

VITAMIN A ADMINISTRATION AND DARK ADAPTION
OF SECOND AND THIRD GRADE CHILDREN

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VITAMIN A ADMINISTRATION AND DARK ADAPTION
OF SECOND AND THIRD GRADE CHILDREN

THESIS

Presented to the Graduate Council of the North
Texas State Teachers College in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

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Denton, Texas

August, 1940

TABLE OF CONTENTS

	Page
LIST OF TABLES.	iv
LIST OF ILLUSTRATIONS	vi
Chapter	
I. Introduction.	1
II. Procedure	5
III. Discussion.	8
IV. Summary	30
APPENDIX.	32
BIBLIOGRAPHY.	45

LIST OF TABLES

Table	Page
1. Comparison of Rohrer's "Critical" Readings of Twelve Children with Those of the Present Study.....	10
2. Average Weekly Gain in "Critical" Dial Readings of One Hundred Eighty Subjects After Vitamin A Administration.....	11
3. The Average Weekly Gain in "Critical" Dial Readings of Two Hundred Twenty-Three Children with Average Reading Expressed in Per Cent Below Normal and the Weekly Per Cent Improvement in Approaching Normal During Vitamin A Therapy.....	17
4. The Range and the Average Weekly Gain in Recovery Dial Reading of One Hundred Eighty Subjects After Vitamin A Administration.....	18
5. The Range and the Average Weekly Percentage Gain in Two Hundred Twenty-Three Recovery Dial Readings.....	20
6. Weekly Percentage Increase Based on Original Per Cent Below Norm in "Critical" Dial Reading of Twenty-Nine Boys and Twenty-Three Girls.....	21
7. A Comparison of the Weekly Percentage Gain in Dark Adaptations of Seven and Eight Year Old Boys and Girls.....	23
8. The Average "Critical" Readings and Number of Weeks Required to Bring the Children of Three Elementary Schools Up to Jeans' Norm.....	24
9. A Comparison of the Curves Obtained When Vitamin A is Administered to Texas Elementary School Children with That Obtained by Jeans.....	28

LIST OF TABLES--Continued

Table	Page
10. Follow-Up Biophotometric Readings of Demonstration School Children During Administration of Haliver Oil.....	33
11. Follow-Up Biophotometric Readings of Some Houston School Children During Administration of Haliver Oil.....	37
12. Follow-Up Biophotometric Readings of Robert E. Lee School Children During Administration of Haliver Oil.....	42

LIST OF ILLUSTRATIONS

Figure	Page
1. Characteristic Dark Adaption Curves of a Child Receiving Vitamin A Over a Three Weeks' Period.	13
2. Characteristic Dark Adaption Curves of a Child Receiving Vitamin A Over a Four Weeks' Period.	14
3. Characteristic Dark Adaption Curves of a Child Receiving Vitamin A Over a Five Weeks' Period.	15
4. Dark Adaption Curves of a Child Receiving Vitamin A Over a Six Weeks' Period	16

CHAPTER I

INTRODUCTION

Evidence points to the fact that impaired dark adaption is one of the early symptoms of vitamin A deficiency.

Jeans¹ and his colleagues in studies of dark adaption of children, first used the Birch-Hirschfeld photometer and later the improved photometer known as the biophotometer. The report of a study using this instrument was published by Jeans², 1933. Twenty-five per cent of the rural children, and fifty-three per cent of the city children reported in this study, showed poor dark adaption. In a later study when 5,000 to 6,000 international units of vitamin A, or the equivalent amount of carotene, was administered daily to children having poor dark adaption, Jeans³, 1934, found that seventy-five to seventy-eight sub-normal subjects regained normal adaption.

Of the one hundred sixty-three subjects tested by Snelling⁴, 1936, approximately twenty per cent gave poor

¹P. C. Jeans, "Vitamin Deficiency in Childhood", Minnesota Medicine, XVI (1933), 688.

²Ibid.

³P. C. Jeans and Zelma Zentmire, "Prevalence of Vitamin A Deficiency Among Children in Iowa", American Journal of Diseases of Children, XLVIII (1934), 922.

⁴C. E. Snelling, "Vitamin A Deficiency in Children", American Journal of Diseases of Children, LI (1936), 494.

dark adaption responses. Twenty-three of the subjects with poor dark adaption were given cod liver oil. Eighteen of the twenty-three gave normal readings after a period of supplementary feeding ranging from two to six weeks. These findings confirm those of Jeans⁵. However, Snelling⁶, 1936, in a second study, administered 13,000 units of vitamin A daily to sixty-four subjects for three weeks prior to testing. The therapy was then continued for another three weeks and the subjects were again tested. The results were variable showing no evidence of improvement in dark adaption upon the administration of vitamin A.

In a survey of two hundred elementary school children in east London and Cambridge, Maitra and Harris⁷, 1937, found twenty-two to thirty-six per cent sub-normal in dark adaption. Forty of these children were re-examined and given a vitamin A supplement of Halibut liver oil. After receiving the therapy for four weeks, seventy-five per cent became normal and twenty-two per cent showed marked improvement. Twenty children serving as controls received no vitamin A supplement. At the end of the experiment, ninety per cent of the control group remained unchanged as to dark adaption classification.

⁵P. C. Jeans and Zelma Zentmire, "Prevalence of Vitamin A Deficiency Among Iowa Children", American Journal of Diseases of Children, XLVIII (1934), 923.

⁶C. E. Snelling, "The Biophotometer (Prober-Paybor) in Testing Vitamin A Deficiency", Journal of Pediatrics, IX (1936), 655.

⁷N. K. Maitra and Leslie J. Harris, "Vitamin A Deficiency Among School Children", Lancet, II (1937), 1009-1014.

In a study carried out in conjunction with the United States Public Health Service, Palmer⁸, 1938, divided equally and at random one hundred six children. One-half of the group serving as controls received .05 units vitamin A daily, and the other half received a daily supplement of 18,000 units vitamin A in the form of Halibut liver oil capsules. Results showed no consistent improvement for either group. However, in an earlier study, Palmer and Blumberg⁹, 1937, report that the two hundred forty-seven children used in that study showed definite improvement in dark adaption when repeated tests were made even though no vitamin A supplement was administered. Since these children improved without vitamin A therapy, decreasing the fifty-six per cent in the sub-normal group to seventeen per cent, similar improvement was to have been expected in both the treated and untreated groups of the 1937 study. However, this is not the case, since the authors state that no consistent improvement was shown by either group. Yet the gain in dark adaption of the earlier study was attributed to a "learning factor". Why was the "learning factor" not evident in the 1938 study?

⁸C. E. Palmer, "The Dark Adaptation Test for Vitamin A Deficiency", American Journal of Public Health, XXVIII (1938), 309.

⁹C. E. Palmer and Harold Blumberg, "Use of Dark Adaptation Technique in the Measurement of Vitamin A Deficiency in Children", Public Health Reports, LII (1937), 1403.

Since there is obviously a divergence of opinion concerning the reliability of dark adaption tests, this study, part of a long-time co-operative study of the Education and Home Economics Departments of the North Texas State Teachers College, was formulated for the following purposes: (1) To determine if a learning factor is involved when repeated tests are made with a dark adaption instrument, (2) To determine if the dark adaption of a group of second and third grade children showing poor dark adaption can be improved by the daily administration of Haliver oil capsules, (3) To obtain a dark adaption curve for two hundred twenty-three grade children of Denton, Texas.

CHAPTER II

PROCEDURE

A description of the biophotometer and other dark adaptation instruments is given by Rohrer¹ in the study, "Dark Adaptation of Second and Third Grade Children". The biophotometric tests for the present study were made in a dark room with the Prober-Faytor² instrument. The long testing method as described by Jeans³, 1937, was used. All subjects who usually wore glasses wore them while being tested.

In order to develop skill in operating the instrument, preliminary tests were made on thirty-five college students and twelve second and third grade children.

Rohrer⁴ designates eighty of the children tested as falling in Jeans⁵ clinical or sub-clinical groupings.

¹ Lois Rohrer, "Dark Adaptation of Second and Third Grade Children" (Unpublished Thesis for Master's Degree, Dept. of Home Economics, North Texas State Teachers College, 1940).

² Prober-Faytor Biophotometer, Cincinnati, Ohio, Purchased Nov., 1939.

