Some Psychological and Physical Characteristics of Retarded Girls Before and Following Treatment with Glutamic Acid

BY

SISTER MAUREEN HARNEY, O.S.B., M.A.
College of St. Scholastica
Duluth, Minnesota

A DISSERTATION

SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL OF ARTS AND SCIENCES OF THE CATHOLIC UNIVERSITY OF AMERICA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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Chapter I

INTRODUCTION

During the past few years, there has been considerable interest in the effect of glutamic acid[1] on the learning ability of animal and human subjects. The results of the animal studies have been contradictory; most of the studies done in laboratories other than in the Neurological Institute have not shown beneficial effects. All the published studies done on the human subjects have shown beneficial effects. All of these studies except one have been carried on by members of the staff of the Neurological Institute. The fact that most of the previous studies have been done at the Neurological Institute might lead one to believe that the beneficial results were due to an experimental artifact. If such results were obtained elsewhere, it might be presumed that the effectiveness was the result of the treatment with glutamic acid. The present experiment was undertaken to determine the effect of natural glutamic acid on a group of retarded girls who were entirely separated from the institution where most of the previous studies were done.

[1] It is important to note that when writing about natural glutamic acid the form l(+) glutamic acid or L-glutamic acid is used.

Chapter II

RELATED STUDIES

In order to have some understanding of the studies reported in the literature and also the present study, it is necessary to review briefly some of the theoretical background underlying the effects of glutamic acid. According to Waelsch:

> A study of the effects of glutamic acid differentiates itself from the common problems of nutrition which deal mainly with indispensable food components for two reasons: (1) glutamic acid is a dispensable amino acid which is apparently synthesized in considerable amount by the mammalian organism; (2) it exerts its clinical effects in added relatively small amounts to a complete and satisfactory diet. (23)

In order to analyze the intellectual gain which results from the administration of glutamic acid, it is necessary according to Waelsch (23) to determine whether the gain lies in the acquisition of new intellectual tools, in a growth of intelligence, or in increased ability to make use of the capacity already present. It was noted as a result of administration of glutamic acid that certain patients who formerly had appeared dull and generally lethargic were stimulated to alertness, persistence and greater capacity for accomplishment. Improved emotional stability also resulted in some cases. Thus an improvement in general factors of personality adjustment predominated over the gain in specific intellectual functions.

These findings seem to indicate that glutamic acid facilitates the use of the individual's potentialities by the removal of inhibiting forces rather than by serving to increase actual intelligence. This concept admits a biochemical interpretation based on the possibility of deficiencies which may result in a slowing down of a biochemical reaction. Hence it may be assumed that a biochemical mechanism already in process may be speeded up by the addition of one of the reaction elements such as glutamic acid.

Several studies concerning glutamic acid and brain metabolism have been reported. These studies show no evidence for the theory that glutamic acid is directly involved in brain metabolism. The possibility, however, that brain metabolism may be affected by glutamic acid seems worthy of consideration.

Waelsch in collaboration with Nachmanson and John found that

> . . . the enzyme system which synthesizes acetyl choline when inactivated by dialysis may be reactivated to a certain degree by the addition of L-glutamic acid. . . . Since acetyl choline appears to be one of the powerful effector substances of the nervous system it seems possible that the amino acid exerts its influence on the function of this organ through a regulation of acetyl choline synthesis. (15)

Weil-Marlherbe (25) in his work on brain metabolism found that of all the amino acids L-glutamic was the only one that gave evidence of fulfilling a specific role in connection with carbohydrate metabolism and was also the only one oxidized in the brain.

The first experiment dealing with the effect of glutamic acid treatment was reported in 1943 by Price, Waelsch and Putnam (18). These experimenters selected for treatment 8 patients with seizures associated with slow wave activity in the electroencephelogram, namely petit mal and psychomotor types. The patients selected did not respond to anti-convu - sive medication. Two patients were given from 16 to 20 grams of dl-glutamic acid hydrochloride a day while the remaining six received 4 grams 3 times a day in addition to the anti-convulsive medication.

In all cases the petit mal seizures were greatly decreased and there was a mental and physical alertness noted. The patients seemed happier and were more congenial.

In 1944 two experimental studies on the effect of glutamic acid on the learning of white rats were reported. Zimmerman and Ross (33) studied the "Effect of Glutamic Acid and Other Amino Acids in the Maze Learning in the White Rat." An experimental group consisted of 17 male albino rats of the Sherman strain and the control group of 9 rats of the same strain. The Warner-Warden linear maze was selected for testing. The experimental group was placed in cages and given basic food and amino acid, while the control group was given only the basic food. After 10 days in which the animals made the laboratory adjustment, they were given a 4 day preliminary adjustment period in which they explored the disconnected mazes. They were then subjected to the connected maze once a day until they reached 4 out of 5 perfect trials. The experimental group learned the maze in less time, had fewer trials and made less errors than the control group.

Albert and Warden (2) showed that adding l(+) glutamic acid to the normal diet of the white rats enabled them to advance further in a series of increasingly difficult problems than rats that did not have glutamic acid. They used the box problem of Warden, Jenkins and Warner.

In 1946 two experimental studies on the effect of glutamic acid on human subjects were made. Albert, Hoch and Waelsch (1) gave a preliminary report on the effect of glutamic acid on mentally retarded subjects. They used 8 subjects with a chronological age range of 6 to 26 years and a mental age range of 2 to 8 years. The intelligence quotient ranged from 22 to 73. Before experimentation a battery of tests consisting of the Wechsler-Bellevue or the Stanford-Binet Intelligence Test, one standardized performance test and the Rorschach was administered to all. The Murray T.A.T. was given to those who spoke well. The Drawing of a Man and the Minnesota Pre-School tests were administered to some of the subjects.

Some of the subjects were given l(+) glutamic acid and others the same number of placebos that resembled glutamic acid in appearance. The average dosage of glutamic acid was 18 tablets or 9 grams. After they had been on this for a period of 2 or 3 months, they were retested. Then those who had had the placebos were given glutamic acid and those on glutamic acid were given placebos. This change was repeated a number of times. It was noted that there was a significant rise in mental age during the administration of glutamic acid and that during the successive placebo period the intelligence quotient dropped back to the level achieved before glutamic acid therapy.

Zimmerman, Burgemeister, and Putnam (29) reported on the "Effect of Glutamic Acid on Mental Functioning in Children and Adolescents." The 9 subjects included in this report were selected from a larger study that was going on. The subjects selected on neurological basis were those who showed the least possible complicating organic features. On a psychological basis, they were selected to show the effect of glutamic acid on mental ability at different intellectual levels from childhood to adolescence. Seven subjects had epilepsy and 2 were mentally retarded with no convulsions. Since the chronological age range was 16 months to 17.5 years, different measuring scales had to be used. Six were given the Stanford-Binet, Form L, 1 the Wechsler-Bellevue, 2 the Kuhlman-Binet. Performance tests were given to only 5 of the subjects. Either the Arthur Point Scale of Performance or the Merrill-Palmer was used. The Rorschach Ink Blot was administered to 7 subjects. The same battery was repeated after 6 months of glutamic acid.

The control was a group of 9 clinic children and adolescents who were tested before and after a period in which seizures were either controlled or decreased by non-convulsive therapy other than glutamic acid. The results showed that though the seizures were reduced there was no significant change in the intelligence quotient. In the experimental group in every instance there was a significant increase in the intelligence quotient upon retest. There were also consistent increases in individual performance scores. In both types of tests, the gain was more than the normal rate of increase. The responses to the Rorschach plates on retest were definitely more productive.

In 1947 Zimmerman, Burgemeister and Putnam (28) published the entire study of which the previous paper was a preliminary report. They used in all 69 patients. Twenty-eight were children and adolescents with seizures. Eleven of the 28 were also retarded thus there was a total of 44 mentally retarded subjects. Glutamic acid was administered in gradually increasing doses to the point where increased motor activity was noted or where the subject was distracted and would not cooperate. The dose was gradually

reduced to the point where the activity could be made productive. In most instances, the dosage ranged between 12 and 24 grams a day given in three doses. The same battery of tests was used as stated in the preliminary report. In the analysis of the data, the group of 38 with intelligence quotients below 65 was treated separately. In this group there was an average gain in mental age of 12 months in a 6 month interval. In the entire experimental group there was a 13 month increase in mental age in the 6 month period. On the performance tests, both groups showed more than a normally expected increase, with the entire group making a 12 month gain while the more retarded group showed a 9 month gain. On comparing the first and second Rorschach protocols, there was a marked improvement in form, in quality, in the ability to perceive details, and an increase of 6% in popular responses. This reflects better social and emotional adjustment.

The control consisted of the previous intelligence tests of 37 subjects in the study who were tested over a period of 6 months to 8 years prior to glutamic acid therapy. The test results showed a drop in the intelligence quotient as might be expected in a retarded group, because the discrepancies between chronological age and mental age tend to widen more than the expected amounts as the child increases in age. It is the belief of the authors "that glutamic acid enhances the capacity to act intelligently in human beings."

The following year the same authors (31) reported on the "Ceiling Effect of Glutamic Acid upon Intelligence in Children and in Adolescents." This report comprises 30 subjects completing a full year of glutamic acid therapy. Sixteen of the group were mentally retarded without convulsions, 14 were children and adolescents with convulsive seizures, 7 of these were mentally retarded. The chronological age of the group ranged from 5 to 16 years with intelligent quotients ranging from 38 to 131 at the time of the first test. The battery of tests was the same as that used in the previous study. Retesting was done after 6 months and again after 1 year. The results on the Stanford-Binet after 1 year of glutamic acid showed an average gain of 24 months in mental age and the same average gain in performance tests. However, the gain in mental age in both types of intelligence tests was greater during the first 6 month period than during the second 6 months. In 97% of the group the second intelligence quotient on the Stanford-Binet was greater than the first but in only 53% of the group was the third greater than the second. This would lead us to believe that although the intelligence scores for the group were still rising at the end of a year, they appeared to be rapidly approaching the ceiling. This is also true of the performance scores. This leveling off might indicate that a normal rate of mental development may be reached or that these subjects might achieve 1 year of mental age in a year of chronological age. As the normal rate of

development is much higher than these subjects attained before treatment the question is whether the normal rate will be maintained or whether the subjects will drop back to the rate attained before glutamic acid therapy.

The protocols of the Rorschach agree with findings on the Stanford-Binet and Performance: namely, more qualitative and quantitative changes during the first six months than during the second 6 month period.

The control used in this study was exactly the same as in the previous study and the results are the same: namely, a decrease in the intelligence quotient of this group.

In 1948 Marx (12) published an article on the "Effects of Supranormal Glutamic Acid in Maze Learning." He used 125 white rats of Wistar strain. Thirty-three were used as a control and given 1 cc. of distilled water daily, 56 were used as experimental group and given 1 cc. of solution containing 200 milligrams of l(+) glutamic acid, and a third group of 36 was given 1 cc. of solution containing 200 milligrams of glycene to check the specificity of the action of glutamic acid. The apparatus used for testing was the Stone Multiple T Water Maze. Errors and the time taken to reach the goal were recorded. The person recording the errors and the time did not know from which group each rat came.

Superior records for errors and time were found for the control group although in no case was the difference significant as critical ratios for all measures were below 1.00. The differences in physical growth were not significant.

The author discusses the reasons for discrepancy in findings of different animal experimenters by suggesting that glutamic acid may possibly influence learning performance rather than learning ability. As performance is a function of several major variables Marx states:

> Thus it is possible that slight differences in general alertness or activity level may be sufficient to account for a significant difference in the learning of a fairly simple maze by running with one trial daily; but may not be sufficient to produce such a difference in the learning under massed practice conditions, of a long and complex maze by swimming, which requires considerably more vigorous behavior and certainly involves a much greater total energy expenditure. (12)

In September of 1948 Stellar and McElroy (19) published the results of their work "Does Glutamic Acid Have Any Effect on Learning?" These two workers followed the procedure of Zimmerman and Ross in all except that they used a different strain of animal. They used 28 pigmented rats of the Lashley strain descendants and divided them into 2 groups which were matched for sex, weight and litter. The experimental group before each feeding was given a 5 gram dish of basic diet containing 200 mg. of neutralized l(+) glutamic acid and only the control group was given the extra 5 grams of meal. After ten days both groups were allowed 4 days of ex-

ploration of the disconnected mazes as a preliminary to the actual testing. Then for 21 days each rat was given 1 trial daily in the connected maze. Results showed that both groups learned the maze in the same length of time. Later they were tested on more difficult mazes but no difference was detected between the 2 groups with regard to errors, time, or number of trials to reach the goal. These experimenters feel that negative findings indicate that beneficial results from glutamic acid are not general to all procedures, strains, dosages, ages and tests. They conclude from their findings, as compared with those of Zimmerman and Ross, that glutamic acid administration is beneficial to rats of Sherman strain only.

