AN OBSERVATION ON STEREOGNOSIS IN PRESCHOOL CEREBRAL PALSIED CHILDREN

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MEI-JIN CHEN, B. S.

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Denton, Texas

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We hereby recommend that the **paper** prepared under our supervision by **Mei-Jin Chen** entitled **AN OBSERVATION ON STEREOGNOSIS IN PRESCHOOL CEREBRAL PALSIED CHILDREN**

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Master of Occupational Therapy

Committee:

Ruth Pershing
Chairman

Nancy L. Griffin

[illegible]

[illegible]

Accepted:

Mary Evelyn Huey
Dean of Graduate Studies

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The ability to identify objects by touching or feeling them, without benefit of vision, is a habitual part of one's daily life. The ability, known as "stereognoisis." is one component of perceptual-motor function. Gilfoyle and Grady (9) defined perception as the organization and interpretation of sensation. The achievement of stereognosis depends on the integration of tactual perception and proprioception, and is influenced by vision. In the developing child, gnostic age like mental age increases with chronological age. Benton and Schultz (6), and Hoop (11) indicated that older children can interpret the feel of objects in the hand much better than younger children can. Ferreri (8) stated that brain lesions can negate or retard development of this function.

A child with this type of perceptual-motor dysfunction, according to Ayres' hypothesis on perceptual-motor developmental sequences, probably would be delayed in developing body scheme in early childhood. Motor planning would become difficult without depending on visual aid. Ayres (2) suggested that skill in manual tasks would be difficult to develop, and motor learning would be difficult when hand dexterity was demanded. Benton (6) and Ferreri (8) found that a child with neuromuscular disability who has stereognosis impaired often shows a more marked disuse of his extremity than his motor disability warrants. According to Monfraix (14) and Rusk (16) astereognosis, or retardation in the development of stereognosis, has been stated as one kind of deficit which may occur in children with cerebral palsy.

Since astereognosis can impede normal motor learning as well as the development of body scheme and its associated functions, early detection of retardation in the development of stereognosis is important.

Purpose of the Study

It was the purpose of this study to determine the variance in stereognostic function in a sample of cerebral palsied preschool children compared with a "normal" sample of children within the same age group. The findings should assist occupational therapists in determining developmental deficits in stereognosis, and in implementing a treatment program to facilitate improvement.

Definition of Terms

The following definitions are relevant to this study:

Stereognosis--Benton (6) defined stereognosis as the ability to recognize an object solely by the means of the mechanisms of active touch, without the aid of vision.

Cerebral Palsy--Denhoff (7) defined cerebral palsy as a manifestation, or group of manifestations, of impaired neurologic function due to aberrant structure, growth or development of the central nervous system. The manifestation of impaired neurologic function may be observed as a variety of neuro-motor, intellectual, sensory, and behavior signs and symptoms singly or in combination and varying in degrees.

Spasticity--According to Denhoff (7), spasticity is characterized by a lower threshold of the stretch reflex, an enlarged reflexogenic area, augmental responses with clonus, and an abnormal electromyographic record (synchronization of discharge rate in various parts of the spastic muscles). The pathologic stretch reflex must be present to make a diagnosis of spasticity. There is a tendency toward greater involvement and contractures, affecting the anti-gravity muscles.

Athetosis--According to Denhoff (7) athetosis is characterized by an abnormal amount and types of involuntary motion, normal reflexes, normal electromyographic findings, uncontrolled, incoordination with varying degrees of tension.

Hemiplegia--Slominski and Hament (18) defined as involvement of one-half of the body vertically; arm and leg on the same side of the body.

Quadriplegia--Slominski and Hament (18) defined quadriplegia as equal involvement of all four extremities.

Diplegia--Slominski and Hament (18) defined diplegia as bilateral symmetrical involvement, with lower extremities more severe than upper extremities.

Body scheme--According to Ayres (2), body scheme is the knowledge one has of the construction and spatial relationship of the different anatomical elements that make up the body. It involves being able to visualize these elements in movement and in different positional relationships.

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CHAPTER II

REVIEW OF THE LITERATURE

The review of literature is presented in three parts. The first part gives the normal development of stereognosis. The second reviews the importance of stereognosis. The third concerns the impairment of stereognosis in the cerebral palsied.