³ P. C. Jeans, Evelyn Blanchard and Zelma Zentnaire, "Dark Adaptation and Vitamin A: A New Photometric Technique", Journal of American Medical Association, CVIII (1937), 451-458.

⁴ Rohrer, "Dark Adaptation of Second and Third Grade Children", Unpublished Thesis for Master's Degree, June, 1940.

⁵ Jeans, Blanchard and Zentnaire, "Dark Adaptation of Vitamin A: A New Photometric Technique", Journal of American Medical Association, CVIII (1937), 451-458.

Evidently these children are either not receiving enough vitamin A or are not assimilating enough to meet their optimum requirement.

To determine whether or not the condition of these children could be improved, permission to feed vitamin A supplement was obtained from fifty-two parents. Through the co-operation of the school officials, twenty-nine boys and twenty-three girls, ranging in age from seven to ten years, received one plain Parke-Davis Haliver Oil Capsule daily. Each capsule contained not less than ten thousand U. S. P. vitamin A and one hundred forty-five U. S. P. vitamin D. The classroom teacher gave each child his capsule every school day at the same hour in the morning. Two capsules were sent home on Friday for the child to take Saturday and Sunday. If upon questioning it was found that the capsules were not taken over the week-end, the child was given two capsules on Monday and Tuesday so that he had eight between each testing. Following the daily administration of the Haliver Oil Capsule, biophotometric readings were made at weekly intervals on the same day of the week, at the same hour of the day. In order to adhere to this routine, several children (varying from three to nine in number) were brought in a group from the outlying school systems to the testing laboratory. To facilitate time and yet avoid any inconsistencies in method, the following plan was used:

When child A had finished nine minutes of the foreperiod, another child, B, was given his initial reading and was started on his foreperiod in the dark. By this time, A was ready for the last reading in the foreperiod, followed by the exposure to the bright light. After this three minutes' exposure to the bright light, it was time for B's second fore-period reading. Thus, by dovetailing the two, considerable time could be saved. This economy of time is valuable when large numbers are being tested periodically. Several times, however, unavoidable circumstances prevented testing on the designated day. In this event, the vitamin A administration was continued and the test made at the proper time the following week. Feeding was continued until the subject fell within Jeans⁶ norm for a person with optimum vitamin A stores. Consequently, the dark adaption of each child was studied over a period of time.

⁶Ibid.

CHAPTER III

DISCUSSION

The fifty-two children from the three different schools (Rohrer's study) were studied during vitamin A administration, March the third to May the twenty-ninth, and are discussed as one group unless otherwise indicated.

The criticism that there is a learning factor involved in using the biophotometer as a measurement of dark adaption has been advanced by some investigators. Palmer and Blumberg¹, 1937, attributed their significant individual variations to a learning factor. They based their findings on a biophotometric study of five hundred eighty-five elementary school children who were given repeated tests, and the authors report improvement in the apparent dark adaption as the subjects became familiar with the test. Supplementary Halibut Liver Oil Capsules, eighteen thousand U. S. P., were administered to twenty-five of the "borderline" children for six to eight weeks. Sixteen of the twenty-five children did not show normal adaption at the end of that time. If the first group improved, due to a learning factor, so that they reached

¹C. E. Palmer and Harold Blumberg, "Use of Dark Adaption Technique (Biophotometer) in the Measurement of Vitamin A Deficiency in Children", Public Health Reports, LII (1937), 1403.

normal, why did the second group not improve due to this same cause? Baum and McCord², 1940, also report that of nineteen subjects used, several showed improvement on repeated tests without the administration of vitamin A. No correlation was found between biophotometeric readings and the vitamin A content of the blood.

In order to determine if familiarity with the test affects results, the following checks are used in this study: the usual procedure is followed except that the electrical switch is not turned on. Under these conditions it is impossible to see any of the dots on the quincux. Without exception, the children complain that they see no dots because it is too dark; but when the electrical switch is turned on by the examiner, the subjects promptly tell how many dots appear. To prevent the children from associating the clicking sound made by turning on the electrical switch with the appearance of the dots, some counteracting noise is made by the examiner. On other occasions, when taking the second reading of the foreperiod, the illumination indicator is rapidly turned until it reaches ninety on the dial. According to the children's previous test reading, it is impossible for them to see all the dots on the quincux at this point. The suggestion is then made to the children that they are seeing five dots now, but all subjects answer that they do not see five.

²G. S. Baum and Augusta B. McCord, "The Relationship Between Biophotometeric Tests and Vitamin A in the Blood of Children", Journal of Pediatrics, XVI (1940) 409.

Another check is shown in Table 1. The children from school D reported by Rohrer³ are retested. There is not enough variation in the readings to be considered significant, although as much as three weeks elapsed between tests.

TABLE 1

COMPARISON OF ROHRER'S "CRITICAL" READINGS OF TWELVE CHILDREN WITH THOSE OF THE PRESENT STUDY

Case Number	Critical	Dial	Reading
	Rohrer's		Present Study
1	10		4
2	11		4
3	12		11
4	17		4
5	5		5
6	21		4
7	15		14
8	17		5
9	14		13
10	7		4
11	11		9
12	4		0

If there is a difference in the two tests, the second shows poorer dark adaption than the first. On the basis of these findings, the data used in this study cannot be attributed to a learning factor.

³ Lois Rohrer, "Dark Adaptation of Second and Third Grade Children" (Unpublished Thesis for Master's Degree, Dept. of Home Economics, North Texas State Teachers College, 1940).

Bochner and Williams⁴, 1958, and Jeans⁵, 1957, report that the initial reading of the Recovery Period, immediately after exposure to the bright light, and the last reading of this period are thought to be the most significant ones. The first reading after exposure to the bright light is known as the "critical" one, and it is the "critical" reading that will be referred to most frequently in this study.

Table 2 shows that following the administration of vitamin A there is a weekly increase in the dark adaptation ability as shown by the increase in the numerical values of the "critical" readings.

TABLE 2

AVERAGE WEEKLY GAIN IN "CRITICAL" DIAL READING OF
180 SUBJECTS AFTER VITAMIN A ADMINISTRATION

Critical Reading				
Weeks	No. Subjects	Sum of reading	Average Increase	Range
1st	40	314	6.54	0 - 12
2nd	33	147	4.09	1 - 10
3rd	30	259	5.14	2 - 18
4th	30	174	4.08	2 - 13
5th	8	34	4.25	2 - 8

⁴L. E. Bochner and D. R. Williams, "A Study of the Biophotometer as a Means of Measuring Vitamin A Status of Human Adults", The Journal of Nutrition, XVI (1958), 347.

⁵P. C. Jeans, "Dark Adaptation of Vitamin A: A New Photometric Technique", Journal American Medical Association, CCXXXI (1957), 451-452.

At the end of the first week of supplementary vitamin A feeding, the average increase in dark adaption per person is 6.54 with a range of 0 - 18. However, at the end of two weeks of vitamin A therapy, the average increase is 4.06 (range 1 - 10), showing that the rate of improvement is not quite so rapid as it was after one week. At the end of the third week an average increase of 5.14 (range 2 - 13) is shown. This gain is greater than that obtained after two weeks of vitamin A therapy but less than that obtained after the first week. However, there is little difference in the amount gained at the end of the fourth and fifth weeks, 4.05 and 4.25 respectively.

It is evident that while the gain in dark adaption per week during vitamin A administration is not identical, the average range is such that the differences are less than the variations found in individual weeks. For instance, the average range, 6.54 to 4.06, is negligible when one considers that the range in the first week is 0 - 18. We might conclude, on the basis of the dial readings, that the weekly gain during the time the subjects are receiving the Haliver Oil Capsules is similar.

