for first 5^{o} of angulation, 2 points for each 5^{o} unit or part thereof over the first 5^{o} of
___ roof
___ window
___ tree
___ house
___ dog
___ person
___ for each 1/4-inch unit[1] over 1/4-inch that window is off center horizontally (of roof)
___ (vertically) window touches edge of roof or is closer than 1/16-inch
___ for each 1/4-inch unit[1] roof is from house (over 1/4-inch)
___ for each 1/4-inch unit[1] roof is off center of house (over 1/4-inch)
___ for each 1/4-inch unit[1] leaf mass is off center with trunk (over 1/4-inch)
___ for each 1/4-inch unit[1] leaf mass is from trunk (over 1/4-inch)
___ for each instance of a part touching another incorrectly
___ for each 1/4-inch unit[1] (over 1/4-inch) that parts over-lap incorrectly
___ for each 1/4-inch unit[1] that parts extend beyond edge of page

for each 1/4-inch unit[1] that the following pieces are from bottom of page (if at least one piece touches bottom of page)

___ house
___ trunk
___ dog

in the case where none of the above three touches bottom of page, then a line is drawn parallel to bottom of page tangent with the house. If neither of the other two pieces (trunk/dog) is more than 1/2-inch from that line, then the line may serve as the bottom of the page and one point is deducted for each 1/4-inch unit[1] that the following are from the line

___ trunk
___ dog
___ additionally, one point is deducted for each 1/4-inch unit[1] that the line is from the bottom of page
___ for each 1/4-inch unit[1] figure is from bottom of door frame

=== General Integration/Visual-Motor Sub-score

======= TOTAL SPATIAL AWARENESS TASK SCORE

Time score: latency period _____min., _____sec.
time to complete _____min., _____sec.
(beginning with first part moved)

ASYMMETRICAL TONIC NECK REFLEX SCREENING

	left	right	
no	______	______	(0)
?	______	______	(1)
yes	______	______	(2)

COMMENTS:

[1] or part thereof beyond 1/16-inch

APPENDIX E

TABLE XII

FREQUENCIES OF ATNR SCORES BY SEX

ATNR Scores	Sex	
	Female	Male
0	7	3
1	5	1
2	4	8
3	2	5
4	5	9

Chi-Square = 7.87 d.f. = 4 p = .10

TABLE XIII

FREQUENCIES OF ATNR-L SCORES BY SEX

ATNR-L Sub-score	Sex Female	Male
0	12	7
1	6	10
2	5	9

Chi-Square = 3.29 d.f. = 2 p = .19

TABLE XIV

FREQUENCIES OF ATNR-R SCORES BY SEX

ATNR-R Sub-score	Sex Female	Male
0	9	4
1	5	4
2	9	18

Chi-Square = 4.87 d.f. = 2 p = .09

VITA

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Candidate for the Degree of

Master of Science

Thesis: PERFORMANCE OF 4-YEAR-OLDS ON A SPATIAL RELATIONSHIP TASK, CORRELATED WITH ASYMMETRICAL TONIC NECK REFLEX BEHAVIOR

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