In March of 1949 Zimmerman, Burgemeister and Putnam (32) published a study entitled "The Effect of Glutamic Acid upon the Mental and Physical Growth of Mongols." This work is based upon a study of 30 cases of mongolism and 30 control cases who are retarded but not mongoloids. In the experimental group the intelligence quotients of all were below eighty, and the cases in the control group were chosen to match the initial intelligence quotients of the experimental group. The experimental group ranged in chronological age from 3 to 35 years with 4 cases above 20 years of age. Each case except the 4 cases over 20 years was matched for chronological age with an individual in the control group. Four over 16 years of age in the control group were selected to match the 4 cases over 20 years. Since 11 of the 30 mongols were residing in a special school, the environment for some of the cases was constant. No attempt was made to keep constant the environment of the control group.

Glutamic acid was administered to both groups at the same time in manner and amount described in former studies of these authors. Procedure for testing and test battery were the same as in former work of these authors.

The intelligence quotient of the experimental group averaged 46 and the performance quotient averaged 45.5, indicating severe mental retardation, poor form perception and poor motor coordination.

On the Stanford-Binet intelligence test the experimental group attained an average gain of 8 months in mental age during 6 months of glutamic acid. Individual intelligence quotient changes ranged from 0 points to 20 points during glutamic acid therapy. The control group on the same intelligence test averaged a gain of 12 months in mental age in this 6 month period. Performance test results showed a 9 month improvement in mental age in the control group but no significant change in the experimental group. The authors believe this last to be due to the fact that there is a difference in potentiality for motor improvement between the mongoloid and non-mongoloid group.

For the heights and weights, only the records of growth of mongoloid subjects in the institution were used because previous heights and weights

were available for purposes of comparison. The record of heights for the 11 cases for 2 years previous to and during glutamic acid indicate that striking increments in height occurred during glutamic acid treatment. The average rate of growth is slightly greater than that attained for the 2 previous years. The results also showed an unusual amount of weight gain during the treatment period. Physical improvement in mongols also included improved texture of skin and hair. In a few cases it was thought that the child looked less mongoloid.

This same year Levine (11) published "Can We Speed Up the Slow Child?" This publication is based on a preliminary report of the effect of glutamic acid upon the mental functioning of the slow, deaf child. The subjects of this study were 6 pupils of the Lexington School for the Deaf with intelligence quotients ranging from 61 to 81 and chronological ages ranging from 6 years 10 months to 14 years 3 months.

Before administration of glutamic acid, one of the following tests scales was used: Merrill-Palmer Scale of Mental Tests, Pintner-Patterson Scale of Performance Tests or the Wechsler-Bellevue Performance Scale. Goodenough "Draw-a-Man Test," Hiskey Drawing Completion and Wechsler Block-Design Test were also given to each subject. Glutamic acid was then administered beginning with 6 grams a day and gradually increasing to the maximum dosage of 18 grams a day within a 6 weeks period. After 9 weeks of treatment the subjects were retested using the same battery of tests. Glutamic acid was then discontinued for 3 months and the subjects were again retested.

It was noted that after glutamic acid treatment there was an increase in intelligence quotients ranging from 8 to 17 points with an average increase of 13 points. The general behavior showed greater alertness and responsiveness to environment.

At the termination of the non-treatment period the subjects were less alert and the average increase in intelligence quotients dropped to three points.

Although these findings were very encouraging Levine feels that because of the small number of cases studied one cannot come to any definite conclusion about the universally effective results of such treatment on the deaf nor of the limitations that might be encountered.

These studies can be summarized by dividing them into experiments performed on animals and experiments performed on human subjects. As was noted previously the results of the studies on animals have been contradictory. On closer inspection, however, we find that there have been several variables in the experiments which might account for the differences. For example: different strain of rats, different methods of measuring learning and different dosages of glutamic acid. In order properly to evaluate the

results of glutamic acid there should be only one variable in the experimental design. Until a systematic approach to the problem has been undertaken one is not justified in comparing results.

As regards the comparison of animal studies with human studies one factor stands out above all others; namely, in those studies concerned with human subjects, we use measures of capacity rather than of ability always being aware, however, of the limitations of the tools and that we measure capacity indirectly. This is quite different, however, from measuring a specific ability in learning such as running a maze. A fact which is more pertinent in evaluating these studies is that those with human subjects have all used natural glutamic acid. The general method of measuring results has usually been the same: some test of general intelligence. We have, therefore, a comparable design among these experiments and, as one would expect, fairly comparable results.

Chapter III

PLAN AND PROCEDURE

This study was undertaken to determine changes in mental age, school achievement, personality and physical growth of a group of retarded girls following six months' treatment with natural glutamic acid. The subjects used for this study were 35 girls enrolled in Saint Gertrude's School of Arts and Crafts, a boarding school for retarded girls. The number actually completing the study was 31. Three were dropped because they were day students and there was definite evidence that they did not cooperate in taking glutamic acid over week ends and during vacation periods. One was dropped because she left school before completion of the experiment. Permission to administer glutamic acid to this group was obtained from parents, school doctors and family physicians.

As shown in Table 1, the chronological ages of the group at the beginning of the experiment ranged from 6 years 3 months to 24 years 3 months with an average of 11 years 2 months. The chronological ages at the time of retest ranged from 7 years to 24 years 11 months with an average of 11 years 10 months.

DOSAGE

The glutamic acid was administered in tablets of ½ gram each. Doctor J. C. Price at the Neurological Institute was consulted and on his recommendation the experiment began with 2 tablets 4 times a day increasing the dosage at the end of 10 days. After a month, the glutamic acid was given only 3 times a day and the interval between increase in dosage was reduced to 5 days. The increase was continued until tolerance was reached. This was established by evidence of increased motor and psychic acitivity. There was some gastric distress on the part of a few cases. The glutamic acid was discontinued with these cases for a day and started again with a smaller dosage and gradually increased to the point of tolerance. Two of the group reached tolerance at 20 pills or 10 grams of glutamic acid 3 times a day. The remaining 29 took 28 pills or 14 grams of glutamic acid 3 times a day. Even with the large dosage of 84 pills or 42 grams of glutamic acid a day there was no evidence of distractability or aimless physical acitivty. However, Doctor Price advised that 42 grams a day be made our maximum dosage. The general dosage as recommended in the literature is from 6 grams to 24 grams a day.

METHODS OF TESTING

As the purpose of this experiment was to study the changes in intelligence, achievement and personality, the following battery of tests was used: tests

of general intelligence were the Stanford-Binet Intelligence Test (22), Goodenough "Draw-a-Man Test (8) and A Point Scale of Performance (3, 4); those measuring achievement were Stanford Achievement (10) and Metropolitan Achievement (9); and as measures of personality the Mosaic

TABLE 1

Distribution of Chronological Ages at the Time of Initial Test and Retest

CASE	INITIAL TEST		RETEST	
	years	*months*	*years*	*months*
1	7	1	7	10
2	18	3	19	
3	16	5	17	1
4	11	4	12	
5	9	11	10	7
6	10	5	11	2
7	6	3	7	
8	24	3	24	11
9	8	4	8	10
10	8	11	9	8
11	11	4	12	
12	6	6	7	2
13	10	10	11	6
14	11	10	12	5
15	17	2	17	10
16	10	3	10	11
17	8	1	8	9
18	14	3	14	11
19	11	4	11	11
20	10	2	10	10
21	9	8	10	5
22	7	3	7	9
23	10		10	8
24	7	10	8	6
25	7	6	8	2
26	16	9	17	5
27	11	6	12	3
28	8	3	8	11
29	15	3	15	11
30	7	5	8	2
31	12	3	12	10

Test (26), the Rorschach Test (5) and the Graphic Rating Scale for the Study of Character (14).

Prior to the administration of l(+) glutamic acid the 31 subjects were given the Stanford-Binet Intelligence Test Form L, 29 were given the Draw-A-Man Test and 29 were tested with A Point Scale of Performance

Form I. Achievement tests were administered to 27 of the group, 8 taking Stanford Achievement Form D and 7 the Primary Form G. The remaining 12 were given the Metropolitan Achievement with 7 taking Primary I Form R and 5 Primary II Form R. The Mosaic Test was administered to the 31 subjects and the Rorschach to 28 subjects. Thirty subjects were rated on the Graphic Rating Scale for the Study of Character. The heights and weights of 31 subjects were recorded. Retesting began after six months of glutamic acid therapy using the same battery of tests with the following alternate forms: Stanford-Binet Form M, A Point Scale of Performance Form II, Stanford Achievement Test Intermediate Form H, Primary Form D, and Metropolitan Achievement Test Primary I and II Form S.

Instead of a separate control group, the "control" in this experiment consistcd of the previous records of Intelligence Tests of 24 subjects and Achievement tests of 17 subjects. The heights and weights were compared with norms of a comparable age group.

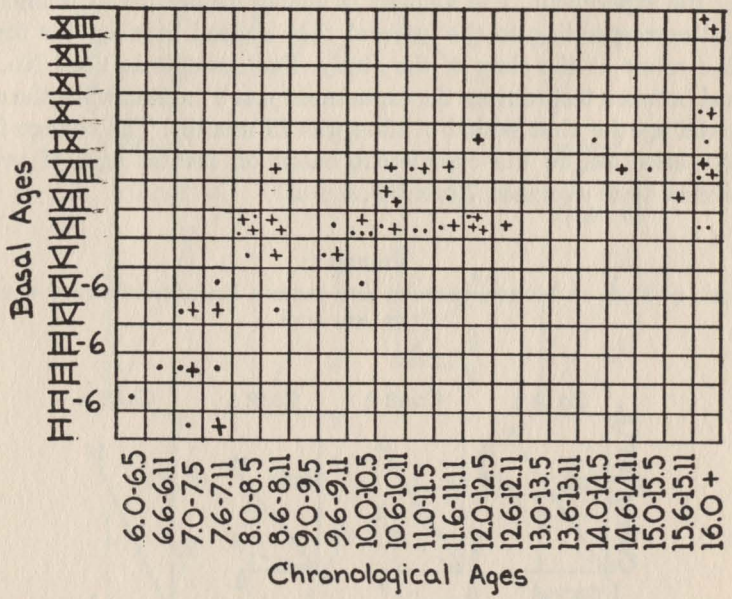
Chapter IV

ANALYSIS OF DATA

STANFORD-BINET INTELLIGENCE TEST

The distribution of mental ages and intelligence quotients on the Stanford-Binet Intelligence Tests before and after administration of l(+) glutamic acid is shown in Tables 2 and 3 respectively. The table of distri-

Figure 1
Scatter Diagram of Chronological Ages and Basal Mental Ages for the Test and Retest of the Stanford-Binet Intelligence Test
(.) First Test (+) Retest



bution of intelligence quotients is included for information only since it did not seem essential to compute differences for I.Q. as well as M.A. The mental ages before glutamic acid therapy range from 2 years 9 months to 12 years 8 months with a mean age of 7 years 5 months and a standard deviation of 29.18 months. The standard error of the mean is 5.33.

The mental ages in the retesting at conclusion of the study range from 2 years 10 months to 14 years 2 months with a mean age of 8 years 5 months and a standard deviation of 30.04 months. The standard error of the

mean is 5.48. The actual change in mental ages ranges from a loss of 4 months to a gain of 2 years with an average gain of 1 year or 12.19 months. The standard error of the difference, computed for correlated means, is 1.09. The "t" value is 11.18. A "t" value of 11.18 gives evidence of a very significant change in the mental ages between the 2 tests as this value is much greater than the criterion for significance at the 1 per cent level. ($t_{.01} = 2.75$.)

The scatter diagram (Figure 1) shows the basal ages for corresponding chronological ages for the intelligence tests before and at the conclusion of the study.

Figure 2 shows the change in mental ages of the 24 subjects in the experiment who were in attendance at Saint Gertrude's School before and during the administration of glutamic acid. The broken line shows the change in mental ages before the use of glutamic acid and the heavy line the changes during the experiment. The amount of change before the experiment was reduced corresponding to the interval that elapsed between the first test and the retest at the close of the study. For example in Case No. 1 the interval between tests during the experiment was 9 months while the change in mental age for that period of time was 13 months. The change for a 9 month period before the experiment based on mental ages of previous intelligence tests averaged 7 months.