According to the graphing of typical cases (Figures 1, 2, 3 and 4) the distance between the first two readings is greatest, suggesting greater dark adaption during the first week of vitamin A therapy. Consequently, these data are evaluated according to the weekly percentage gain in

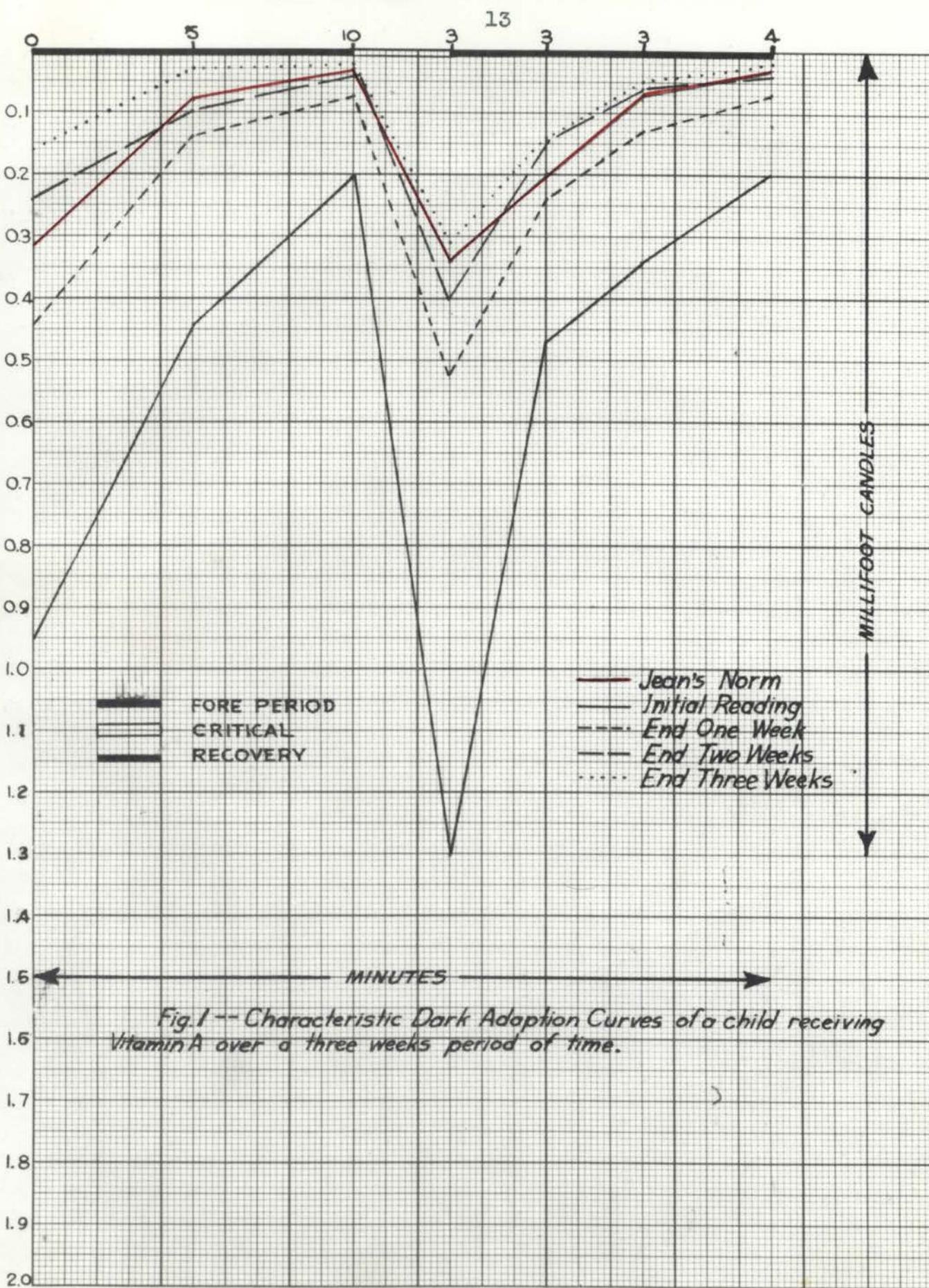


Fig. 1 -- Characteristic Dark Adaptation Curves of a child receiving Vitamin A over a three weeks period of time.

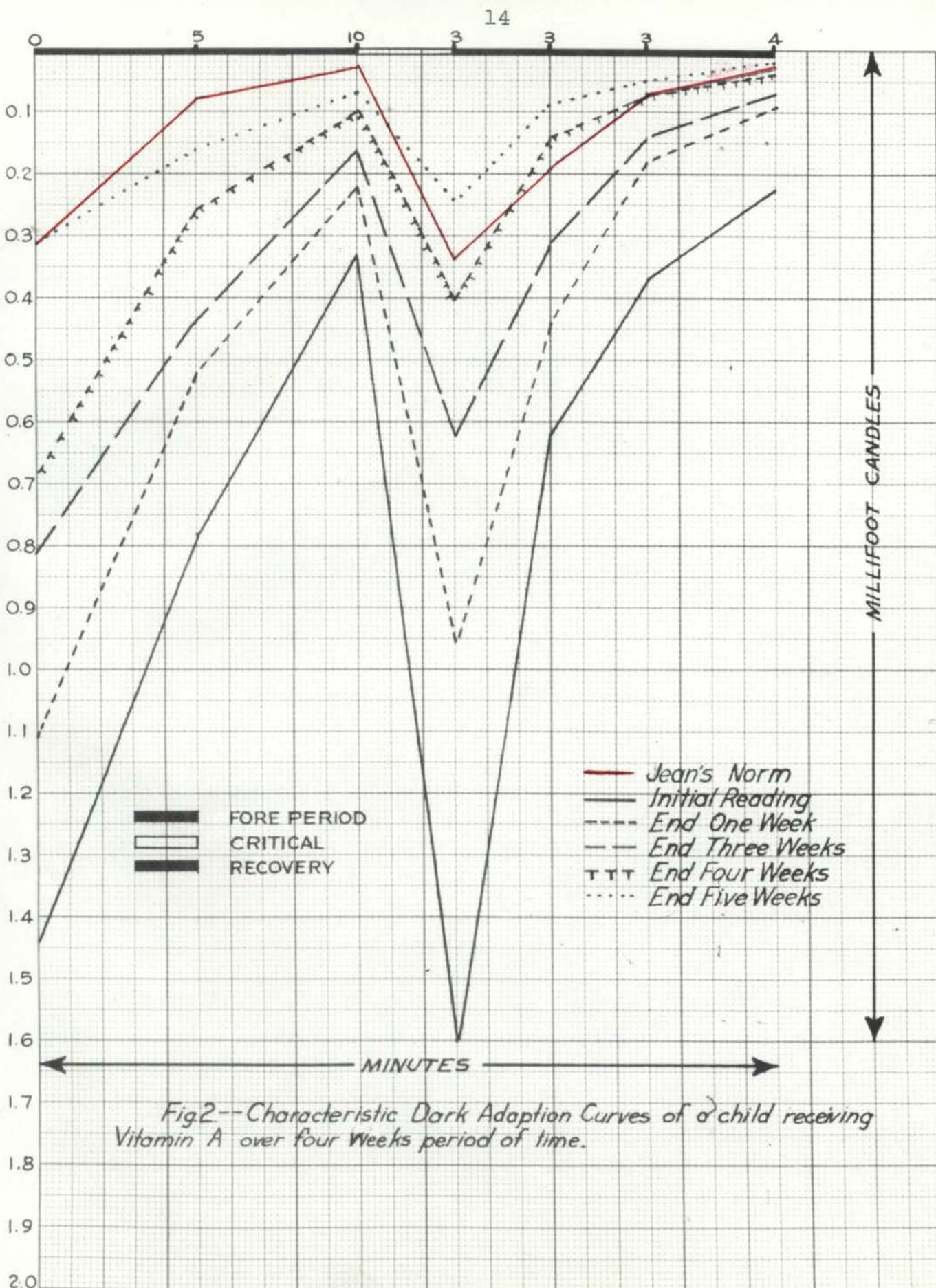
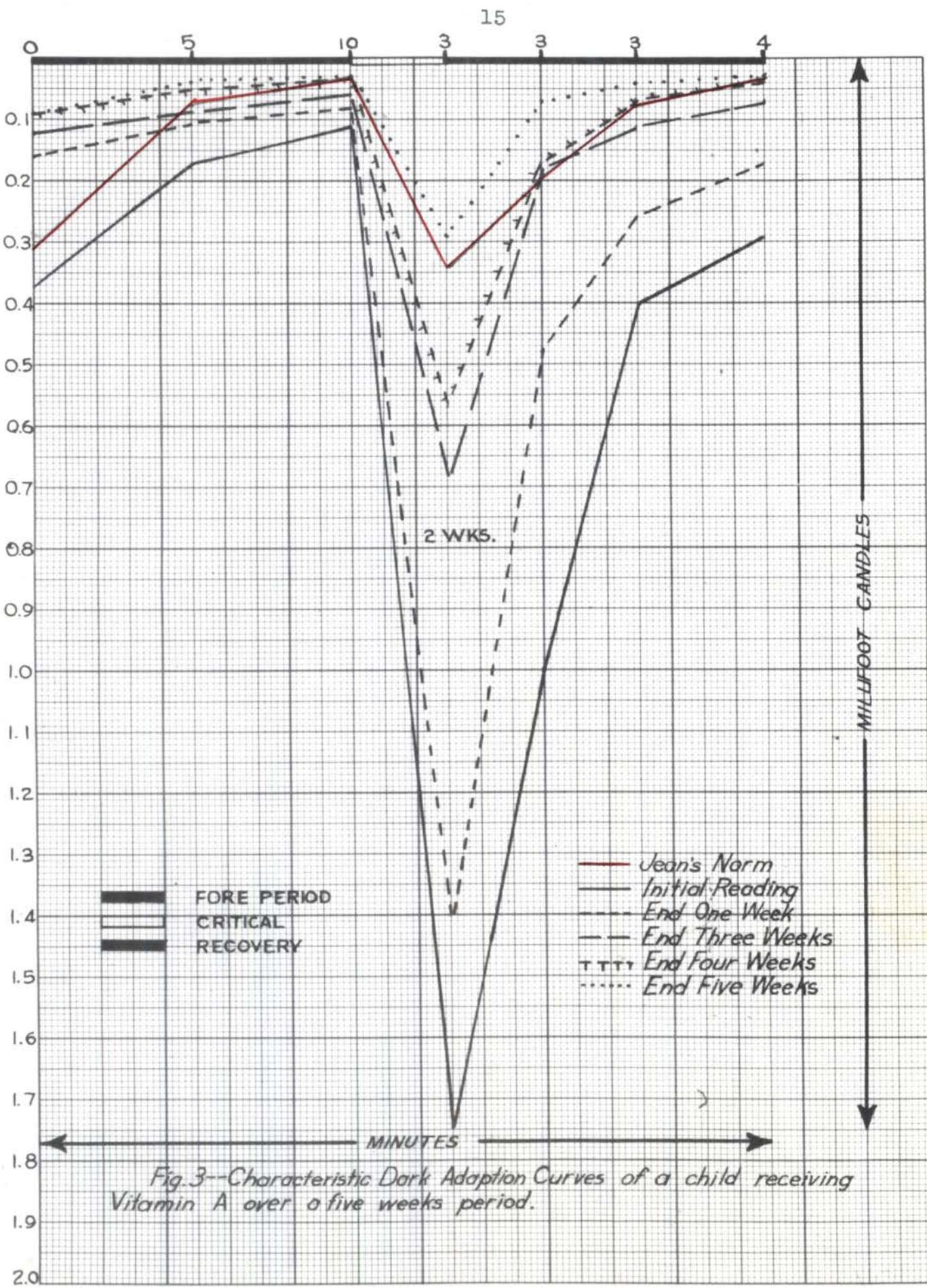