The Normal Development of Stereognosis

Gilfoyle (9) stated that stereognosis is a perceptual-motor function, the formation of which derives from a continuous development and integration of sensory assimilation and motor accommodation of the organism. The process of sensory assimilation results in perceptual behavior which guides purposeful motor behavior. Ayres (2), Grinker (10), and House (13) explain that the development of tactual, proprioceptive and visual perception is the foundation for stereognosis.

During the apedal period, the development of tactual perception and proprioception are predominant. The development of these two perceptions can facilitate the development of later visual perception. According to Wilson and Wilson (20), previous tactile and proprioceptive experience facilitated visual learning in the normal monkey.

Ayres (2,3) discussed two functional cutaneous afferent systems, the protective (protopathic) system and the discriminative (epicritic) system. The response to protective system stimulation is apt to be a primitive one of avoidance and withdrawal for protection. Tactual perception, including localization, and tactual discrimination, is a function of the discrimitive system. Tactual perception is able to develop only when the organism can control its primitive schema. Ayres (1, 2, 3) further stated that without such control a person remains tactually defensive, protecting himself from an external world rather than exploring the world. According to Gilfoyle (9), a grasp reflex is present only after the disappearance of avoidance and traction response of the hand. By repetitive exploration through grasping, tactual perception and proprioception are assimilated to develop a crude palmar grasp by four to five months of age.

Gilfoyle (9) emphasized that the quadrupedal period is an important phase in developing form perception. The child at this level of rapid development has the opportunity to view his environment from different positions and is beginning to explore it. His righting reaction in response to position in space is influenced by both labyrinthine and visual stimuli. The optical righting reaction is elicited by the same position as the labyrinthine righting reaction. Visual orientation represents cortical participation and becomes more significant at this level. Throughout this period when the child projects himself more into space and is more affected by visual perception, his activity changes significantly. By eight to ten months of age he not only gropes after the stimulus, but also orients himself to it and grasps it. Visual-spatial relation develops significantly at this period. Development of visual perception allows the visualization of objects in motion and in different positions. Progress in the development of proprioception and tactual perception allows the child to integrate the experience of his own body in motion and movement to a different position. This adds a new dimension of knowledge to form perception. The perception of form develops as the child manipulates objects. Tactual, proprioceptive and visual impulses give him information about the shape, size, and texture of the object.

Gilfoyle (9) explained that in the bipedal stage, by continuous and repetitive motor accommodation, a pincer grasp develops. Tactual stimulation to one digit no longer includes flexion of all digits. Voluntary prehension and eye-hand coordination progress.

According to House (13) manual perception of form is a function of tactual discrimination and is associated with stereognosis. Its formation is first dependent on visual assurance. Later tactual perception and proprioception function by recalling previous manual memory. Tactual perception tells the texture, while proprioception elicited in adapting hand movements to the object determines the shape and size.

A theoretical framework, established and explored by Piaget and Inhelder, has recently been reinvestigated by Hoop (11, 12), whose studies produced similar results. Familiar objects, topological forms and geometrical shapes were used in both studies to test the developmental sequence of stereognosis. Results indicated that each type of response is perfected at a different stage. Results indicated that the child two and a half to three and a half years old recognized familiar objects readily. Children at this age used global hand movements (seizing, touching, pressing, rolling from hand to hand) which enabled them to recognize only familiar objects. The subjects were not able to recognize topological or abstract shapes. Researchers theorized that this was because perceptual-motor function was not well developed yet.

Children three and a half to four years old were able to find the relationship of proximity and separation through movement. For example, they followed the contours step by step in surrounding and traversing the object. Through this increased hand coordination, the children were able to recognize topological forms. However, the information was not enough to allow recognition of geometrical shapes.

Children four to four and a half years old began crude differentiation of rectilinear and curvilinear shapes. Between five and five and a half years progressive differentiation of shapes was made according to angles and dimensions. Between six and a half and seven years, orders and distance were simultaneously accounted for and complex forms could be distinguished.

Benton (6), in a study of stereognosis using familiar objects only, found that older children recognized a greater number of objects than younger ones.