FIGURE 2

CHANGES IN M.A. IN MONTHS BEFORE AND DURING EXPERIMENTATION WITH l(+) GLUTAMIC ACID

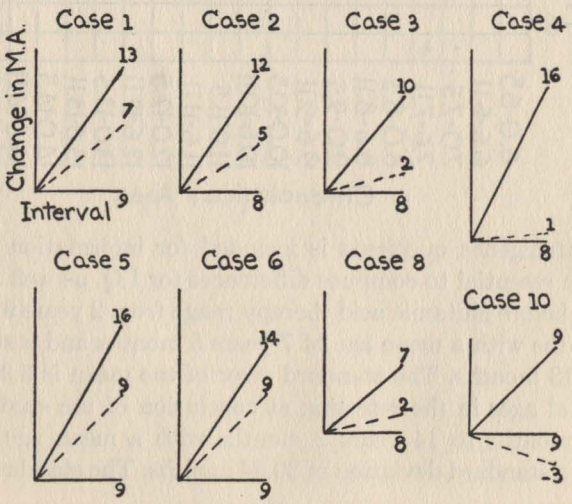
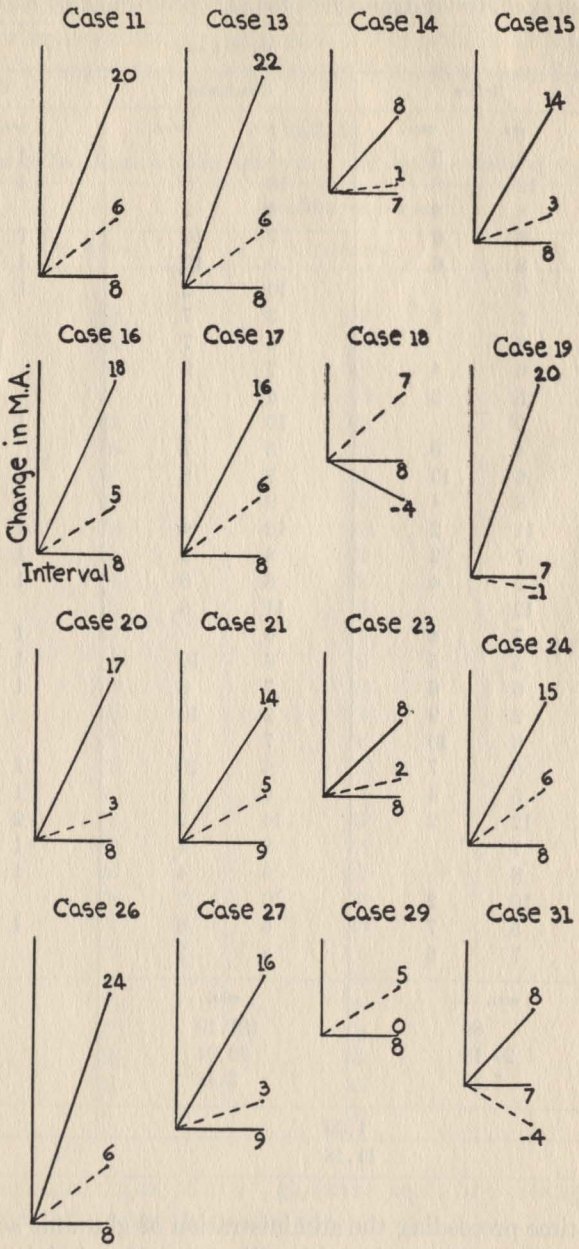


FIGURE 2—Continued



In all but 2 cases, the changes during the administration of l(+) glutamic acid are much greater than the changes that occurred during the same

TABLE 2

Distribution of Mental Ages Before and at Conclusion of the Experiment

CASE	MENTAL AGE					
	Before		Conclusion		Change	
	yrs.	*mos.*	*yrs.*	*mos.*	*yrs.*	*mos.*
1	4	5	5	6	1	1
2	12	8	13	8	1	
3	8	4	9	2		10
4	6	6	7	10	1	4
5	8	6	9	10	1	4
6	9		10	2	1	2
7	3	1	3	7		6
8	9		9	7		7
9	6	4	7	2		10
10	5	3	6			9
11	9		10	8	1	8
12	4	9	5	7		10
13	6	10	8	8	1	10
14	8	4	9			8
15	11	2	12	4	1	2
16	7	2	8	8	1	6
17	7	4	8	8	1	4
18	12		11	8		4
19	7	4	9		1	8
20	5	5	6	10	1	5
21	6	6	7	8	1	2
22	2	9	2	10		1
23	6	10	7	6		8
24	5	7	6	10	1	3
25	5	4	6	4	1	
26	12	2	14	2	2	
27	7		8	4	1	4
28	8		9	4	1	4
29	10	2	10	2		
30	5	7	6	8	1	1
31	7	6	8	2		8
	mos.		*mos.*			
M.	89		101.19			
S.D.	29.18		30.04			
$S.E._m$	5.33		5.48			
$S.E._{Diff.}$		1.09				
t.		11.18				

interval of time preceeding the administration of glutamic acid. This conclusion is based on the results of intelligence tests administered over the period of past attendance at Saint Gertrude's School. The 2 exceptions are

Case No. 18 and Case No. 29. Case No. 18 shows a loss of 4 months in an interval of 8 months during the experimentation with glutamic acid. In previous intelligence tests she has a gain of 7 months in an 8 month period. Case No. 29 averaged an improvement of 5 months in an 8 month period

TABLE 3

Distribution of Intelligence Quotients Before and at Conclusion of the Experiment

CASE	INTELLIGENCE QUOTIENT		
	Before	Conclusion	Change
			points
1	62	70	8
2	84	91	7
3	56	61	5
4	57	65	8
5	86	93	7
6	86	91	5
7	49	51	2
8	60	64	4
9	76	81	5
10	59	62	3
11	79	89	10
12	73	78	5
13	63	75	12
14	70	72	2
15	74	82	8
16	70	79	9
17	91	99	8
18	87	82	−5
19	65	76	11
20	53	63	10
21	67	74	7
22	38	37	−1
23	68	70	2
24	71	80	9
25	71	78	7
26	81	94	13
27	61	68	7
28	97	105	8
29	70	68	−2
30	75	82	7
31	61	64	3

before the administration of l(+) glutamic acid, but during the experiment there was no change in mental age.

A POINT SCALE OF PERFORMANCE

A Point Scale of Performance Form I and Form II was broken down

into the 5 tests that make up the scale. The Mare and Foal Test of Form I was given but it is not included in the statistical analysis because there is no similar test in Performance Test Form II. The mental ages of Cases No. 7 and No. 22 were in the 3 year age level so this test was not administered to them. Although only the raw scores were used in the statistical analysis, the year norms are tabulated for all the tests that make up this scale in order to give more meaning to the scores.

Knox Cube

The distribution of the raw scores and year norms of the 29 cases taking the Knox Cube Test before and after l(+) glutamic acid are shown in Table 4.

The lowest year norm on Test I was less than 5.5 years and the highest was 12.5; the lowest on Test II was less than 4.5 years while the highest was 15.5.

The raw scores on Knox Cube Form I range from 1.0 to 10.0 with a mean score of 4.69. The standard deviation was 2.40 and the standard error of the mean was .454. The scores on Knox Cube Form II range from 1.0 to 14.0 with a mean of 7.91 and a standard deviation of 3.12. The standard error of the mean was .590. The difference between the mean scores on Form I and Form II was 3.22 and the standard error of the difference was .410. This gives a "t" value of 7.85 which shows a significant change in scores, as this value is much greater than the criterion of significance at the 1 per cent level. ($t_{.01} = 2.76$). The ability of the group to do this performance test therefore was improved.

Seguin Formboard

Table 5 shows the raw scores and year norms for the subjects before and at the conclusion of the experiment.

The year norms on Seguin Formboard Form I ranged from less than 5.5 to 14.5 and on Form II the range was from less than 4.5 to 14.5/15.5. The raw scores in Form I ranged from 12 to 79 with an average score of 24.55. The standard deviation was 13.26 and the standard error of the mean was 2.51. The raw scores on Form II ranged from 11 to 50 with a mean score of 22.10. The standard deviation was 8.92 and the standard error of the mean was 1.69. The difference between the means was 2.45 and the standard error of the difference was 1.36. This gives a "t" value of 1.80. To show improvement in this test the raw scores should be less in Form II than in Form I. This is true in a number of cases but the change is not significant because the "t" value is less than the criterion required for significance at the 5 per cent level ($t_{.05} = 2.05$).

TABLE 4

Distribution of Raw Scores and Year Norms for the Initial Knox Cube Test (Form I) and the Retest (Form II)

CASE	INITIAL		RETEST	
	Score	Year norm	Score	Year norm
1	1.0	Less than 5.5	1.0	Less than 4.5
2	7.0	8.5	8.5	7.5
3	3.5	5.5	6.5	5.5
4	5.0	6.5	6.0	5.5
5	6.0	6.5	7.5	6.5
6	5.5	6.5	9.5	8.5
8	5.0	6.5	12.5	15.5
9	2.5	Less than 5.5	5.5	5.5
10	2.0	Less than 5.5	1.0	Less than 4.5
11	8.0	12.5	7.0	5.5
12	2.0	Less than 5.5	5.5	5.5
13	9.5	12.5	13.5	15.5
14	4.0	5.5	9.0	7.5
15	8.0	12.5	9.5	8.5
16	3.5	5.5	10.5	11.5
17	5.5	6.5	9.5	8.5
18	5.0	6.5	8.0	6.5
19	3.5	5.5	9.5	8.5
20	1.0	Less than 5.5	3.0	Less than 4.5
21	3.5	5.5	9.0	7.5
23	4.5	5.5	9.0	7.5
24	3.5	5.5	4.5	4.5
25	3.0	Less than 5.5	8.5	7.5
26	8.5	12.5	14.0	15.5
27	5.5	6.5	9.0	7.5
28	4.5	5.5	6.5	5.5
29	4.5	5.5	8.5	7.5
30	1.0	Less than 5.5	6.0	5.5
31	10.0	12.5	11.5	13.5
M.	4.69		7.91	
S.D.	2.40		3.12	
$S.E._m$	.454		.590	
$S.E._{diff.}$	.410			
t.	7.85			

Porteus Maze (Arthur Revision)

Table 6 gives the distribution of raw scores and year norms for Porteus Maze I and II:

The lowest year norm in Porteus Maze Form I was less than 5.5 years

TABLE 5

Distribution of Raw Scores and Year Norms for Initial Test of Sequin Formboard (Form I) and Retest (Form II)

CASE	INITIAL TEST		RETEST	
	Raw score	Year norm	Raw score	Year norm
1	40	Less than 5.5	44	Less than 4.5
2	17	9.5	18	7.5
3	18	8.5	26	4.5
4	18	8.5	15	9.5
5	18	8.5	19	6.5
6	16	9.5	15	9.5
8	16	9.5	17	8.5
9	31	Less than 5.5	28	4.5
10	20	7.5	22	5.5
11	20	7.5	18	7.5
12	30	Less than 5.5	28	4.5
13	15	10.5	14	10.5
14	16	9.5	13	11.5
15	17	9.5	18	7.5
16	27	5.5	21	5.5
17	26	5.5	30	4.5
18	17	9.5	12	12.5
				13.5
19	17	9.5	15	9.5
20	79	Less than 5.5	50	Less than 4.5
21	21	7.5	18	7.5
23	50	Less than 5.5	27	4.5
24	30	Less than 5.5	25	4.5
25	32	Less than 5.5	35	Less than 4.5
26	12	14.5	11	14.5/
				15.5
27	20	7.5	21	5.5
28	19	8.5	20	6.5
29	17	9.5	16	8.5
30	33	Less than 5.5	26	4.5
31	20	7.5	19	6.5
M.	24.55		22.10	
S.D.	13.26		8.92	
$S.E._m$	2.51		1.69	
$S.E._{diff.}$	1.36			
t.	1.80			

and the highest year norm was 14.5; the lowest year norm in Form II was less than 4.5 years and the highest was 15.5+ years. The raw scores in Form I ranged from 4.0 to 16.0 with a mean of 7.90 and a standard deviation

TABLE 6

Distribution of Raw Scores and Year Norms for Porteus Maze Form I (Initial) and Form II (Retest)

CASE	FORM I		FORM II	
	Score	Year norm	Score	Year norm
1	4.0	Less than 5.5	4.0	Less than 4.5
2	10.0	8.5	10.5	8.5
3	11.5	9.5	12.0	9.5
4	11.0	9.5	16.5	15.5
5	7.5	6.5	9.5	7.5
6	13.0	11.5	14.5	13.5
8	9.5	8.5	8.0	6.5
9	5.5	Less than 5.5	7.0	5.5
10	4.5	Less than 5.5	4.5	4.5
11	8.5	7.5	12.5	10.5
12	5.5	Less than 5.5	7.0	5.5
13	13.0	11.5	15.5	15.5+
14	6.5	5.5	9.5	7.5
15	11.0	9.5	11.5	9.5
16	5.5	Less than 5.5	4.5	4.5
17	6.0	Less than 5.5	7.5	6.5
18	9.5	8.5	9.5	7.5
19	9.0	7.5	13.0	10.5
20	4.5	Less than 5.5	4.0	Less than 4.5
21	5.0	Less than 5.5	8.0	6.5
23	6.0	Less than 5.5	8.0	6.5
24	5.0	Less than 5.5	7.0	5.5
25	5.0	Less than 5.5	7.0	5.5
26	16.0	14.5	17.0	15.5
27	10.0	8.5	10.5	8.5
28	5.0	Less than 5.5	11.0	8.5
29	6.5	5.5	9.5	7.5
30	6.0	Less than 5.5	8.0	6.5
31	9.0	7.5	15.0	14.5/ 15.5
M.	7.90		9.72	
S.D.	3.05		3.63	
$S.E._{m}$	.576		.686	
$S.E._{diff.}$	.361			
t.	5.04			

of 3.05. The standard error of the mean was .576. On Performance Form II, the range was from 4.0 to 17.0 with a mean score of 9.72 and a standard deviation of 3.63. The standard error of the mean was .686. The difference between the means is 1.82 with a standard error of the difference of .361.

This gives a "t" value of 5.04 which is much greater than the criterion for significance at the 1 per cent level ($t_{.01} = 2.76$). This indicates a significant change in scores on Porteus Maze between Form I and Form II.