Fig 2--Characteristic Dark Adaptation Curves of a child receiving Vitamin A over four Weeks period of time.



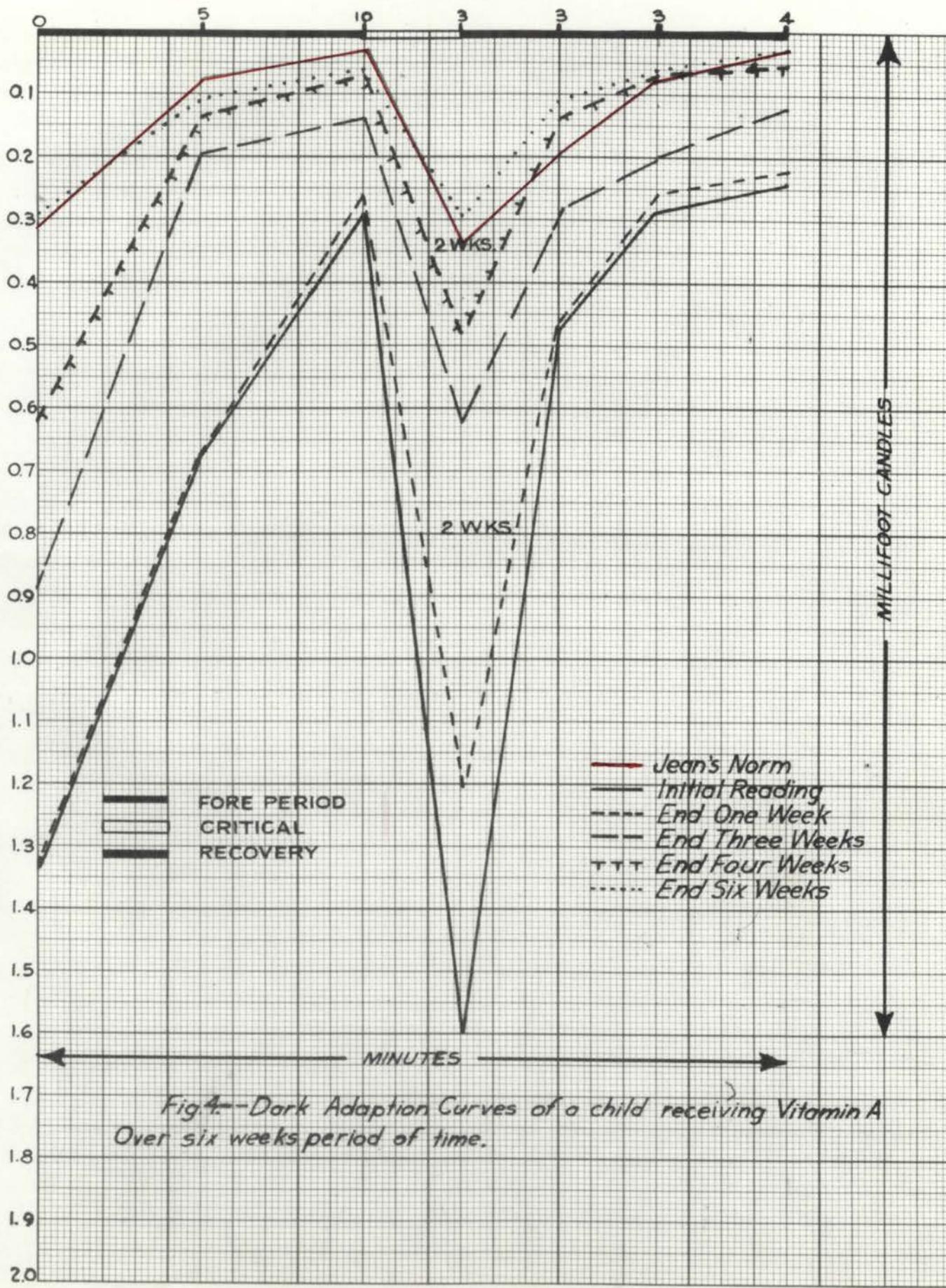


Table 3. It will be noted from this table that the greatest gain, thirty per cent, in dark adaption occurs after the child has received the Maliver Oil the first week.

TABLE 3

THE AVERAGE WEEKLY GAIN IN "CRITICAL" DIAL READINGS OF
225 CHILDREN WITH AVERAGE READINGS EXPRESSED IN PER
CENT BELOW NORMAL AND THE WEEKLY PER CENT
IMPROVEMENT IN APPROACHING NORMAL DUR-
ING VITAMIN A THERAPY

Weeks	No. Subj.	"Critical"			
		Sum of Readings	Av. Readings	Av. Reading Expressed in Per Cent Below Norm of 22	Weekly Per Cent of Improvement
Initial	52	301	5.73	74	
1st	48	599	12.40	44	30
2nd	36	596	15.50	30	14
3rd	60	1015	20.30	8	22
4th	37	851	23.00	0.4*	8.4

*Above normal.

The percentage increase for the following weeks is fourteen, twenty-two, twelve, and eight and four-tenths respectively. The percentage gain at the end of four weeks does not represent all children because some did not have weekly tests (procedure), nor does it include the seven who were carried over a period of five weeks and the one who was carried over six weeks. Therefore, when the percentage gain is calculated, the greatest increase in dark adaption occurs following the first week of vitamin A therapy. This fact coincides with the evidence shown in the graphs mentioned above.