Hoop (12) explained that the role of perception or motor activity demonstrating stereognostic ability is dependent on the kind of form, object, or shapes used in testing. In the recognition of familiar objects, less motor coordination of the hand is required. With geometric shapes, because dimensions, order and distance must be determined by hand movement, motor control is an important factor.

The Importance of Stereognosis

Ayres (2) stated that both the tactual discriminative system and the proprioceptive system belong to the medial lemniscal tract. The tract, responding only to highly specific types of stimuli, serves a discriminative function in interpretation of the spatial and temporal aspects of touch-pressure and kinesthetic stimuli. The threshold of receptors associated with this system is higher, and the receptive fields are smaller. The receptors are distributed mainly in the extremities, especially in the hand. The finest two-point discrimination possessed by the hand is based in this mechanism. Ontogenetically, the hand is the first body part which can explore the rest of the body as well as the environment. The process of organizing tactual and proprioceptive impulses along with visual stimuli into meaningful perception is the most basic ontogenetic step in perceptual-motor development. Without adequate maturation in these areas more highly adaptive behaviors such as body scheme formation, motor planning, visuo-spatial perception, and motor skill will not ensue.

The importance of tactual, proprioceptive, and visual perception in developing body scheme and tactual-motor coordination was reflected in an experiment conducted by Nissen and his associates (15). The experiment restricted tactual, kinesthetic, and manipulative experience of a chimpanzee in the regions of hand to elbow and feet to knee from the age of four weeks. Manual exploration of contours and textures was impossible. After thirty months of restriction, the chimpanzee indicated a number of deficiencies in tactual-motor coordination. He did not attempt to bring his fingers to a stimulated region on the dorsal trunk or head. Approximation of the fingers to a locus of stimulation on the ventral trunk or limbs was slow, halting, and inaccurate.

Without prior development of the ability to localize tactual stimuli, the chimpanzee could not discriminate between widely separated tactual stimuli. Ayres (2) attributed this phenomenon to inadequately developed body scheme. Nissen (15) found that after the release of the restriction, the chimpanzee also showed inability to adaptive behavior. He did not grasp or cling to the attendant who carried him. When a milk-bottle was placed upright in front of him, he put his mouth to the nipple to try to suck, but made no attempt to lift the bottle. Pieces of food on the floor were picked up with his lips. It was suggested that restriction of tactual, kinesthetic and manipulative experience would interfere with the development of visual perception; therefore, the chimpanzee received visual training for a two-month interval when he was sixteen months old. Rapid learning of visual discrimination habits indicated that lack of opportunity for manipulation and for association of visual with tactual-kinesthetic sensation from hands and feet did not noticeably handicap this chimpanzee in developing perception of size, form and depth. According to Nissen (15) however, the results did not disprove the possibility that an association of tactual-motor with visual experience is necessary for the development of visual size, form and depth perception. Schilder (17) stated that control of the movement of the limbs is one of the major factors in the development of body scheme.

Deficiencies in tactual-motor coordination resulting from impairment of stereognosis would interfere with the development of body scheme in early childhood.

Impairment of Stereognosis in the Cerebral Palsied

Cerebral palsy is a specific type of cerebral dysfunction. The dysfunction may be present in a single manifestation or as a combination of impaired neurologic functions of varying degrees of severity. Denhoff and Robinault (7) have classified the dysfunction into six groups: 1) neuro-motor, 2) intellectual, 3) consciousness, 4) neuro-sensory, 5) behavioral, and 6) perceptual.

Impairment of stereognosis, according to Denhoff and Robinault's classification, involves deficits of two areas: neuro-motor and perception. Rusk (16) stated that "In a sense the totality of the sensory input is not only an activating force for motor performance, but also a modulatory and guidance mechanism in motor performance." The sensory input mentioned by Rusk seems to be interchangeable with the term perception which refers to both tactual perception and proprioception. Rusk (16) also stated that Strauss and Lehtinen described perception as the mental process which mediates between sensation and thought. Thus perception is intimately related to abstract cognitive function on the one hand to use of symbols in communication (speech, language, reading and writing) on the other. Without tactual perception and proprioception (kinesthetic perception) the hand will lose its function of modulation and guidance in its motor performance.