TABLE 7

Distribution of Year Norms on Healy Form I (Initial Test) and Healy Form II (Retest)

CASE	FORM I	FORM II
	Year norms	Year norms
1	Less than 5.5	4.5
2	8.5	9.5
3	5.5	6.5
4	5.5	4.5
5	9.5	9.5
6	7.5	8.5
8	7.5	10.5
9	Less than 5.5	Less than 4.5
10	Less than 5.5	4.5
11	8.5	7.5
12	Less than 5.5	4.5
13	8.5	7.5
14	8.5	7.5
15	7.5	6.5
16	5.5	5.5
17	6.5	7.5
18	7.5	6.5
19	10.5	8.5
20	Less than 5.5	4.5
21	5.5	6.5
23	7.5	7.5
24	5.5	4.5
25	5.5	5.5
26	10.5	15.5+
27	7.5	8.5
28	5.5	4.5
29	7.5	10.5
30	Less than 5.5	Less than 4.5
31	5.5	7.5

Healy Picture Completion

The raw scores of Healy Form II are so different from the raw scores on Healy Form I that they can not be used as a means of comparison in the usual way. Therefore the year norms for each subject are shown in Table 7.

The Year Norms can not be averaged because the test is not standardized for mental ages below 5.5 and 4.5. Therefore the raw scores were averaged and looked up in the Manual (3, 4). The average raw score for Healy I was

220.93. This falls in the Year Norm distribution of from 6.5 to 7.5. The average raw score for Healy II was 23.38. This also falls in the Year Norm distribution of from 6.5 to 7.5. We conclude from this that there is no significant difference in scores between Healy Picture Completion Form I and Form II.

TABLE 8

Distribution of Year Norms on Kohs Block Form I (Initial Test) and Stencil Form II (Retest)

CASE	KOHS BLOCK YEAR NORMS	STENCIL YEAR NORMS
1	Less than 5.5	Less than 4.5
2	15.5	13.5
3	5.5	6.5
4	Less than 5.5	6.5
5	5.5	7.5
6	10.5	14.5
8	7.5	8.5
9	Less than 5.5	5.5
10	Less than 5.5	Less than 4.5
11	6.5	10.5
12	Less than 5.5	5.5
13	6.5	7.5
14	5.5	7.5
15	8.5	6.5
16	5.5	6.5
17	Less than 5.5	5.5
18	12.5	15.5
19	8.5	7.5
20	Less than 5.5	5.5
21	Less than 5.5	5.5
23	5.5	5.5
24	Less than 5.5	5.5
25	5.5	5.5
26	11.5	15.5
27	5.5	7.5
28	8.5	12.5
29	7.5	7.5
30	Less than 5.5	5.5
31	6.5	5.5

Kohs Block and Stencil Design

There is no Kohs Block in Form II so Kohs Block of Form I was compared with the Stencil Design which has been substituted by Arthur for this subtest. Because of differences in scoring between these 2 subtests the raw scores on the Kohs Block cannot be compared in the usual way with those on the Stencil Design and are not included in Table 8. The Year

TABLE 9

Distribution of Scores and Mental Ages on the Goodenough Drawing of a Man Test Before and After Six Months Glutamic Acid Treatment

CASE	SCORE		MENTAL AGE			
			Before		After	
	Before	After	Yrs.	Mos.	Yrs.	Mos.
1	2	9	3	6	5	3
2	24	21	9	0	8	3
3	15	15	6	9	6	9
4	17	15	7	3	6	9
5	19	21	7	9	8	3
6	35	27	11	9	9	9
8	25	23	9	3	8	9
9	11	8	5	9	5	0
10	7	12	4	9	6	0
11	20	17	8	0	7	3
12	6	10	4	6	5	6
13	17	18	7	3	7	6
14	14	18	6	6	7	6
15	20	14	8	0	6	6
16	14	14	6	6	6	6
17	8	9	5	0	5	3
18	25	18	9	3	7	6
19	24	18	9	0	7	6
20	12	8	6	0	5	0
21	17	14	7	3	6	6
23	17	17	7	3	7	3
24	18	13	7	6	6	3
25	16	20	7	0	8	0
26	32	33	11	0	11	3
27	12	13	6	0	6	3
28	19	20	7	9	8	0
29	25	20	9	3	8	0
30	16	13	7	0	6	3
31	15	16	6	9	7	0
M. =	17.31	16.34				
S.D. =	7.20	5.56				
$S.E._m$ =	1.36	1.05				
$S.E._{diff.}$ =	.704					
t.	1.38					

Norms cannot be averaged because the test has not been standardized for mental ages below 5.5 and 4.5. The raw scores were averaged and the Year Norm found for it. The average score on the Kohs Block was 14.72 which lies in the 7.5 to 8.5 Year Norm range. The average on the Stencil

Design was 5.28 which also lies in the 7.5 to 8.5 Year Norm range. We conclude that there is no significant difference between the scores in these two tests.

GOODENOUGH DRAW-A-MAN TEST

The raw scores and the mental ages of the twenty-nine cases taking the Draw-A-Man Test are found in Table 9.

The mental ages before glutamic acid treatment ranged from 3 years 6 months to 11 years 9 months with a mean of 7 years 4 months. At the time of retesting the mental age range was from 5 years to 11 years, with an average mental age of 7 years 1 month.

The raw scores were used to determine whether there was a significant change in the drawings of the subjects in the study. The scores on the first drawing ranged from 2 to 35 with a mean of 17.31 and a standard deviation of 7.20. The standard error of the mean was 1.36. The scores on the second drawing ranged from 8 to 33 with a mean of 16.34 and a standard deviation of 5.56. The standard error of the mean was 1.05. The difference between the mean scores was .97 with a standard error of the difference being .704. The "t" value is 1.38. The value of "t" shows that the difference is not significant. In fact it is less than that required for significance at the 10 per cent level ($t_{.10} = 1.70$).

ACHIEVEMENT TESTS

Reading

The distribution of reading grade scores is shown in Table 10.

Three girls of the study, Cases No. 7, 20, and 22, did not take achievement tests because the work they were capable of doing in reading, arithmetic and spelling was below the first grade level. One subject, Case No. 8, age 24 years 3 months, was not given an achievement test because she does not follow the work of the academic program.

The reading grade scores on the first test ranged from 1.0 to 7.2 with a mean of 2.71. The standard deviation was 1.536 and the standard error of the mean was .301. On the retest the grade scores ranged from 1.4 to 7.2 with a mean of 3.25. The standard deviation was 1.502 and the standard error of the mean was .295. The difference between the means was .54 and the standard error of the difference was .084 giving a "t" value of 6.43. This value of "t" shows a significant change in reading scores between the two tests. A "t" value of 6.43 is much greater than the criterion for significance at the 1 per cent level ($t_{.01} = 2.78$).

Figure 3 is the graph of the change in Reading grade scores for the 17 cases who were in attendance at Saint Gertrude's School and able to score on an achievement test at least a school term previous to the period

of the study. The broken line shows the change in scores before the administration of l(+) glutamic acid and the heavy line the change between the initial test and retest of the experiment. The progress made by the subjects

TABLE 10

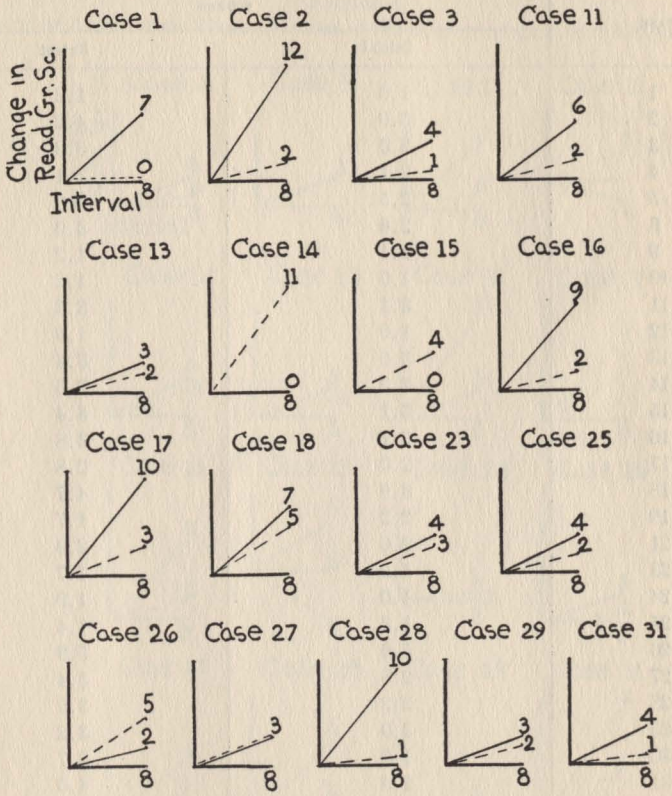
Distribution of the Reading Grade Scores Before and After Glutamic Acid Treatment

CASE	GRADE SCORES	
	Before	After
1	1.2	1.9
2	5.2	6.4
3	3.2	3.6
4	1.9	2.1
5	1.7	2.4
6	1.9	1.9
9	1.5	1.8
10	1.3	2.4
11	3.2	3.8
12	1.0	1.4
13	3.5	3.8
14	2.7	2.7
15	7.2	7.2
16	2.9	3.8
17	2.5	3.3
18	5.1	5.8
19	2.1	2.5
21	2.3	2.9
23	2.6	2.9
24	1.4	2.1
25	1.3	1.7
26	6.0	6.2
27	2.9	3.2
28	1.4	2.4
29	3.1	3.4
30	1.2	3.1
31	2.9	3.3
M.	2.71	3.25
S.D.	1.536	1.502
$S.E._m$	.301	.295
$S.E._{diff.}$	.084	
t.	6.43	

before the experiment was reduced corresponding to the interval that elapsed between the reading test immediately preceding the experiment and the retest at the close of the experiment. For example Case No. 2 made

2 months progress during an 8 month period preceding administration of glutamic acid and 9 months progress in the same interval of time during the experiment. 12

FIGURE 3
CHANGE IN READING GRADE SCORES BEFORE AND DURING THE EXPERIMENT



Arithmetic

The arithmetic grade scores for the 27 cases are shown in Table 11. The grade scores on the initial test ranged from 1.0 to 5.6 with a mean grade score of 2.44 and a standard deviation of 1.215. The standard error of the mean was .238. The grade scores on the retest ranged from 1.0 to 5.9. The mean of the scores on the retest was 2.89 with a standard deviation of 1.269. The standard error of the mean was .249. The difference between the grade scores on the two tests was .45 and the standard error of the difference is .092. This gives a "t" value of 4.89. As the criterion for significance at the one per cent level is 2.78, a "t" value of 4.89 shows a significant

change in arithmetic grade scores between the test at the beginning and at the end of the experiment with glutamic acid.

TABLE 11

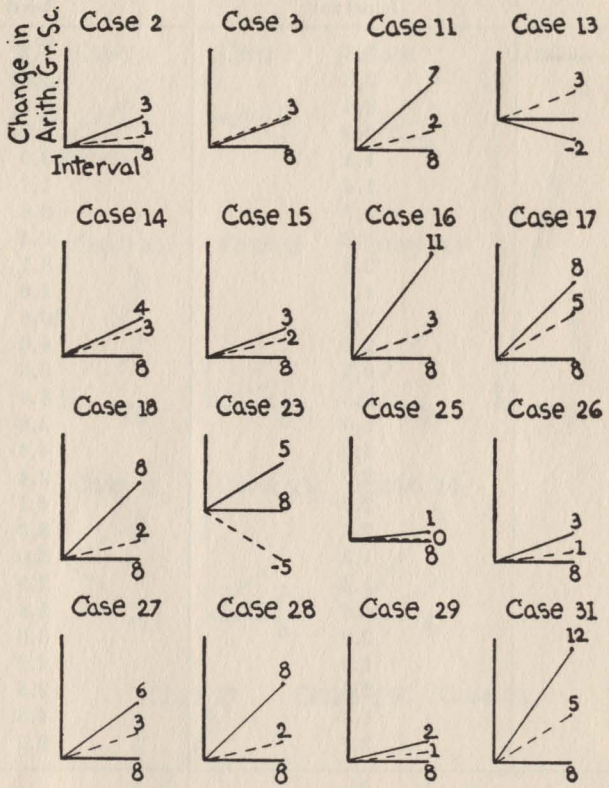
Distribution of the Grade Scores on the Initial Test and Retest of Arithmetic Achievement Test

CASE	SCORES	
	Initial	Retest
1	1.0	1.2
2	3.9	4.2
3	3.0	3.3
4	2.1	2.1
5	2.5	2.6
6	2.6	3.0
9	1.1	1.2
10	1.0	1.2
11	3.1	3.8
12	1.0	1.0
13	3.6	3.4
14	2.2	2.6
15	5.1	5.4
16	2.7	3.8
17	2.0	2.8
18	3.9	4.7
19	2.2	1.7
21	2.0	2.9
23	1.2	1.7
24	1.0	1.9
25	1.3	1.4
26	5.6	5.9
27	2.8	3.4
28	2.2	3.0
29	3.0	3.2
30	1.0	2.7
31	2.8	4.0
M.	2.44	2.89
S.D.	1.215	1.269
$S.E._{m}$	.238	.249
$S.E._{diff.}$	.092	
t.	4.89	

Figure 4 shows the change in arithmetic grade scores for the 16 cases who were in attendance at St. Gertrude's and able to score on an achievement test at least a school term previous to the experiment. The broken line shows the change in grade scores before the administration of 1(+)

glutamic acid and the heavy line shows the change between initial test and retest. The amount of change before the experiment was reduced corresponding to the interval that elapsed between the test and retest of the experiment. For example in Case No. 2 the interval between tests during the study was 8 months while the change in the arithmetic grade score was

FIGURE 4
CHANGE IN ARITHMETIC GRADE SCORES BEFORE AND DURING THE EXPERIMENT



3 months. The change in the arithmetic grade score for an 8 month period based on achievement tests previous to the experiment averaged 1 month.