Since some investigators, Boohar and Williams⁶, 1937, and Jeans⁷, 1937, consider the last reading of the Recovery Period to be significant also, the findings for this period are given in Tables 4 and 5.

TABLE 4

THE RANGE AND AVERAGE WEEKLY GAIN IN RECOVERY
DIAL READING OF 180 SUBJECTS AFTER
VITAMIN A ADMINISTRATION

Weeks	No. Subj.	Recovery		
		Sum of Readings	Average Weekly Gain	Range
1st	48	426	8.80	0 - 23
2nd	56	273	7.50	1 - 20
3rd	50	367	7.30	0 - 23
4th	38	279	6.00	0 - 19
5th	8	41	5.12	0 - 12

It is evident from Table 4 that following vitamin A therapy there is a weekly increase in dark adaption ability at the end of the Recovery Period. At the end of the first week of vitamin A administration, the average increase in dark adaption per person is 8.8 (range 0 - 23). After the subject receives Haliver Oil Capsules for two weeks, the average increase is 7.5 with a range of 1 - 20. As is the case in the critical period, when the calculation is based

⁶Boohar and Williams, "A Study of the Biophotometer as a Means of Measuring Vitamin A Status of Human Adults", The Journal of Nutrition, XVI (1937), 347.

⁷Jeans, "Dark Adaptation of Vitamin A: A New Photometric Technique", Journal of American Medical Association, CVIII (1937), 451-458.

on the numerical values, the rate of improvement is more rapid after the first week of feeding than after two weeks. At the end of the third week, an average increase of 7.5 (range 0 - 23) is shown. This gain is slightly less than that of the previous week, but the difference is so small it cannot be considered significant. The amount gained at the end of the fourth and fifth weeks is 6.0 (range 0 - 10) and 5.12 (range 0 - 12) respectively. It seems, then, that the greatest increase in dark adaption occurs after the first week of vitamin A therapy, with a steady decrease in the amount gained from week to week. The fluctuations in gain that occur in the critical readings (Table 2) do not seem to occur at the end of the ten minute Recovery Period.

However, when the weekly percentage gain is calculated, Table 5, a smaller weekly increase is shown than occurs in the dark adaption of the "critical" readings, Table 2. For instance, the average gain for subjects receiving vitamin A therapy at the end of the first week is fifteen per cent (range 0 - 23), and at the end of the second week the gain is fourteen per cent (range 1 - 20) as compared with twenty-eight per cent (range 0 - 18) and eighteen per cent (range 2 - 13) respectively for the "critical" period. The following weeks show a gain of eleven, eight and eight-tenths per cent (ranges 0 - 23, 0 - 10, and 0 - 12) as compared with sixteen, twelve, and one per cent (ranges 2 - 13, 2 - 13, and 2 - 3) respectively for the "critical" period.

TABLE 5

THE RANGE AND AVERAGE WEEKLY PERCENTAGE GAIN
IN 225 RECOVERY DIAL READINGS

Weeks	No. Subj.	Recovery				
		Sum of Read- ings	Average Read- ings	Per Cent Below Norm	Per Cent Gain	Range
Initial	52	1323	25.44	49.0		14 - 50
1st	48	1590	33.12	34.0	15.0	19 - 50
2nd	36	1439	39.97	20.0	14.0	25 - 52
3rd	50	2275	45.50	9.0	11.0	38 - 57
4th	38	1884	49.57	0.0	8.2	34 - 57
5th	8	400	50.00	0.0	0.8	44 - 54

Consequently, when it is considered that the range is wider in the Recovery Period and the percentage gain smaller, the "critical" period seems to be the more significant. Although the dark adaption at the end of the Recovery Period may be used in evaluating the effects of vitamin A therapy in mass studies, it seems that it is not as indicative of results in a study for research purposes as the reading of the "critical" period.

It is suggested by Matria and Harris⁸, 1937, Booher and Williams⁹, 1938, and Hecht and Mandelbaum¹⁰, 1939, that

⁸M. K. Matria and Leslie J. Harris, "Vitamin A Deficiency Among School Children", Lancet, II (October, 1937), 1014.

⁹Booher and Williams, "A Study of the Biophotometer as a Means of Measuring Vitamin A Status of Human Adults", The Journal of Nutrition, XVI (1938), 353.

¹⁰Selig Hecht and Joseph Mandelbaum, "The Relation Between Vitamin A and Dark Adaptation", Journal of American Medical Association, CXII (1939), 1910-1916.

there is a difference in the rate of speed at which various ages reach the norm of an individual with optimum vitamin A stores. There may also be a variation in dark adaption of the sexes. There are twenty-nine boys and twenty-three girls used in this study. Of the fifty-two used, forty-five are either seven or eight years old. Table 6 gives a comparison of the weekly dark adaption of seven and eight year old boys and girls.

TABLE 6

WEEKLY PERCENTAGE INCREASE BASED ON ORIGINAL PER CENT
BELOW NORM IN "CRITICAL" DIAL READING OF
29 BOYS AND 23 Girls

Wks.	"Critical" Reading							
	Boys				Girls			
	No. Cases	Sum of Read-ing	Per cent below Norm	Wkly. Per cent Gain	No. Cases	Sum of Read-ing	Per cent below Norm	Wkly. Per cent Gain
Init.	29	165	75.0		23	127.00	76.0	
1st	27	354	41.0	34.0	21	245.00	50.0	26.0
2nd	20	362	23.0	18.0	16	344.00	34.0	16.0
3rd	28	577	10.0	13.0	22	438.00	13.0	21.0
4th	20	463	0.4*	10.4	18	411.00	0.8	12.8
5th	4	89	0.3*	0.1	4	0.96	0.4*	0.8
6th	1	24	0.4*	0.1				

*Above norm.

It is evident that at the end of the first week the "Critical" readings show that the boys gained thirty-four per cent while the girls gained only twenty-six per cent.

After two weeks of Haliver oil administration, the boys gained eighteen per cent with the girls gaining sixteen per cent. It is apparent that the boys gained more at the end of the first and second weeks than did the girls. For the three successive weeks, the girls gained twenty-one, thirteen, ten and one-tenth per cent, showing the most rapid gain for the girls for the latter weeks. Hence, when only percentage gain for the sexes is considered, it seems that there is little evidence supporting the suggestions that there is a variation in the rate of speed at which the sexes respond to vitamin A therapy.

The entire group of fifty-two is considered on the basis of age in Table 7. Of the nine seven year old boys, forty-four per cent reached Jeans'¹¹ norm in three weeks and forty-four per cent in four weeks, while eleven per cent came up in five weeks. Of the fourteen eight year old boys, twenty-eight per cent came up in three weeks, sixty-four per cent in four weeks, and eight per cent in six weeks. There are eleven girls in both the seven and eight year age groups, and the two groups came up at exactly the same rate of speed. In both groups, eighteen per cent came up in three weeks, sixty-four per cent in four weeks, and eighteen per cent came up in

¹¹Jean, "Dark Adaptation of Vitamin A: A New Photometric Technique", Journal of American Medical Association, CVIII (1937), 451-458.

five weeks. The study includes four nine year old boys and one nine year old girl; all came up in four weeks. There are two ten year old boys; one came up to normal in three weeks, and one in four weeks. It is apparent that the majority of the subjects reached Jeans¹² norm in three weeks; therefore, three weeks is the mode for this group of children.

TABLE 7

A COMPARISON OF THE WEEKLY PERCENTAGE GAIN IN DARK ADAPTION OF 7 AND 8 YEAR OLD BOYS AND GIRLS*

Weeks	7 Year Olds				8 Year Olds			
	Boys		Girls		Boys		Girls	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
3	4	44	2	18	4	28	2	18
4	4	44	7	64	9	64	7	64
5	1	11	2	18			2	18
6					1	8		

*Four nine year old boys came up in four weeks. One nine year old girl came up in four weeks. Two ten year old boys came up in three weeks and four weeks respectively.

This study includes children from three schools, D, R, and S. The sixteen children from school D received vitamin A therapy from March the third to April the seventeenth. As shown in Table 8, the average "critical" reading for this group when the study begins is 8.12 (range 0 - 14). This is

¹²Ibid.

the highest initial reading for the three schools. It takes this group an average of 3.95 (range 3 - 6) weeks to reach Jeang's 13 norm. From school R there are also sixteen children receiving Haliver oil capsules from March the twelfth to April the thirtieth; this is approximately the same length of time as that for school D.