Schilder (17) has said that motility should not be separate from perception. Even the motion itself is a stimulus to initiate proprioception. The impulse of motor action and perception is in a relationship of mutual feedback. The development of one facilitates the other. Wilson and Wilson (19) found that in the normal monkey, previous tactual and proprioceptive experience facilitated visual learning. Ayres (2) has stated that visual perception, tactual perception and resistance to the muscle might be well used to help the development of kinesthetic perception. In perceptual-motor function, deficit of either the perceptual or the motor aspect can interfere with the development of the other.

Barret and Jones (5) used a multi-sensory training procedure for toddlers to investigate its effect on motor function of the hemiplegic hand in cerebral palsied children. The results indicated that by application of this procedure a significant increase in the spontaneous use of the affected hand was seen. Barret and Jones (5) further explained that, according to Bobath, specific sensory stimulation and training of proprioception, tactual sensation and stereognosis if given at an early age will encourage the child to use his affected hand. Ayres (2) and Barret and Jones (5) emphasized that since sensation is basic to perception, sensory training may help the development of perception and motor function.

In 1961, Monfraix, Tardieu and Tardieu (14) tested manual perception in children with cerebral palsy. They found that disorders of manual perception were shown in all forms of cerebral palsy. It was more frequent and severe with spasticity or rigidity than with athetosis. Impairment of stereognosis was more frequent when the right side was affected rather than the left, and also in unilateral rather than in bilateral cases.

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CHAPTER III

METHOD AND PROCEDURES

Purpose of This Study

The purpose of this study was to measure the stereognostic ability in the children with cerebral palsy, using the Benton and Schultz test, to determine whether children with cerebral palsy have a disturbance in the development of stereognosis.

The Benton and Schultz Study on Stereognosis

Benton and Schultz tested 156 normal children, 92 boys and 64 girls, ranging in age from three years zero months to five years ten months. The children were divided into three groups. The first group ranged in age from five years to five years ten months ($\underline{N}$=100), the second from four years to four years eleven months ($\underline{N}$=34), the third from three years to three years eleven months ($\underline{N}$=22).

The test consisted of sixteen familiar objects, equivalent in difficulty value, which were presented individually to the child for stereognostic response. The objects were divided into two series designated as Form A and Form B, and both forms were given. Both the preferred and non-preferred hands were tested. Test "score" on each of the forms was the number of correct identifications.

Results of the Benton and Schultz study (6) indicated that there was an age trend in recognizing an object in the hand; the older children recognized more objects than the younger. No significant differences were obtained from the performance of boys or girls, or for performance with preferred hand versus non-preferred hand.

The Present Study

Fourteen children with various forms of cerebral palsy were tested in this study. The children ranged in age from three years eleven months to six years one month. Thirteen children were selected from the Cerebral Palsy Treatment Center in Houston, and one was selected from the Elks Crippled Children's Hospital at Gonzales. One child having a diagnosis of minimal brain damage with mild mental retardation was included in this study.

Since stereognosis represents cortical function, the patients used in this study were required to have intact basic sensation of the hand. The ability to open the hand actively or passively was required so that an object could be inserted. It was not necessary for the patient to talk, but he was expected to be able to understand the testing procedure and to respond in some consistent manner, by either a gesture or a nod of the head.

The objects used in testing were the same as those used by Benton and Schultz (6). Some of the objects differed slightly in size because the exact size could not be located.

Testing design and procedures used in this study were based on the study of Benton and Schultz. The objects both on Form A and Form B were prepared in two sets. One set was used to insert in the child's hand. The other set was placed on peg boards where children who were not able to name the objects could point to them. The peg boards were painted in yellow to attract but not visually overstimulate the children. Both peg boards were presented simultaneously during all testing.

The objects comprising the two test forms were as follows:

Form A

1. A rubber ball, 2½ inches in diameter.
2. A metal table fork of the usual size.
3. A sharpened pencil, 5 inches in length.
4. A toy ring with simulated gem attached to it.
5. A toy plastic straight-backed chair, 2 inches in height.
6. A pair of children's sun-glasses.
7. A yale key.
8. A plastic drinking cup with handle, 2½ inches in diameter and 3 inches in height.