Spelling

The spelling grade scores are shown in Table 12.

The grade scores ranged from 1.0 to 9.5 on the initial test with a mean grade score of 2.71. The standard deviation was 1.905 and the standard error of the mean was .374. On the retest the scores ranged from 1.0 to 10.6

with a mean grade score of 3.68. The standard deviation was 2.057 and the standard error of the mean was .403. The difference between the mean grade score of the two tests was .97 and the standard error of the difference

TABLE 12

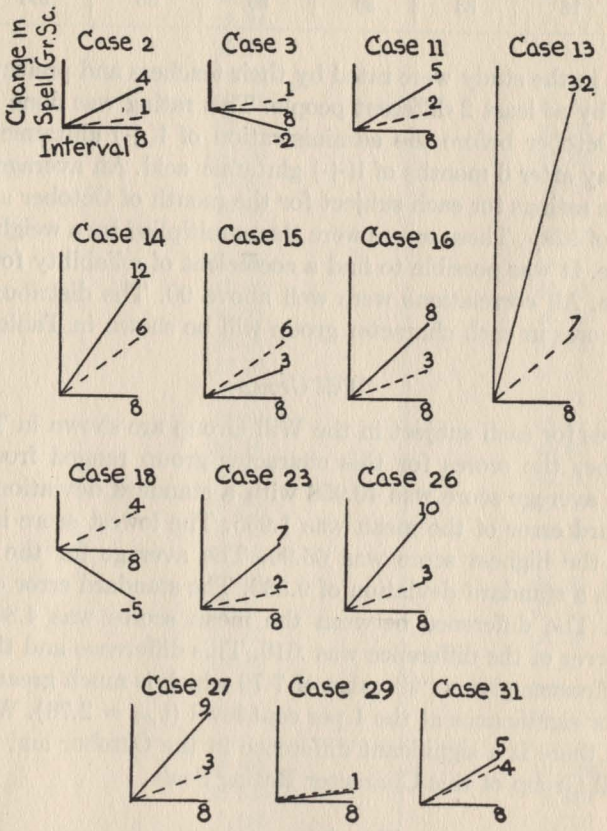
Distribution of the Grade Scores on the Test and Retest of Spelling Achievement Tests

CASE	GRADE SCORES	
	Initial test	Retest
1	1.3	3.2
2	2.6	3.0
3	3.4	3.2
4	2.0	2.2
5	1.3	2.9
6	1.4	1.7
9	1.7	2.8
10	1.3	2.4
11	2.6	3.1
12	1.0	1.0
13	7.4	10.6
14	2.8	4.0
15	9.5	9.8
16	2.6	3.4
17	1.9	3.8
18	4.9	4.4
19	2.0	2.4
21	2.9	4.1
23	2.3	3.0
24	1.3	3.0
25	1.3	2.9
26	4.6	5.6
27	2.9	3.8
28	1.9	2.8
29	2.4	2.5
30	1.3	4.6
31	2.7	3.2
M.	2.71	3.68
S.D.	1.905	2.057
$S.E._m$	.374	.403
$S.E._{diff.}$	.176	
t.	5.51	

was .176. The change in grade scores of the two tests is a significant change as the value of "t" is 5.51. This value is greater than the criterion for significance at the 1 per cent level ($t_{.01} = 2.78$).

Figure 5 is a graph of the changes in spelling grade scores before and during the administration of l(+) glutamic acid for the 13 cases who were in attendance at St. Gertrude's and able to score on the achievement test at least a school term previous to the experiment. The broken line shows the change in grade scores before the experiment and the heavy line the

FIGURE 5
CHANGE IN SPELLING GRADE SCORES BEFORE AND DURING THE EXPERIMENT



change between the initial test and retest. The amount of change before the experiment was reduced corresponding to the interval that elapsed between initial test and retest of the experiment. For example in Case No. 2 the interval between tests during the study was 8 months while the change in spelling grade scores was 4 months. The change in the spelling grade scores for an 8 month period based on achievement tests previous to the experiment averaged 1 month.

GRAPHIC RATING SCALE FOR THE STUDY OF CHARACTER

The Graphic Rating Scale for the Study of Character is a type of scale in which the subject is rated to show how much of the trait under consideration she possesses. For example:

NOT AT ALL	VERY LITTLE	SOMEWHAT	AVERAGE	MORE THAN AVERAGE	DECIDEDLY	EXTREMELY	MARK
0	16	33	50	66	83	100	

Thirty girls in the study were rated by their teachers and prefects; thus all were rated by at least 2 different people. This rating was done during the month of October before the administration of l(+) glutamic acid, and again in May after 6 months of l(+) glutamic acid. An average score was made of the ratings for each subject for the month of October and also for the month of May. These scores were then multiplied by a weight provided by the scale. It was possible to find a coefficient of reliability for each part of the scale. All correlations were well above 90. The distribution of the weighted scores in each character group will be shown in Tables 13 to 16.

Will Group

The scores for each subject in the Will Group are shown in Table 13.

In October the scores for this character group ranged from 23.76 to 67.21. The average score was 40.958 with a standard deviation of 10.529. The standard error of the mean was 1.955. The lowest score in May was 31.01 and the highest score was 66.96. The average for the group was 45.759 with a standard deviation of 9.530. The standard error of the mean was 1.770. The difference between the mean scores was 4.801 and the standard error of the difference was .616. This difference and the standard error of difference give a "t" value of 7.79 which is much greater than the criterion for significance at the 1 per cent level ($t_{.01} = 2.76$). We may conclude that there is a significant difference in the October and May scores on the Will Group of this Character Rating Scale.

Cheerfulness Group

Table 14 gives the scores in the cheerfulness group.

In October the scores on this character group ranged from 31.73 to 66.55 with an average of 51.886. The standard deviation was 8.470 and the standard error of the mean was 1.573. In May the scores ranged from 37.62 to 71.22 with a mean of 55.516. The standard deviation was 8.240 and the standard error of the mean was 1.530. The difference between the mean scores was 3.630 and the standard error of the difference was .582. This

TABLE 13

Distribution of the October and May Scores on the Will Group of the Graphic Rating Scale for the Study of Character

CASE	SCORES	
	October	May
1	26.80	33.02
2	67.21	66.96
3	52.06	57.55
4	43.34	47.07
5	39.17	45.55
6	48.20	50.11
7	40.19	42.19
8	27.39	31.76
9	38.95	41.89
10	24.53	36.69
11	46.45	52.14
12	30.91	38.85
13	50.87	56.00
14	47.92	56.35
15	39.92	40.52
16	30.73	39.51
17	23.76	31.01
18	39.56	40.72
19	41.66	50.12
20	35.74	34.67
21	27.21	33.85
23	39.63	45.99
24	29.48	35.11
25	51.90	55.01
26	62.12	64.65
27	41.71	47.57
28	51.12	54.66
29	40.28	41.67
30	46.55	55.49
31	37.39	46.08
M. =	40.958	45.759
S.D. =	10.529	9.530
$S.E._m$ =	1.955	1.770
$S.E._{diff.}$ =	.616	
t.	7.79	

gives a "t" value of 6.24 which is beyond the criterion for significance at the 1 per cent level ($t_{.01} = 2.76$). This would lead us to believe that there is a significant difference between the October and May scores of this character group and hence a change in the trait.

TABLE 14

Distribution of the October and May Scores in the Cheerfulness Group of the Graphic Scale for the Study of Character

CASE	SCORES	
	October	May
1	54.51	59.44
2	57.69	57.47
3	60.32	64.71
4	56.66	58.84
5	45.91	54.14
6	63.33	67.81
7	49.70	54.27
8	66.55	71.22
9	49.89	55.86
10	44.66	48.79
11	55.15	58.63
12	31.73	37.94
13	47.99	50.48
14	60.45	58.88
15	64.05	65.26
16	45.06	46.04
17	51.64	59.18
18	43.04	42.84
19	53.31	58.62
20	60.70	58.49
21	36.03	37.62
23	58.95	66.79
24	51.80	54.36
25	35.05	39.05
26	55.23	57.89
27	58.94	55.29
28	43.81	53.84
29	53.23	59.00
30	49.82	55.94
31	51.38	56.80
M. =	51.886	55.516
S.D. =	8.470	8.240
$S.E._m$ =	1.573	1.530
$S.E._{diff.}$ =	.582	
t.	6.24	

Sociability Group

The scores for this group are found in Table 15.

In October the scores of the Sociability group ranged from 14.85 to 67.94, with a mean score of 48.836 and a standard deviation of 10.976. The

TABLE 15

Distribution of the October and May Scores on the Sociability Group of the Graphic Rating Scale for the Study of Character

CASE	SCORES	
	October	May
1	59.06	62.64
2	54.76	53.12
3	53.64	57.87
4	48.39	51.34
5	52.29	59.35
6	67.94	69.55
7	53.50	55.02
8	46.64	51.68
9	45.65	52.63
10	52.60	56.53
11	63.18	64.83
12	14.85	21.76
13	33.27	45.20
14	59.06	60.03
15	59.62	60.09
16	49.17	50.53
17	59.71	68.40
18	44.96	44.37
19	38.55	46.70
20	47.01	51.25
21	51.79	56.01
23	45.57	51.85
24	46.52	52.72
25	24.79	31.59
26	53.08	55.62
27	44.80	48.26
28	57.22	63.83
29	49.86	52.58
30	33.87	35.15
31	53.74	57.74
M. =	48.836	52.941
S.D. =	10.976	10.077
$S.E._m$ =	2.038	1.871
$S.E._{diff.}$ =	.577	
t.	7.11	

standard error of the mean was 2.038. In May the scores ranged from 21.76 to 69.55 with an average score of 52.941. The standard deviation was 10.077 and the standard error of the mean was 1.871. The difference between the means of the October and May scores is 4.105 and the standard error

TABLE 16

Distribution of the October and May Scores on the Emotionality Group of the Graphic Rating Scale for the Study of Character

CASE	SCORES	
	October	May
1	28.64	27.69
2	39.30	47.35
3	39.63	42.64
4	28.98	30.44
5	49.25	52.96
6	34.27	29.25
7	43.05	42.03
8	24.60	25.28
9	36.65	46.03
10	46.86	45.33
11	38.70	40.04
12	39.57	35.63
13	32.34	36.97
14	52.07	50.78
15	30.85	28.44
16	56.08	55.10
17	35.60	34.69
18	64.37	59.97
19	27.37	27.77
20	43.30	47.85
21	55.93	52.21
23	29.09	28.45
24	34.71	35.10
25	13.94	13.83
26	39.78	38.12
27	28.82	28.02
28	36.77	37.08
29	27.32	23.80
30	24.63	21.99
31	53.26	48.45
M. =	37.858	37.776
S.D. =	11.039	11.067
$S.E._m$ =	2.050	2.055
$S.E._{diff.}$ =	.649	
t.	.126	

of the mean is .577. This gives a "t" value of 7.11 which shows a significant change between the two scores as this is much greater than the criterion for significance at the 1 per cent level ($t_{.01} = 2.76$). Judging from the high "t" value we could conclude that there is also a change in this character trait after the glutamic acid therapy.

Emotionality Group

The scores for the Emotionality group will be shown in Table 16.

The scores on Emotionality in October ranged from 13.94 to 64.37 with a mean of 37.858, a standard deviation of 11.039, and a standard error of the mean of 2.050. In May the scores ranged from 13.83 to 59.97 with a mean of 37.776. The standard deviation was 11.067 and the standard error of the mean was 2.055. The difference between the mean scores is .082 and the standard error of the mean is .649. In order to show improvement in this character trait, the mean for May should be lower than the mean for October. It meets that requirement but the difference is not large enough to show a significant change. The "t" value for this group is .126 which is much lower than the criterion for significance at the 50 per cent level ($t_{.50} = .689$). We would conclude from this then that there was no significant change in the emotionality group of character traits.

MOSAIC TEST

The Mosaic Test was designed by Margaret Lowenfeld. It is a projective technique used to study the characteristics of personality. It consists of a number of squares, right angled triangles, diamonds, equilateral and scalene triangles in colors of red, yellow, blue, green, black and white. The subject is seated before the examiner and told to make something in the tray, using any or all of the colors and as many pieces as she pleases. There is no time limit. The examiner then makes a copy of the mosaic and classifies it. Although there are no standardized norms, Wertham and Golden (21) list 23 classifications for the Mosaic Test which serves as a frame work in the study of personality.