TABLE 8

THE AVERAGE INITIAL "CRITICAL" READINGS AND
NUMBER OF WEEKS REQUIRED TO BRING THE
CHILDREN OF THREE ELEMENTARY
SCHOOLS UP TO JEANG'S¹³

	School D	School R	School S
Time of Experiment	3/4 to 5/17	3/12 to 4/30	4/30 to 5/29
Number of Children	16	16	20
Composite Weeks	65	63	77
Av. No. of Weeks	3.30	3.95	3.85
Range of Weeks	3 - 6	3 - 6	3 - 6
Av. "Critical" Reading	8.12	4.81	4.90

The first "critical" reading for school R's group is only 4.81 (range 0 - 14), which is lower than school D. However, school R reached the norm in the same average time, 3.95 weeks, as did school D. School S includes twenty children who are tested over the period extending from April the thirtieth to May the twenty-ninth. The average initial "critical" reading for this group is 4.9 (range 0 - 10), and it took an average of 3.85 weeks (range 3 - 6 weeks) for them to reach the norm. Although it took approximately the same

number of weeks for each school to come up to the norm for a person with optimum vitamin A stores, it is evident that school R gained a greater amount in the same period of time than did school D. Although school S was a little lower in the initial reading, it also took a little longer to reach the norm than did school R, but not as long as for school D. This suggestion of seasonal variation may be due to the fact that the children tested in April and May were getting more fresh vegetables and also dairy products from cows that had access to green food than those children who are tested in March. In this section, peas, greens, garden lettuce, and onions are obtainable in early April. The average low income of the families of the children tested would account for the failure of the children to receive out-of-season vegetables, which are usually expensive, from the market.

Zayaz¹⁴ and co-workers, in a study of four hundred twenty-eight children, classified in five groups according to socio-economic status, also found a tendency toward a lower average biophotometric rating for children in the lower income groupings.

According to studies made by Jeghers¹⁵, 1937, and Schuck

¹⁴Stella Louise Zayaz, Pauline Beery Mack, Phyllis Kent Sprague, and Arthur W. Bauman, "Nutritional Status of School Children in a Small Industrial City", Child Development, II (1940).

¹⁵Harold Jeghers, "The Degree and Prevalence of Vitamin A Deficiency in Adults", Journal of American Medical Association, CIX (1937), 758-761.

and Miller¹⁶, 1938, the subjects seem to improve in dark adaption when vitamin A therapy is administered much more rapidly than the mode of three weeks for this group. During the twenty-eight day feeding period of the present study, these children received 280,000 U. S. P. of vitamin A (4 wks. \times 7 days in wk., \times 10,000 U. S. P. per day) before they give a test similar to that of a person with dark normal adaption. In other studies the subjects received 20,000 vitamin A U. S. P. daily. On this basis, it would supposedly take only two weeks for those receiving 20,000, and nine days for those receiving 30,000. Probably, the comparatively small amounts of vitamin A given daily account for the rather long period it takes the subjects to give normal adaption. Since all children improve in this period on this small dosage of vitamin A, the low initial readings are probably due to a lack of vitamin A in the diet rather than to an inability to absorb it if it is available. Therefore, the implications here are that through a little thought and planning in the selection and serving of foods, the children in this group could attain and maintain normal dark adaption by obtaining vitamin A in foods rather than by supplementary vitamin A therapy.

Since no studies of this kind have been done in this locality, Jeans'¹⁷ curve is used for comparing the dark

¹⁶Cecelia Schuck and Wilma O. Miller, "Dark Adaptation of the Eye and Vitamin A Storage in Young Adults", Archives of Internal Medicine, LXI (1938), 975.

¹⁷Jeans, "Dark Adaptation of Vitamin A: A New Photometric Technique", Journal of American Medical Association, CVIII (1937), 451-458.

adaption ability of this group. When vitamin A administration continues until all children attain the curve for a normal person, as prescribed by Jeans¹⁸, the average curve, Table 9, for the group is obtained.

When all children are included, the first two readings in the foreperiod are greater than the same two readings in Jeans' curve. The present study shows average dial readings of thirty-two and forty for the first and second readings respectively, while Jeans' readings are twenty-three and thirty. However, at the end of the ten minute foreperiod, the dial reading of forty-six for the present study is a little lower than the study referred to above, which is forty-eight. Twenty-two is the dial reading for the "critical" period in Jeans' curve; the average for the present study is 23.81. All three readings in the Recovery Period are higher than those of the reference study, being 36.5, 44.51, and 51.6 for the present study, as compared with twenty-eight, forty, and fifty in the former reference study.

When the average readings for the boys are calculated separately, these readings are higher in every instance than those of Jeans¹⁹, except for the "critical" period. For example, the initial average reading for the entire group is 32.32, while the same average reading for the boys alone is thirty-four. The two other readings in the foreperiod vary little when calculated for the entire group and for the boys

¹⁸Ibid.

¹⁹Ibid.

TABLE 9

A COMPARISON OF THE CURVES OBTAINED WHEN VITAMIN A IS ADMINISTERED TO TEEN SCHOOL CHILDREN WITH THOSE OBTAINED BY CERTAIN STUDIES REFERRED TO IN THIS PAPER

DAILY DOSE: 100,000 IU. DURATION OF TEST: 10 MIN.

Studies	No. of Cases	Initial	5 min.	10 min.	"Critical"	5 min.	3 min.	10 min.
Present	29 boys 25 girls 54	54.00 50.00 52.52 25.00	41.20 29.50 40.50 40.00	46.30 45.00 46.30 48.00	25.70 25.90 25.84 22.00	37.00 35.60 36.50 38.00	44.80 44.10 44.92 40.00	52.00 51.10 51.67 50.00
Total								
Jean's*								

*P. C. Jean's, "Dairy Adaptation of Vitamin A: A New Photometric Technique," *Journal of American Medical Association*, CVIII (1937), 451-459.

rather than for the entire group. The girls are considered separately, and it is found that they have higher dial readings in every period than those Jeans²⁰ gives. However, the girls are slightly lower than the boys in every reading except the "critical", which is 23.7 for the boys and 23.9 for the girls.

These variations are not significant since the difference in the reading is not great enough to change a child's vitamin A classification.

²⁰Ibid.

CHAPTER 4

SUMMARY

Fifty-two second and third grade children are studied from March to May, 1940, for dark adaption following vitamin A administration.

The checks used in this study give no evidence of a learning factor.

It appears that the "Critical" reading is the most significant one when using the biophotometric test in technical studies, since the improvement is less in the Recovery Period and the range greater than in the "Critical" period.

This study shows no significant variation in the rate of speed at which the dark adaption improves at different ages or for the sexes.

Evidence that there is a seasonal variation in dark adaption ability is presented.

There is not enough difference in the curve obtained from fifty-two Texas elementary school children and Jeans'¹ curve to be considered important. No importance can be attached to localities.

All fifty-two of the children used in this study improved

¹P. C. Jeans, Evelyn Blanchard and Zelma Zentmire, "Dark Adaptation and Vitamin A: A New Photometric Technique", Journal of American Medical Association, CVIII (1937), 451-458.

in dark adaption ability when 10,000 U. S. P. vitamin A Haliver oil capsules were administered daily over a period of time ranging from three to six weeks. Since only a small dosage of vitamin A is administered during this time, it is probable that optimum dark adaption could be attained and maintained if the children receive only a well balanced diet.