Form B

1. A metal teaspoon of usual size.
2. A plastic comb, 5 inches in length.*
3. A metal table knife of the usual size.
4. A cardboard box with cover, 5 3/4" x 3" x 1½".*
5. A stiff-covered book, 7" x 5" x 1".*
6. A water glass of the usual size.
7. A toy plastic table, 2" square and 3½" high.*
8. A penny.

*size different from Benton and Schultz.

A 12-inch square cardboard box, from which the front and back sides had been removed, was used for the testing. A curtain was attached to the front side of the box. The investigator inserted an object through the open back of the box and the child felt the object without seeing it by inserting his hand under the curtain at the front side.

Use of the curtain on the front of the box allowed the child's eyes to remain open, which, according to Ayres (4) tends to minimize tactile defensiveness and undue anxiety.

Before testing, the child was oriented to each test item on the peg boards, and was instructed to name what he felt in his hand. If a verbal response was not possible, an alternate method of response was agreed upon. If the child had severe motor involvement preventing independent manipulation of the object, the investigator assisted in the child's manipulation.

A one-inch cube (block) was used as a practice item. When the child demonstrated his understanding of the instructions the actual test was administered. In children with cerebral palsy, motor dysfunction and loss of perception are not necessarily parallel. For example, Monfraix (14) found that perceptual disturbance may be bilateral when the motor damage is unilateral. Either perceptual or motor dysfunction can interfere with the formation of hand dominance; therefore, in the present study the hands were simply designated right and left hand. Both test form A and test form B were given to each hand for each of the 14 children in this group.

Basis for Comparison

In the Benton and Schultz study (6), the average score of both forms was determined. The mean score of the preferred hand was 7.2, and that of the non-preferred hand was 7.0.

As a basis for comparing the Benton and Schultz score with those of the present study, in which hand preference was not established, twenty scores of the preferred hand and another twenty scores from the non-preferred hand were selected from the largest of the three original groups. These scores were used to compare individually with the right and left hand scores obtained in the present study. The mean scores of the two hands for the groups selected from the Benton and Schultz data differed only slightly from the original total group scores. The new mean score was 7.1 for the preferred hand, and 6.9 for the non-preferred hand.

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CHAPTER IV

PRESENTATION OF FINDINGS

Twenty scores of preferred hand and another twenty scores of non-preferred hand from the Benton and Schultz sample were selected to compare with the scores of the 14 subjects in this sample group to determine if the children with cerebral palsy had disturbance in stereognostic function. The preferred hand was used to compare with the right hand, and non-preferred hand was used to compare with the left hand. Results shown in Table I indicate that the mean scores and standard deviations are very similar in the normal and cerebral palsied children at this age range.

TABLE I

MEAN SCORE AND STANDARD DEVIATION OF STEREOGNOSTIC FUNCTION IN NORMAL AND CEREBRAL PALSIED GROUPS OF CHILDREN

Group	No. Subjects	Hand Tested	Mean Score	S.D.
Normal	20	Preferred	7.15	0.69
Normal	20	Non-preferred	6.98	0.72
Cerebral Palsied	14	Right	6.36	1.81
Cerebral Palsied	14	Left	7.00	0.94

Results of the analysis of variance shown in Table II indicate no significant difference on the basis of group or handedness. The F-ratio for interaction effect of group and handedness does reach the 10 0/0 per cent level of significance. This is probably due to the fact that since hypothetical averaged scores were used for the normal group any difference in the preferred and non-preferred hand score for the individual subject was lost. Differences did appear between the performance of right and left hand in the cerebral palsied subjects.

TABLE II

VARIANCE OF STEREOGNOSTIC FUNCTION BETWEEN NORMAL AND CEREBRAL PALSIED CHILDREN

Source	SS	df	ms	P
Total	334.51	67	-	-
Between subject	199.01	33	-	-
Groups	9.70	1	9.70	$> .10$
Error b	189.30	32	5.92	-
Within subject	135.50	34	-	-
Handedness	1.78	1	1.78	$> .10$
Handedness X Group	11.02	1	11.02	$< .10$
Errow w	122.71	32	3.83	-

The results of this study indicated that no significant variance in stereognostic ability existed between normal and cerebral palsied children in this age group. The following factors may have influenced the above finding:

1. Small sample group.

2. The children selected from the Houston Cerebral Palsy Treatment Center had been receiving physical therapy, occupational therapy, and special education. The children were not only familiar with the testing situation but also may have improved their perceptual-motor function through years of treatment.