For this study 18 items are listed. One item, No. 2, is taken from the classification of designs from the Children's Centre in London and the remaining 17 from the list of Wertham and Golden. These 17 were selected as being most useful for this study.

The list used for the classifications of the designs is as follows:

1. Number of designs.
2. Fundamental pattern.
3. Representation of definite "concrete" object or an "abstract" design or incoherent pattern.
4. Harmony of design as a whole.
5. Simple or complex design.
6. Compactness or looseness of design.
7. Distinctness of configuration.
8. "Static" or dynamic (indicating movement).
9. Expression of configuration by pieces or empty spaces they enclose.

10. Position of the design within the frame of the tray (e.g. relation to margin, general distribution, "all-over pattern").
11. Number of pieces.
12. Choice of color (preferences, indiscriminate, harmonious, indicating natural colors of object, decorative ornamentation of concrete object, etc.).
13. Choice of shapes.
14. Emphasis on form or color.
15. Simple geometric design.
16. Evidence of fixation in form or color on individual piece put down ("stone-bound" design).
17. Symmetry (absent, present in color or form or both, exaggerated, etc.).
18. Repetition; stereotype.

As there is no objective criterion for the interpretation of the Mosaic Test the designs of the subjects both before and after glutamic acid were recorded and classified according to the 18 items listed. The classifications and interpretations were made by a clinical psychologist and the experimenter. The ratings of the subjects will be found on the following pages.

Case 1. On the first mosaic, Case 1 merely put 6 pieces on the tray placing 2 of the same shape together. On the second, she used 20 red pieces of any shape placing them along the edge. The increase in the number of pieces shows that she is able to do more, but the placement along the edge indicates insecurity and marked need of support.

Case 2. This subject was scored both times on 16 of the 18 items used in the classification of the designs. Patterns of both mosaics were similar in that she used diamonds in approximately the same way but there was a difference in color. The use of color in the mosaic indicated that she allowed strong feelings to be more openly expressed but still in a sociably acceptable way.

Case 3. Both patterns were very similar and could be scored on 14 items. In the second one, however, there were fewer red pieces used which might be interpreted to mean diminution of hostility.

Case 4. The first time the subject began by trying to fill the tray by placing different colored squares together and then tiring of this, placing indiscriminate shapes along the other 3 edges of the tray. This clinging to the edge indicates insecurity and inadequacy. There is also evidence of a great deal of constriction. The second time the subject's pattern was scored on 12 of the items which showed some attempt at organization. There was also less constriction shown and definite loss of the clinging to the edge.

Case 5. The first mosaic attempted produced 1 design which was in-

coherent, loose, showed no harmony and no configuration. The subject used several shapes but with white the predominating color giving evidence of denial of emotion. The second time the subject produced 2 designs which were compact, abstract, showed harmony of color and some configuration. She used only 2 shapes and the colors red and green. This indicates stronger feelings which are not directed outward, and control of emotion.

Case 6. The subject first produced a well formed boat using the colors indiscriminately, and the sun and water in their natural color. All these objects had the correct location in relation to each other. In the second test she made 6 designs each of 2 right triangles of different colors which she placed close to an edge of varied colored squares. The subject called these triangular forms boats. In the first there is present evidence of strong feelings which are not directed outward and there is an attempt at control. With considerable help this subject is able to express some aggression. The second, however, shows strong feelings of inadequacy and insecurity. All feeling is kept very close to herself.

Case 7. Two red squares, 1 green and 2 black squares, were placed one next to the other on one side of the tray and called a train. The rest of the tray was dotted indiscriminately with shapes and colors. The second was less scattered but did not adequately represent what she set out to make. If she were paying attention to color, the hostility was considerably less on the second test, but both confirm the presence of strong feeling.

Case 8. The first and second production of this subject were very similar. In the first she had 4 geometric designs and in the second 6. The first designs were better in that she used more pieces in the making of each design but the structure of the designs show ambivalence in the direction of feelings. The second showed improvement in personality in that she was able to direct more feelings away from herself, as shown by interrelationship of pieces with each design.

Case 9. On both tests this subject just placed blocks in corners. In the first she used 3 triangular forms of different colors that actually fit while on the second she placed 2 white blocks of different triangular shapes that did not fill in the corners. This subject was able to do more with the test the first time. She was able to show some aggression in the first with some attempt at control. The second is complete denial of emotion and constriction and both show insecurity in placement of pieces.

Case 10. Both times the subject attempted to fill the tray with indiscriminate form and color. The second, however, showed more planning and not as much insecurity, but an increase in the number of pieces that show hostility.

Case 11. On the first test this subject made 9 geometric designs, all except one placed along the edge while on the second she gave us 11 with 3

located in the center of the tray. Both show clinging to the edge; however, the first had more pieces in each design and showed better organization. There is more feeling directed against herself in the second while in the first the feelings are held within as shown especially by greater compactness of the design.

Case 12. This subject produced designs that were very similar. She made a number of fundamental designs of different shapes and colors. Blocks of the same shape were placed together. There was about an even distribution of color and good placement both times.

Case 13. Both times this subject began with an attempt at order and some stability, but broke down to a very scattered pattern with no integration. The first time she was compulsive and had to fill the entire tray while the second time she lost some compulsiveness and could leave the tray half filled.

Case 14. On the first test this subject produced 7 simple geometric designs and on the second 9. She increased the number of pieces from 22 to 47 and shapes from 4 to 5. Most of the designs on the second test seem more complex than those of the first and show more consistency in directing of aggressive feelings away from self. In the first there is ambivalence in the direction of feelings.

Case 15. This subject produced 3 geometric designs using 28 pieces of several shapes and 3 colors (white, green, and yellow). On the second test she produced 1 fundamental design of 5 white pieces. In the first she has kept her feelings close to herself. There is a marked element of control and some denial of emotion. The second one indicates a denial of emotion and keeping herself from others.

Case 16. There is not much change in what was made by this subject except that in the first she had 3 geometric designs and in the second 4. In both the controlled feelings are those she shows most obviously.

Case 17. This subject produced 1 fundamental design of 1 shape and indiscriminate choice of color in the first test. There were no feelings openly expressed and it was very constricted. On the second she made 5 fundamental designs of several shapes and each design a different color. This indicates she is able to do more with her feelings because she gives them more open expression.

Case 18. In the first mosaic this subject used 45 pieces and 76 in the second. There is some clinging to the edge and the same idea of putting shapes of similar forms together was carried out in both tests. Both show need of security. In the first she has kept her feelings closer to herself while in the second she has moved out and is able to be more outward in expression of feelings.

Case 19. One concrete object of 3 shapes and 31 pieces was the first

production of this subject. Configuration was shown by pieces and empty spaces. The second test was a repetition of the same concrete object using only 19 pieces and configuration was shown by pieces only. This subject did not allow much expression of emotion in either. The form in the second production is more constricted.

Case 20. On the first test, this subject made no effort to produce anything. She placed different shapes and colors along the edge and then indiscriminately over the tray. This clinging to the edge shows insecurity. On the second test she lost the clinging to the edge and there was the beginning of very elementary organization indicated by the subjects fitting blocks of the same color and shape together to make a fundamental design.

Case 21. Four fundamental designs composed of 26 pieces were the result of the first production of this subject. Four shapes were used each shape composing a different design. There was no color pattern. The designs were normally placed. The second time the mosaic was attempted the subject produced only 1 design in the form of a border and used only 16 pieces of 3 shapes and all colors. In the first it looks like most of her strong feelings are kept close to herself or directed against herself. In the second she doesn't direct feelings so strongly against herself but the force of feeling is blunted so there is very little outward expression of feeling. The second also shows more insecurity and need of support.

Case 22. The first time the mosaic was tried this subject placed 6 pieces in the lower right hand corner while the second time she placed 21 pieces mostly in the upper half of the tray which indicated little outward movement.

Case 23. The first mosaic resulted in 4 fundamental designs using squares and each design of the same color. Three designs were placed along the edge. The second resulted in steps. Each set of steps of three was of the same color. The first designs show insecurity which does not show up in the second attempt.

Case 24. The first attempt by this child resulted in 2 designs using 38 pieces of several shapes and indiscriminate color. One was loose with no definite evidence of configuration while the other was a stone-bound design. In the second she made one stone-bound design and 2 compact designs using a total of 58 pieces. Choice of forms in the first shows that she did not allow open expression while in the second there is more open expression. The compact designs in the second are better than in the first.

Case 25. This subject used 9 equilateral triangles of different colors to produce one simple design in the first mosaic while in the second she used 28 equilateral triangles of various colors to produce the same pattern which she placed along the edge. In the first she was able to keep the design away from the edge. In both there was careful fitting together of pieces of aggres-

sive forms showing rigidity. In the first her feelings were directed against herself while in the second mosaic this was not the case.

Case 26. In the first mosaic this subject used 13 pieces of 3 colors and 4 shapes, and in the second 20 pieces, 2 colors and 1 shape were used. Both showed strong feelings. In the first they were directed toward self but there was some attempt at control. In the second there was noted considerable hostility with no controlling color to balance the strong feelings but the form chosen indicated that the subject would try to be socially conforming.

Case 27. This subject produced very similar designs as shown by 11 items checked. Both patterns had a border design of approximately the same number of squares and an abstract design. This clinging to the edge gives evidence of insecurity. The design of the first mosaic shows that her strong feelings are allowed to come close to the surface and to be more openly expressed while on the second test the design is entirely on the edge of the board and appears to indicate constriction.

Case 28. The 2 patterns of this subject are quite different. In the first she began a border which was discontinued after 12 right triangles had been fitted together and 2 rather fundamental designs of 5 pieces each. The pattern of the two designs was the same but the colors were different. This shows some planning and some insecurity. In the second she attempted 1 concrete object (our flag). She used 66 indiscriminate shapes of the natural color of the flag. This second attempt shows more organization. She was consistent in the proper choice of color but lacking in form. This latter pattern shows the presence of considerable strong feelings which were usually expressed in a socially acceptable way.

Case 29. The 2 mosaics of this subject scored on the same 15 items producing similar fundamental designs with the following exception. On the first the subject used 8 pieces of 2 shapes and 3 colors. On the second she used 4 pieces and 3 colors. There is constriction and little open expression on both. The first showed strong feelings some of which are given the aggressive form. In the second there is some evidence of control as indicated by choice of color and general structure of the design.

Case 30. This subject produced one simple design fitting squares and diamonds together in the first mosaic. It was made of thirty-eight pieces of indiscriminate color and the outside edge of the pattern is along the right edge of the tray. This first attempt shows constriction, insecurity and strong feelings including hostility which are kept close to herself. The second mosaic resulted in four designs using forty-one pieces. One was made of diamonds, two of squares and one of squares and triangles. In all patterns color was used indiscriminately. In this latter attempt the results show less constriction and a total loss of insecurity. In this the strongest feelings are still kept close to self.

Case 31. On the first trial this subject produced a fundamental pattern using four squares (two blue and two white). This shows constriction and very little feeling or warmth of personality. On the second trial the subject used four white right triangles to produce a fundamental design whose configuration was shown by the pieces and the space they enclosed. This second shows a definite denial of emotion and the form used is aggressive.

To summarize the results of the Mosaic Test we find that 16 of the cases studied showed an improved test performance at the end of the experiment. Six evinced similar personality traits according to the test before and after glutamic acid. In a test of this sort it is obviously difficult, in fact, well nigh impossible to give precise evaluation because of the complex nature of the instrument and personality per se. Thus we find that 5 cases showed improvement in some areas on the second test but also some unsatisfactory signs which did not appear on the first administration. The performance of others would at first glance indicate a less satisfactory personality picture. It is felt, however, that no definitive conclusions can be made from the results of this test over such a short period of time, since release of aggression, hostility and the like may be a necessary step toward a better integrated personality.

RORSCHACH SUMMARY

The responses of each subject on the Rorschach Test were scored according to Beck's system of scoring. These records together with the dates of the tests before and after 6 months administration of glutamic acid will be given on the following pages.