APPENDIX

TABLE 10
FOLLOW-UP BIOPHOTOMETRIC READINGS OF DEMONSTRATION SCHOOL
CHILDREN DURING ADMINISTRATION OF HALLIVER OIL

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 3 min.	2nd 3 min.	End of 10 min. period.
B. J. A.	7	3/7/40	19-.959	19-.4450	27-.2250	4-1.600	15-.7440	20-.4090	28-.2060
		3/14/40	12-.810	20-.4090	28-.2060	6-1.350	15-.6250	24-.2910	32-.1470
		5/21/40	12-.810	26-.2660	34-.1240	11-.880	19-.4450	29-.1690	40-.0744
		3/28/40	13-.744	28-.2060	44-.0528	16-.575	35-.1140	39-.0810	46-.0445
		4/4/40	18-.485	31-.1600	45-.0575	20-.409	21-.0682	46-.0445	54-.0225
		4/11/40	24-.291	39-.0810	48-.0576	24-.291	38-.0880	46-.0445	54-.0225
M. B.	8	3/7/40	9-1.040	21-.3760	30-.1750	4-1.600	11-.6800	19-.4450	26-.2430
		3/14/40	12-.810	23-.3160	37-.0959	6-1.350	15-.7440	23-.3160	28-.1890
		5/21/40	14-.682	26-.2460	39-.0810	9-1.040	18-.4850	25-.2670	33-.1350
		3/26/40	16-.575	29-.1890	43-.0575	18-.485	22-.3450	30-.1750	30-.0880
		4/4/40	23-.316	35-.1140	45-.0485	22-.346	35-L1140	40-.0744	50-.0316
		3/8/40	20-.409	29-.1890	32-.1470	11-.880	16-.5750	23-.3160	27-.2250
L. C.	8	3/15/40	23-.316	35-.1350	36-.1040	16-.575	20-.4090	30-.1750	39-.0810
		3/29/40	34-.124	38-.0880	46-.0445	24-.291	40-.0744	46-.0445	50-.0516
		3/8/40	6-1.350	12-.3100	23-.3160	5-1.470	11-.8800	18-.4850	21-.3760
T. C.	7	3/15/40	10-.958	18-.4850	27-.2260	10-.959	16-.5750	25-.2670	30-.1750
		3/29/40	14-.682	24-.2910	35-.1140	19-.445	28-.2060	38-.0880	42-.0525
		4/6/40	32-.147	36-.0880	46-.0445	24-.291	34-.1240	39-.0810	52-.0267
		3/7/40	11-.680	15-.6250	20-.4090	5-1.470	18-.4850	23-.3160	28-.2060
B. A. G.	7	3/14/40	15-.625	19-.4450	29-.1690	9-1.040	23-.3160	27-.2250	36-.1040
		3/21/40	18-.485	20-.4090	51-.1600	13-.744	26-.2460	30-.1750	38-.0880
		3/28/40	21-.376	24-.2910	36-.1040	25-.409	29-.1590	44-.0409	47-.0528
		4/4/40	24-.291	30-.1750	36-.0880	24-.291	30-.1750	49-.0744	50-.0316

TABLE 10--Continued

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 3 min.	2nd 3 min.	End of 10 min. period
C. G.	7	3/7/40	5-1-470	13-7440	22-3460	4-1-600	15-6250	21-3760	27-2250
		3/14/40	8-1-140	16-5750	27-2250	10-959	19-4450	26-1890	37-0959
		3/21/40	12-810	19-4450	31-1600	15-625	25-5160	32-1470	40-0745
		3/28/40	14-682	25-2670	36-1040	20-409	32-1470	40-0744	45-0485
		4/4/40	23-316	31-1600	40-0744	26-246	37-0959	44-0528	52-0267
F. G.	8	3/12/40	20-409	24-2910	59-0810	14-682	23-2060	32-1470	42-0625
		3/19/40	27-225	31-1600	59-0810	19-445	32-1470	38-0880	42-0625
		4/2/40	30-175	35-1140	59-0810	21-376	30-1750	38-0880	42-0625
		4/8/40	35-114	42-6250	45-0485	25-267	35-1140	45-0485	50-0316
D. H.	7	3/7/40	10-959	27-2250	59-0810	14-682	23-3160	32-1470	39-0810
		3/14/40	12-810	26-2460	41-0682	16-575	30-1750	38-0880	43-0575
		3/21/40	14-682	30-1750	42-0525	19-445	34-1240	40-0744	47-0409
		4/4/40	27-225	41-0632	48-0376	23-316	38-0880	44-0528	51-0291
J. J.	7	3/11/40	5-1-470	14-6820	17-5280	5-1-470	10-5590	18-4850	20-4090
		3/18/40	5-1-470	15-6250	24-2910	9-1-040	16-5750	31-3760	28-2050
		4/1/40	14-682	19-4450	34-1240	17-528	24-2910	28-1890	40-0744
		4/8/40	20-409	23-3160	36-1040	19-445	30-1750	38-0880	48-0376
		4/14/40	24-267	30-1750	48-0376	24-291	36-1040	42-0625	51-0291
R. K.	7	3/8/40	5-1-470	29-1890	33-1350	18-744	21-3760	26-2460	32-1470
		3/15/40	11-880	35-1350	40-0744	18-485	24-2910	30-1250	57-0959
		3/29/40	24-291	42-0650	50-0316	26-246	43-0575	48-0376	53-0246

TABLE 10--Continued

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 3 min.	2nd 3 min.	End of 10 min. period
R. K.	8	3/8/40	6-1-350	14-6820	24-2910	4-1-600	18-4350	24-2910	26-2460
	3/15/40	6-1-350	15-2650	25-2570	7-1-250	18-4350	25-2670	27-2250	
	4/5/40	11-880	28-2060	52-1470	15-625	24-2910	28-2060	34-1240	
	4/12/40	15-625	32-1470	40-0744	18-485	32-1470	40-0744	44-0528	
	4/17/40	24-291	35-1140	40-0744	24-291	35-1140	42-0625	50-0316	
C. M.*	8	5/12/40	12-810	21-3760	39-0810	8-1-140	26-2460	34-1240	28-0880
	3/19/40	15-625	23-3160	39-0810	12-810	28-2060	36-1040	42-0682	
	4/2/40	18-485	28-2060	36-1040	21-376	29-1890	37-0959	41-0782	
	4/19/40	26-246	50-1750	40-0744	26-246	38-0880	44-0528	52-0267	
	7	3/7/40	19-445	32-1470	36-1040	9-1-040	22-3460	29-1890	32-1470
P. K. R.	5/14/40	20-409	35-1550	38-0880	13-744	23-3160	30-1750	35-1140	
	3/21/40	25-267	38-0880	40-0744	20-409	25-2670	32-1480	37-0959	
	3/28/40	27-225	42-0625	46-0445	23-316	40-0744	48-0376	49-0346	
D. S.*	7	3/11/40	5-1-750	9-1-0440	16-5750	0-2-250	10-8590	15-6250	21-5760
	3/18/40	5-1-470	10-9590	19-4450	6-1-350	14-6820	24-2910	28-2060	
	4/1/40	10-959	19-4450	28-2060	18-485	25-2460	35-1140	39-0810	
	4/8/40	15-265	25-3160	29-1890	22-346	30-1750	30-0959	45-0375	
	4/15/40	24-291	32-1470	41-0182	24-291	30-1750	39-0810	50-0316	
J. S.*	8	5/12/40	19-445	24-2910	30-1750	12-810	24-2910	35-1140	41-0682
	5/19/40	21-376	26-2460	33-1350	14-682	26-2460	37-0959	43-0575	
	4/2/40	24-291	30-1750	38-0880	20-409	32-1470	40-0744	48-0376	
	4/9/40	25-267	34-1240	41-0682	23-316	38-0880	43-0575	52-0267	

TABLE 10--Continued

Name	Age	Date	Min. 0	Min. 5	Min.* 10	After bright light	1st 5 min.	2nd 3 min.	End of 10 min. period
C. J. W.	9	5/12/40	22-.346	36-.1040	38-.0880	14-.682	19-.2450	48-.2060	39-.0810
		5/19/40	26-.246	30-.1750	36-.1040	14-.682	20-.4090	30-.1750	40-.0744
		4/2/40	26-.246	36-.1040	45-.0485	19-.445	36-.1040	40-.0744	45-.0485
		4/9/40	28-.206	40-.0744	51-.0291	24-.291	40-.0744	43-.0575	53-.0267

*C. M. was absent due to illness; so he had a two week feeding period with a reading at the end of two weeks.

TABLE 11

FOLLOW-UP STEREOGRAPHIC READINGS OF 344 HOUSTON SCHOOL
CHILDREN DURING ADMINISTRATION OF HALIVER OIL.