3. The children may have stereognostic problems in every day life due to motor difficulty rather than to the dysfunction of proprioceptive perception. Some of the children could identify the object only when the investigator assisted in the manipulation of the object. Obviously the subject's proprioception was intact, but the motor difficulty inhibited the proprioceptive input.

4. The more familiar the object, the less motor control required for recognition.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

A sample from the Benton and Schultz study on tactual form perception of normal children was selected to compare with fourteen cerebral palsied children in the identical stereognostic function. Children in both groups were of preschool age range. Results indicated no significant difference between the normal and cerebral palsied children. The small size of the cerebral palsied group, intensive medical and paramedical care received, intact function of proprioception, and familiarity of the objects used in this test probably contributed to the above findings. A further study to determine the individual roles played by proprioceptive perception and motor capacity in stereognostic function is recommended.

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APPENDICES

APPENDIX A

1. Name: ______________________________

2. Sex: boy or girl

3. Date of Test: ______________________________

4. Date of Birth: ______________________________

5. Age: ______________________________

6. Diagnosis:

   Disability:

_______Monoplegia	_______Double Hemiplegia
_______Hemiplegia	_______Quadriplegia
_______Paraplegia	_______Triplegia
_______Diplegia	

   Characteristics:

_______Athetosis	_______Rigidity
_______Spasticity	_______Mixed
_______Ataxia	

7. Sensory Test of Upper Extremity: ______________________________

8. Motor Ability of Upper Extremity: ______________________________

9. Comprehensive Ability: ______________________________

APPENDIX B

Form A

Testing Item	Correct	Incorrect	Remark
1, Ball	Right		
	Left		
2. Fork	Right		
	Left		
3. Pencil	Right		
	Left		
4. Ring	Right		
	Left		
5. Chair	Right		
	Left		
6. Sun-glasses	Right		
	Left		
7. Key	Right		
	Left		
8. Cup	Right		
	Left		
Total	Right		
	Left		

APPENDIX C

Form B

Testing Item	Correct	Incorrect	Remark
1. Teaspoon	Right		
	Left		
2. Comb	Right		
	Left		
3. Knife	Right		
	Left		
4. Cardboard Box	Right		
	Left		
5. Book	Right		
	Left		
6. Water Glass	Right		
	Left		
7. Table	Right		
	Left		
8. Penny	Right		
	Left		
Total	Right		
	Left		

APPENDIX D

AGE AND DIAGNOSIS OF THIS SAMPLE GROUP

Subject	Age Yrs.	Mos.	Diagnosis
1.	3	11	Quadriplegia, Athetosis
2.	4	0	Diplegia, Spasticity
3.	4	3	Quadriplegia, Spasticity with distal Athetosis
4.	4	3	Quadriplegia, Ataxia
5.	4	9	Quadriplegia, Spasticity
6.	4	10	Quadriplegia, Ataxia
7.	5	1	Minimal Brain Damage with Mild Mental Retardation
8.	5	2	Quadriplegia, Athetosis
9.	5	3	Diplegia, Spasticity
10.	5	4	Right Hemiplegia, Spasticity
11.	5	6	Quadriplegia, Ataxia
12.	5	8	Right Hemiplegia, Spasticity
13.	5	10	Quadriplegia, Athetosis
14.	6	1	Quadriplegia, Spasticity

APPENDIX E

DATA FOR BENTON AND SCHULTZ STUDY

Subject	Present Study Rt. Hand	Present Study Lt. Hand	Benton and Schultz Preferred Hand	Benton and Schultz Non-Preferred Hand
1.	13	16	16	16
2.	13	11	16	16
3.	10	12	16	16
4.	13	14	15	15
5.	12	13	15	15
6.	14	16	15	15
7.	16	15	15	15
8.	16	16	15	15
9.	15	13	15	14
10.	15	16	15	14
11.	14	15	15	14
12.	1	16	15	14
13	14	11	14	14
14.	12	12	14	13
15.			14	13
16.			13	13
17.			13	12
18.			12	12
19.			12	12
20.			11	11
Sum	178	196	286	279