	Case I			*Case II*	
Date	11/10/47	6/3/48	Date	11/1/47	5/18/48
T.R.	9	10	T.R.	24	13
Refused	1		W	4	2
W	3	5	D	17	11
D	6	4	Dd	2	
Dds		1	Dds	1	
FM+		1	M	3	
CF	1		M+		3
F+	1	1	CF+	1	1
F−	7	8	CF−		1
A	2	7	FY	1	
H	1		F+	10	6
Na	1		F−	9	2
Ar	3	2	H	7	5
Bt	2		A	14	8
Hh		1	Ad	3	
F%	89	90	F%	79	62
F+%	13	11	F+%	53	75

Case I

Date	11/10/47	6/3/48
A%	22	70
P	1	1
T.T.	6′17″	2′57″
T/R	41.9″	17.7″
T/1R	21.8″	9″
T/CR	27.6″	10.8″

Case II

Date	11/1/47	5/18/48
A%	71	62
P	4	5
T.T.	10′30″	4′55″
T/R	22.1″	22.7″
T/1R	9.2″	4.6″
T/CR	10.2″	3.8″

Case III

Date	11/1/47	6/6/48
T.R.	12	12
W	2	3
D	8	8
Dd	2	1
F+	7	8
F−	5	4
A	12	11
Ad		1
F%	100	100
F+%	58	67
A%	100	100
P	3	5
T.T.	7′54″	4′2″
T/R	39.5″	20.2″
T/1R	15″	14.5″
T/CR	18.4″	19.6″

Case IV

Date	11/11/47	5/29/48
T.R.	11	22
Refused	IV VI	
W	2	3
D	9	18
Dd		1
M+		1
CF−	2	1
CF		1
YF	1	
F+	8	12
F−		5
FM+		1
H	1	1
A	6	13
Bt		2
Cg	1	
Fi	1	
Hh	1	
Im		1
Na		4
Pr	1	1
F%	73	77
F+%	100	72
A%	55	59
P	3	4
T.T.	5′35″	5′54″
T/R	30.5″	11.6″
T/1R	18.6″	13.3″
T/CR	23″	8.2″

Case V

Date	11/9/47	6/6/48
T.R.	15	14
W	7	4
D	6	10
Dd	1	
Dds	1	
M+	1	
CF+	1	1

Case VI

Date	11/9/47	6/5/48
T.R.	17	15
W	2	3
D	13	12
Dd	2	
M+	1	
FM+		1
FC+	1	

	Case V	
Date	11/9/47	6/6/48
CF−	1	1
FC		1
FY		1
FM+	1	2
FM−	1	
F+	6	5
F−	4	3
H	1	1
A	10	9
An	1	1
Bt		2
Cl		1
Ge	1	
Ls	1	
F%	67	57
F+%	60	63
A%	67	64
P	2	4
T.T.	4′25″	3′11″
T/R	17.6″	13.6″
T/1R	6.2″	6.9″
T/CR	7.6″	6.8″

	Case VI	
Date	11/9/47	6/5/48
F+	11	13
F−	4	1
H	2	2
A	9	10
Ad	1	1
An		1
Hh	1	
F%	88	93
F+%	73	93
A%	59	73
P	5	6
T.T.	7′24″	5′34″
T/R	26.1″	22.3″
T/1R	18.1″	14.5″
T/CR	9.8″	13″

	Case VIII	
Date	11/15/47	6/7/48
T.R.	14	13
W	2	4
D	12	9
FM+	1	1
CF−	1	1
F+	9	7
F−	3	4
H	1	1
A	10	11
Ad	1	
Cg	1	1
F%	85	85
F+%	75	64
A%	79	85
P	7	6
T.T.	11′30″	6′18″
T/R	49.3″	29.1″
T/1R	34.9″	16.9″
T/CR	39″	21.4″

	Case IX	
Date	11/7/47	6/4/48
T.R.	17	15
W	2	4
D	11	8
Dd	4	3
F+	10	7
F−	7	6
F		1
H	2	
Hd	5	
A	4	
Ad	2	
Art	1	1
Bt	1	1
Im		2
Na	2	1
F%	100	87
F+%	59	54
A%	35	73
P	1	2
T.T.	14′55″	13′22″
T/R	52.7″	53.5″
T/1R	21.6″	36.4″
T/CR	21″	27.4″

	Case X	
Date	11/12/47	6/4/48
T.R.	12	13
Refused	VI	
W	5	3
D	6	9
Ds	1	1
CF−	1	1
CF+	2	
F+	4	7
F−	5	5
A	4	5
Ad		1
Art	1	
Bt	2	2
Cg	1	2
Cl	3	
Im	1	1
Ls	1	1
F%	75	92
F+%	44	58
A%	33	46
P	3	2
T.T.	4′19″	8′45″
T/R	20.8″	40.4″
T/1R	10.6″	39″
T/CR	14″	27″

	Case XI	
Date	11/1/47	5/31/48
T.R.	6	17
Refused	I VII IX X	
W	2	1
D	3	14
Ds	1	1
Dd		1
CF+		1
F+	4	15
F−	2	1
H	1	3
A	3	3
Ad		5
An	1	2
Ar	1	1
Cg		1
Fi		1
Ls		1
F%	100	94
F+%	67	94
A%	50	47
P	2	3
T.T.	21′55″	9′55″
T/R	3′47″	35″
T/1R	1′38″	28.6″
T/CR	66″	16.6″

	Case XIII	
Date	11/15/47	6/2/48
T.R.	15	15
W	2	4
D	13	11
F+	12	10
F−	3	5
H	1	1
A	14	13
Cg		1
F%	100	100
F+%	80	67
A%	93	87
P	3	3
T.T.	31′23″	13′16″
T/R	2′5″	53″
T/1R	1′19″	25.5″
T/CR	53″	20.2″

	Case XIV	
Date	11/1/47	6/3/48
T.R.	11	17
Refused	IX X	
W	4	3
D	6	12
Dd	1	2
C	2	
CF		1
YF	2	2
YF.C	1	
C.YF		1
F+	5	10
F−	1	2
A	3	6
Bt	1	4
Cg	2	2
Fi	5	5
F%	55	71
F+%	83	83
A%	27	35
P	3	4
T.T.	8′56″	12′29″
T/R	1′7″	1′5″
T/1R	25.5″	47″
T/CR	21.7″	38.2″

	Case XV	
Date	11/9/47	6/2/48
T.R.	12	16
W	5	5
D	5	10
Ds	2	1
C		1
CF+	1	1
CF	1	
CF−	1	
FY	1	
F+	4	6
F−	3	8
H	3	1
HdBl		2
A	6	9
An		2
Bl		1
Ge		1
F%	58	88
F+%	57	43
A%	50	56
T.T.	2′28″	2′4″
T/R	12.3″	7.8″
T/1R	3.5″	2.8″
T/CR	4.2″	2.4″

	Case XVI	
Date	11/11/47	5/3/48
T.R.	11	14
W	5	4
D	6	10
M		1
FM+	1	2
C		1
CF−	1	
CF+	1	
FY	2	
F+	4	5
F−	3	4
H		1
A	6	10
Ar	2	
Fi	1	2
Cl	1	
Ls	1	
Na		1
F%	64	64
F+%	57	56
A%	55	71
P	2	3
T.T.	3′51″	4′44″
T/R	21″	20″
T/1R	10.7″	5.1″
T/CR	9.8″	6.6″

	Case XVII	
Date	11/16/47	6/3/48
T.R.	12	18
Refused	IX	
W	3	4
Ws	1	1
D	7	13
Dd	1	
CF−	1	
CF	1	
CF+	1	1
F+	7	10
F−	3	6
Hd	1	
A	6	12
Art		1
Bt	3	3
Cg		1
Cl	1	1
Na	1	
F%	83	89
F+%	70	63

	Case XVIII	
Date	11/2/47	5/29/48
T.R.	27	15
W	2	8
D	20	7
Dd	3	
Ds	2	
M	2	3
CF+		3
FC	1	
FY	2	
F+	2	9
H	3	3
Hd	1	
A	11	10
Ad	2	
Ar	2	
Bt	3	
Cl	1	
Fi	2	
Mu	1	
Na	1	1

Case XVII

Date	11/16/47	6/3/48
A%	50	67
P	3	2
T.T.	4′8″	10′49″
T/R	20.7″	36.1″
T/1R	9.8″	44.5″
T/CR	16.4″	6.6″

Case XVIII

Date	11/2/47	5/29/48
Ru		1
F%	81	60
F+%	100	100
A%	41	67
P	3	4
T.T.	6′55″	5′
T/R	41.5″	30 ″
T/1R	7 ″	8.5″
T/CR	7.4″	10 ″

Case XIX

Date	11/16/47	5/31/48
T.R.	23	25
W	2	2
D	21	20
Dd		3
CF−		1
CF+		1
FC+	2	1
FY+		1
F+	15	15
F−	6	6
Hd	1	2
A	9	6
Ad	2	3
An	1	1
Bt	7	5
Cg	2	4
Hh		3
Na	1	
F%	91	84
F+%	71	71
A%	39	24
P	5	2
T.T.	8′7″	6′39″
T/R	21.2″	16 ″
T/1R	7.6″	7.6″
T/CR	9.2″	8.8″

Case XX

Date	11/4/47	5/31/48
T.R.	16	20
W	6	1
D	10	19
CF−	3	2
FY	1	
F+	7	11
F−	5	6
F	1	
H	2	2
A	6	8
Ar	1	
Art		1
Bt	2	5
Cg	1	
Cl	2	
Hh	1	2
Ls		1
Na	1	
Tr		1
F%	75	85
F+%	58	65
A%	38	40
P	2	1
T.T.	9′18″	4′35″
T/R	35.9″	13.8″
T/1R	10.3″	6.1″
T/CR	6.6″	5.8″

Case XXI

Date	11/15/47	6/3/48
T.R.	36	19
W	6	4
Ws	3	1
D	22	14
Dd	3	
Ds	2	
C		1

Case XXIII

Date	11/15/47	6/4/48
T.R.	11	11
Refused	II	VI
W	4	3
D	7	8
FM+		1
C	1	
CF	2	

Case XXI

Date	11/15/47	6/3/48
CF+	1	1
YF−	1	
YF+	1	1
V	1	
FM+	6	4
F+	14	4
F−	12	8
A	21	14
An	1	
Ar	1	
Bl	1	2
Bt	4	1
Hole	1	
Ls	2	
Na	2	1
Rc	3	1
F%	72	42
F+%	54	50
A%	58	74
P	3	1
T.T.	7′21″	5′21″
T/R	12.3″	16.7″
T/1R	4.3″	5 ″
T/CR	3.4″	6 ″

Case XXIII

Date	11/15/47	6/4/48
CF+		1
FC+		2
F+	5	6
F−	3	1
H	2	1
A	6	10
Ls	1	
Na		2
F%	73	64
F+%	63	86
A%	55	91
P	3	3
T.T.	10′44″	7′1″
T/R	58.5″	38.3″
T/1R	1′5″	25.7″
T/CR	1′19″	37.8″

Case XXIV

Date	11/11/47	5/29/48
T.R.	15	17
Refused	IV	
W	4	3
D	8	13
Dd	2	
Ds	1	1
FC+	2	
FC−		1
F+	8	11
F−	4	5
H	1	3
Hd		1
A	4	8
Ad	1	
Ar	2	1
Bt	4	1
Cg	1	1
Hh	1	1
Na	1	1
F%	80	94
F+%	67	69
A%	27	47
P	2	3
T.T.	8′2″	4′27″
T/R	32.1″	15.8″
T/1R	16.2″	4.9″
T/CR	8.6″	2.4″

Case XXV

Date	11/12/47	6/3/48
T.R.	14	12
W	2	4
Ws		1
D	8	6
Dd	2	1
Dds	2	
CF−		2
CF+		1
FC+	1	
FM+		1
F+	8	6
F−	5	2
Hdx	4	
A	10	11
Bt		1
F%	93	67
F+%	62	75
A%	71	92
P	3	3
T.T.	5′54″	6′3″
T/R	25.3″	30.3″
T/1R	11 ″	13.6″
T/CR	6 ″	20 ″

Case XXVI

Date	11/15/47	5/29/48
T.R.	27	31
W	2	5
D	21	21
Dd	2	4
Ds	2	1
CF−	1	2
CF+		1
FY		2
F+	18	19
F−	7	8
F	1	
H	1	
Hd		1
A	15	20
Ad	6	2
An	3	4
Art		1
Bt	1	1
Cg		1
Fd		1
Hh	1	
F%	93	87
F+%	72	70
A%	78	71
P	6	7
T.T.	18′55″	16′55″
T/R	42″	32.7″
T/1R	49.6″	20.5″
T/CR	54.2″	16 ″

Case XXVII

Date	11/3/47	6/2/48
T.R.	10	24
W	3	
D	7	24
F+	5	10
F−	5	14
A	10	24
F%	100	100
F+%	50	42
A%	100	100
P	1	2
T.T.	11′35″	13′57″
T/R	69.5″	34.8″
T/1R	49.4″	17.5″
T/CR	46 ″	15.4″

Case XXVIII

Date	11/9/47	6/3/48
T.R.	18	18
W	2	2
D	15	15
Dd	1	1
C	3	
CF+	1	1
CF−		2
F+	6	9
F−	8	6
H	4	
A	1	6
An	1	1
Bl	3	1
Bt	2	2
Cg		1
Fi	1	2
Fd		1

Case XXIX

Date	11/6/47	6/2/48
T.R.	11	13
W	5	9
D	5	4
Ds	1	
CF−	2	1
CF+		1
F+	6	5
F−	3	3
FM		3
A	7	11
An	2	1
Art	1	1
Hh	1	
F%	82	77
F+%	67	63
A%	64	85
P	4	5

Case XXVIII

Date	11/10/47	6/3/48
Hh	3	
Ls		2
Na	3	1
Rc	1	
F%	78	83
F+%	43	60
A%	6	33
P	1	1
T.T.	4′15″	3′22″
T/R	14.2″	11.2″
T/1R	6.1″	7.1″
T/CR	8.2″	7.2″

Case XXIX

Date	11/6/47	6/2/48
T.T.	6′57″	6′10″
T/R	37.9″	28.5″
T/1R	20.9″	22.7″
T/CR	22.8″	12.4″

Case XXX

Date	11/10/47	6/4/48
T.R.	10	14
W	7	5
Ws		1
D	1	7
Dd		1
Dds	2	
C	1	1
C.FY−		1
CF	2	2
CF+	1	1
FY+	2	1
F+	2	6
F−	2	2
H		2
Hd	2	1
A	2	3
Bt		1
Cl	3	3
Na	3	3
Pr		1
F%	40	57
F+%	50	75
A%	20	21
P		1
T.T.	11′23″	4′44″
T/R	1′8″	20.3″
T/1R	20.8″	7.8″
T/CR	37 ″	7.2″

Case XXXI

Date	11/1/47	5/17/48
T.R.	10	10
W	4	1
D	5	9
Dd	1	
F+	2	5
F−	8	5
H	2	2
A	8	8
F%	100	100
F+%	20	50
A%	80	80
P	1	1
T.T.	12′15″	9′20″
T/R	1′27″	56 ″
T/1R	39.3″	41.4″
T/CR	23.4″	34.2″

No single Rorschach category is meaningful except in relation to the entire psychogram. However, the symbols may be isolated for purposes of description and experimentation.

Because these are the records of children, the majority of whom are

mentally retarded, the patterns used in the study of adult cases may not necessarily apply, so it was decided to consider less complex factors. The factors considered will be discussed in the following pages.

Number of Responses

The total number of responses increased in 15 of the 28 cases on second testing. It is the impression of some clinical psychologists that the responses may have increased anyway because the second presentation was not such a new situation as was the first. An increase in the total number of responses may be interpreted as due to a greater amount of motor energy available and generally a greater response to environment.

W

The meaning of area symbols generally and of the W in particular have been set down by Rorschach and accepted by his followers to indicate a measure of intellectual capacity. In other words the number of W responses implies the ability to combine, abstract and generalize.

The W responses of the group are summarized as follows:

Eight show a greater number and an improvement in quality of the W response.

Seven show a decrease in the number of W responses but an improvement in the quality of the response.

Three show a greater number of responses with percentage of good quality the same on both.

One shows an increase in the number of responses but the quality is poor.

Two have the same number of responses but the quality is better the second time.

One has no change; both are of good quality.

Two show a decrease in the number of "W" responses with the quality fair on both tests.

One has a decrease in the number of "W" responses with the quality poor for both.

Two show a decrease in the number and also in the quality of the "W" response.

One had three "W's" on the first record and none on the second Rorschach.

M and FM

In sixteen cases the M or FM does not appear on either the first or the second Rorschach record. In only six cases is there an increase in the number of either one or the other of these categories. We might say that there is

direction of greater assertion and aggression indicated but this is not shown in a sufficiently large number of cases to make a statement about the entire group.

Color Responses

Piotrowski (17) says "Color responses indicate the intensity, frequency and kind of feelings which pertain to the individual's social relations with others." In relation to the color responses we considered the number of responses to cards 8, 9, and 10, decrease in time for color cards and the change in number and quality of the color responses. These were further broken down into interpretive groups of improvement so the trends could be adequately described.

Greater environmental responsiveness is generally shown by the increase of responses to cards 8, 9, and 10, and a decrease in the average time of the first response to cards involving color. Seventeen cases showed an increase in the responses to the last three cards and nineteen showed a decrease in the average time of the first response to five cards involving color. Eleven subjects showed an increase in the number of color responses which indicates a greater desire for social relations. A trend towards more adaptive affectivity is shown by a change from C to CF or FC, plus a change in accompanying form. Eleven cases gave evidence of these changes on the second Rorschach test. Three subjects who refused color cards the first time the test was taken gave fairly adequate responses on the second attempt with some integrating of form and color.

F+%

Beck (5) states F+ indicates "Clearness of perception, of associational processes, of concentration capacity, and voluntary control of intellectual functioning."

The average F+% on the first test is 61% and that on the second is 66%. Thirteen of the twenty-eight cases were below 60% F+ on the first test and made the following changes on the second Rorschach:

Over 25% gain	1	5% gain to 5% loss	4
16% to 25% gain	3	6% to 15% loss	2
6% to 15% gain	3		

Fifteen of the group had F+% above 60% on the first test and made the following changes on the second test:

Over 25% gain	1	5% gain to 5% loss	7
16% to 25% gain	2	6% to 15% loss	3
6% to 15% gain	1	Over 25% loss	1

Eleven had a change ranging between a gain of 5% to a loss of 5% which would not be significant. Seven of this group had an F+% above 60 on the first test. Eleven showed a gain of more than 6% F+ and seven of these had an F+% below 60 on the first test. Five subjects showed a drop between 6% and 15% F+ on the second test but three of these subjects were above 60% F+ on the first test and remained above it on the second test. One subject had 100% F+ on the first test and dropped 29% giving a 71 F+% which is better than F+% on the first test.

Animal %

One usually expects a fairly high A% in working with individuals of low intelligence since these concepts are fairly obvious and easily discerned. When one gets a low A% therefore the concept is usually poorly conceived and of poor quality. This is what occurred in the first administration. On the second administration, the A% increased and the concepts were of better form; that is, they were more in accord with common responses. Thus in this particular case, the increase in A% is a positive sign in terms of more effective application of limited intelligence and in terms of more conforming thought processes.

Popular Responses

The popular response was used as an index of popular thinking, conventionality and social adaptability. Sixteen of the 28 subjects showed a gain in the number of "P" responses on the Rorschach at the conclusion of the experiment.

PHYSICAL ASPECTS

Heights

The 31 subjects in this study were measured in October before the administration of glutamic acid and again in May after 7 months of glutamic acid. The heights in centimeters for October and May are found in Table 17.

The heights in October just previous to the administration of glutamic acid ranged from 110.0 cms. to 168.1 cms. with an average of 138.00 cms. The standard deviation was 15.64 cms. and the standard error of the mean was 2.86 cms. The heights toward the end of May after 7 months of glutamic acid ranged from 112.2 cms. to 169.1 cms. with an average of 141.00 cms. The standard deviation was 14.90 cms. and the standard error of the mean was 2.72 cms. The difference between the average heights of the experimental group was 3.00 cms. and the standard error of the difference was .257 cms.

The heights of the experimental group were compared with the heights of normals of the same age, as reported in the study by Stuart and Meredith

(20). The heights of this normal group ranged from 115.9 cms. to 162.5 cms. with an average of 140.36 cms. The standard deviation was 14.61 cms. and

TABLE 17

Distribution of Heights in October and May

CASE	HEIGHT IN CENTIMETERS	
	October	May
1	116.3	120.3
2	153.1	154.7
3	156.9	158.4
4	140.0	143.4
5	140.6	145.3
6	135.0	137.2
7	110.9	117.5
8	159.4	159.7
9	115.3	120.6
10	134.1	138.1
11	146.3	149.4
12	110.0	112.2
13	145.0	147.8
14	139.4	143.8
15	167.5	169.4
16	142.3	147.2
17	131.3	135.6
18	147.2	148.1
19	149.4	151.9
20	145.9	147.5
21	133.4	135.9
22	120.6	124.4
23	127.5	130.0
24	120.0	123.4
25	128.8	131.9
26	168.1	169.1
27	143.8	147.5
28	141.2	144.7
29	148.8	149.7
30	112.2	115.3
31	147.8	151.2
M.	138.00	141.00
S.D.	15.64	14.90
$S.D._m$	2.86	2.72
$S.E._{diff.}$	.257	

the standard error of the mean was 2.67 cms. The heights for this same group with a 7 month increment ranged from 119.1 cms. to 162.5 cms. with an average of 143.24 cms. which represents a gain of 2.88 cms. The

standard deviation was 13.65 cms. and the standard error of the mean was 2.49 cms. The difference between the gain of the experimental group and the

TABLE 18

Distribution of Weights in October and May

CASE	WEIGHT IN POUNDS	
	October	May
1	50	53
2	105	107
3	120	120
4	95	98
5	86	99
6	65	73
7	46	49
8	140	140
9	40	45
10	67	73
11	95	104
12	36	40
13	86	109
14	81	90
15	142	144
16	89	94
17	83	84
18	96	104
19	93	105
20	107	108
21	78	79
22	53	58
23	55	61
24	53	48
25	50	50
26	132	134
27	86	100
28	73	77
29	95	99
30	40	45
31	102	110
M.	81.90	87.10
S.D.	28.63	28.98
$S.E._m$	5.23	5.29
$S.E._{diff.}$	1.05	

gain of the norms is .12 cms. So small a difference in heights has no significance. Therefore, the glutamic acid did not effect significant changes in the heights of the 31 subjects in this study.

Weights

The weights of the 31 subjects were recorded in October before administration of glutamic acid and again in May after 7 months treatment with glutamic acid. The distribution of weights is shown in Table 18.

The weights in October ranged from 36 pounds to 140 pounds with a mean of 81.90 pounds and a standard deviation of 28.63 pounds. The standard error of the mean was 5.23 pounds. The weights at the end of the experiment ranged from 40 pounds to 140 pounds with an average of 87.10 pounds and a standard deviation of 28.98 pounds. The standard error of the mean was 5.29 pounds. The difference between the average weights at the beginning and end of the study was 5.20 pounds and the standard error of the difference was 1.05 pounds.

The weights of the experimental group were compared with the weight norms (20) for a comparable age group of normal subjects, as was done for the heights. The weights of the norms ranged from 46.5 pounds to 122.0 pounds with a mean of 77.37 pounds and a standard deviation of 23.76 pounds. The standard error of the mean was 4.34 pounds. The weight norms for the same age group with a 7 month increment ranged from 52.2 pounds to 122.0 pounds with an average of 81.09 pounds. The standard deviation was 22.93 pounds and the standard error of the mean was 4.19 pounds. The difference between the means of the norms is 3.72 pounds and the standard error of the difference was .363.

The difference between the gain for the experimental group (5.20 pounds) and the gain for the norms (3.72 pounds) was 1.48 pounds. To determine whether this was a significant difference the "Test of Significance for a Difference Between Arithmetic Means Derived from Non-Correlated Samples" (16) was used. "T" was found to be 1.33. Peatman (16) states that if the "T" ratio is less than 2.0 the difference is insignificant. From a "T" value of 1.33, therefore, we may conclude that the difference of increase in weight between the experimental group and the norms was insignificant and that glutamic acid did not affect the weights of the subjects in this study.

Chapter V

SUMMARY AND CONCLUSION

This study was undertaken to determine the mental, achievement, personality, and physical changes (height and weight) of 31 retarded girls after at least six months administration of l(+) glutamic acid.

1. The changes in mental age as determined by the Stanford-Binet Intelligence Test before and after glutamic acid were very significant and in most cases the gain in mental age between tests was much greater than the change that occurred in these same subjects in an equal period before glutamic acid.

2. The Arthur Point Scale of Performance was broken down into individual tests and the results analyzed. The gain in performance scores between Knox Cube Form I and Form II and Porteus Maze Form I and Form II was significant while the gain between Seguin Formboard Form I and Form II and Healy Form I and Form II was not significant. Kohs Block of Form I was compared with the Stencil Design of Form II and changes in performance scores were not significant.

3. The mental ages as determined by the Goodenough Drawing of a Man Test before and at the end of the experiment did not show a significant gain.

4. There was a significant gain shown in the grade scores achieved by this group in tests in Reading, Spelling and Arithmetic, and in most cases the gain was greater than that on past achievement tests.

5. On the basis of the weighted scores of the subjects on each of the character groups in the "Graphic Rating Scale for the Study of Character," there was a significant change for the better in the will group, cheerfulness group and sociability group, but not a significant change in the emotionality group.

6. On the Mosaic Test many of the patterns were similar but very often there was a change of location, color, shape, and number of pieces which indicated some change in personality as measured by this test.

7. In general, the second test of the Rorschach Inkblot showed a trend to increased ability to abstract and generalize and an increase in greater control of thought processes. There was evidence of greater social responsiveness and a greater amount of motor energy available in the second tests. There was also a tendency toward emotional adaptability and control.

8. The results of this study indicated that glutamic acid had little effect on the physical growth of these subjects as measured by height and weight.

From the data contained in this study, it may be concluded that glutamic acid had beneficial effects upon mental age, personality and school achievement but did not affect physical growth as measured by height and weight.

APPENDIX

The following formulae were used in computing statistics:

$$M = \frac{\Sigma X}{N}$$

$$\sigma = \sqrt{\frac{\Sigma X^2}{N} - M^2}$$

$$\sigma_m = \frac{\sigma}{\sqrt{N - 1}}$$

$$r = \frac{\frac{\Sigma XY}{N} - M_x M_y}{\sigma_x \sigma_y}$$

$$\sigma_{diff.} = \sqrt{\sigma^2_{m_x} + \sigma^2_{m_y} + 2r_{xy}\sigma_{m_x}\sigma_{m_y}}$$

$$t = \frac{Diff.}{\sigma_{diff.}}$$

Correlation of Test and Retest Scores in this study are as follows:

Stanford-Binet Intelligence	.98	Will Group	.95
Knox Cube	.72	Cheerfulness Group	.93
Seguin Formboard	.86	Sociability Group	.96
Porteus Maze	.85	Emotionality Group	.95
Goodenough Draw-A-Man	.86	Heights	.997
Reading	.96	Weights	.98
Arithmetic	.93	Height (Normal Group)	.996
Spelling	.90	Weights (Normal Group)	.997

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