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 5 min.	2nd 5 min.	End of 10 min. period
H. B.	10	5/1/40	6-1-3600	8-1-1400	12-8100	9-1-040	12-8100	21-3760	27-2250
		5/8/40	18-4850	30-1750	37-0959	17-526	34-1240	35-0880	41-0682
		5/15/40	36-1040	40-0744	45-0485	20-409	38-0980	45-0485	51-0291
		44-0528	49-0546	52-0267	24-281	40-0744	50-0316	53-0246	
J. H. B.	7	5/1/40	5-1-7600	9-1-0400	14-6320	5-1-750	9-1-1400	10-6380	14-6320
		5/8/40	24-2810	34-1240	38-0680	15-744	28-1350	35-1140	37-0959
		5/15/40	38-1830	37-0959	40-0744	17-526	34-1310	20-1800	39-0880
		5/22/40	30-1750	39-1810	45-0575	19-445	25-2670	30-1750	39-0310
V. L. C.	8	5/5/40	11-8800	22-3460	25-2670	9-1-040	19-4450	22-5460	25-2670
		5/10/40	20-4090	30-1750	35-1140	14-632	19-4450	22-3460	25-2670
		5/17/40	25-2670	34-1240	39-0810	16-575	25-3160	31-1600	38-0880
		5/24/40	28-3060	36-1040	43-0575	19-445	25-2670	40-0744	46-0445
J. F.	7	5/1/40	35-1140	42-0625	50-0316	23-516	42-0625	45-0409	50-0516
		5/8/40	39-1830	40-0744	41-0682	20-409	31-1600	35-1140	40-0744
		5/15/40	40-1830	40-0744	41-0682	20-409	31-1600	35-1140	40-0744
		5/22/40	40-1830	40-0744	41-0682	20-409	31-1600	35-1140	40-0744
		5/29/40	30-1750	40-0744	42-0625	23-316	33-1350	30-0625	50-0316

TABLE 11—Continued

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 3 min.	2nd 3 min.	End of 10 min. period
K. R. G.	8	4/30/40 5/7/40 5/14/40 5/21/40	18-.8100 14-.6820 19-.4450 25-.2670 30-.1780	14-.6380 16-.5750 30-.1750 33-.1350 35-.1140	16-.5750 19-.4450 17-.528 19-.445 23-.316	441.600 14-.6820 21-.5780 27-.2250 30-.1750	621.3500 20-.4090 25-.2670 33-.1350 41-.0682	10-.3580 20-.4090 25-.2670 33-.1350 41-.0682	15-.6250 25-.2680 31-.1600 44-.0528 53-.0246
B. H. C.	8	4/30/40 5/14/40 5/21/40	6-1.3500 52-.1470 37-.0959	19-.2450 34-.1840 39-.0810	22-.5460 56-1.0400 41-.0682	6-1.350 15-.625 19-.445	12-.8100 20-.2460 24-.1240	16-.3780 36-.1040 42-.0625	21-.3760 37-.0659 44-.0528 53-.0246
J. G.	8	4/24/40 4/30/40 5/7/40 5/14/40 5/21/40	5-1.7500 25-.2870 27-.2250 38-.0830	9-1.0400 29-.1850 30-.1750 44-.5280	14-.6820 32-.1470 35-.1140 47-.0409	0-2.250 18-.435 19-.445 21-.376	5-1.4700 24-.2910 28-.1890 32-.1470	11-.6800 36-.1140 37-.0959 44-.0528	15-.6250 37-.0659 41-.0682 50-.0316
D. H.	8	4/30/40 5/6/40 5/13/40 5/20/40 5/27/40	3-1.7500 9-1.0400 18-.4850 29-.1090 40-.0744	5-1.4700 15-.6250 25-.2810 26-.1040 50-.0316	7-.1240 21-.3760 54-.1240 44-.0528 52-.0267	5-1.450 0-1.040 14-.682 18-.435 23-.316	7-1.2400 24-.6820 28-.4090 25-.2670 34-.1240	9-1.0400 24-.4090 28-.2060 30-.1750 44-.0528	21-.3760 28-.2060 34-.1240 38-.0880 53-.0246
D. M. L.	8	5/3/40 5/10/40 5/17/40 5/24/40	11-.6800 21-.0576 18-.4350 43-.0575	17-.5280 30-.1750 39-.0880 45-.0435	25-.3180 35-.1140 43-.0575	5-1.750 15-.625 18-.435	10-.6580 37-.0959 42-.0625	55-.0206 48-.0576 50-.0316	58-.0160 50-.0246 55-.0225 57-.0175

TABLE II—Continued

Name	Age	Date	Min. 0	Min. 5	Min. 10	Min.	After bright light	1st 3 min.	2nd 3 min.	End of 10 min. period
J. W.	8	5/3/40	11-•3800	22-•3460	25-•2670	9-1-040	18-•4450	20-•4090	21-•3760	
		5/10/40	20-•4090	25-•2670	30-•1750	15-•025	25-•2670	27-•2260	31-•1600	
		5/17/40	33-•1350	39-•0810	41-•0682	18-•485	35-•1350	38-•0880	41-•0682	
		5/24/40	33-•1350	41-•0682	45-•0485	20-•409	34-•1240	39-•0810	45-•0485	
R. M.	8	4/30/40	11-•8800	14-•6820	19-•4450	6-1-350	21-•3760	22-•3460	23-•1890	
		5/7/40	12-•8100	25-•2670	25-•2670	14-•682	24-•2910	31-•1600	35-•1140	
		5/14/40	15-•6250	35-•1140	41-•0682	16-•575	35-•1550	37-•0859	47-•0409	
		5/21/40	27-•2250	42-•2250	45-•0485	19-•445	35-•1350	43-•0575	48-•0576	
B. J. N.	8	5/15/40	3-•1750	8-1-1400	14-•6820	0-2-250	9-1-0400	12-•8100	16-•5750	
		5/20/40	15-•6250	26-•2460	30-•1750	16-•575	22-•3460	30-•1750	34-•1240	
		5/27/40	28-•2080	35-•1140	41-•0682	19-•445	25-•2670	32-•1460	42-•0625	
J. D. O. S.	9	4/30/40	2-1-0500	19-•4450	20-•4090	4-1-600	10-•9590	14-•6820	21-•3760	
		5/7/40	20-•4090	25-•2670	31-•1600	14-•682	25-•3160	32-•1470	36-•1040	
		5/14/40	27-•2250	37-•0959	39-•0810	16-•575	29-•1380	37-•0959	39-•0810	
		5/21/40	42-•1470	40-•0744	44-•0528	18-•485	36-•1040	39-•0810	41-•0682	
B. J. P.	8	5/1/40	4-1-6000	21-•2760	25-•2670	1-•206	10-•9590	15-•6250	20-•1890	
		5/8/40	20-•4090	28-•2060	32-•1450	14-•682	24-•2910	32-•1470	36-•1040	
		5/15/40	23-•3160	30-•1750	32-•1470	16-•575	27-•2250	35-•1140	40-•0744	
		5/22/40	36-•0880	43-•0376	20-•0316	24-•291	42-•0625	48-•0376	52-•0267	

TABLE 11--Continued

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 3 min.	2nd 5 min.	End of 10 min. period
E. P. b	7	4-1-6000	20-	4090	24-	2910	9-1-040	10-5950	24-0910
		18-4850	30-	1750	40-	0744	15-625	25-2670	45-0744
		36-1040	45-	0485	48-	0376	17-528	23-3160	43-1140
		45-0575	47-	0409	49-	0346	24-291	29-1890	43-0575
							29-1890	43-0575	52-0267
E. F. P.	8	4/24/40	14-	6820	23-	3160	24-	2910	9-1-040
		4/3/40	20-	4090	27-	2250	31-	1600	16-575
		5/7/40	28-	2060	34-	1240	36-	1040	18-485
		5/14/40	42-	0625	45-	0485	48-	0376	21-376
		5/21/40	43-	0575	48-	0376	50-	0316	23-316
F. J. P.	9	12-8100	15-	6250	17-	5280	0-2-250	9-1-0400	11-0400
		14-6820	17-	5280	23-	3160	12-810	20-4090	25-4090
		27-2250	30-	1750	35-	1140	16-575	32-1470	38-0880
		32-1470	35-	1140	37-	0959	22-346	34-1240	43-0682
		5/22/40	38-	0680	42-	0625	48-0376	24-291	38-0880
G. S.	7	11-8800	16-	5750	19-	4450	6-1-350	9-1-0400	14-0400
		20-4090	30-	1750	37-	0959	14-682	31-1600	34-1240
		25-2670	31-	1600	38-	0880	18-485	36-1040	40-0700
		33-1350	42-	0625	47-	0409	20-409	38-0810	42-0625
		35-1140	44-	0528	49-	0346	23-316	39-0810	44-0528
V. L. W.	7	12-8100	14-	6820	25-	2670	5-1-470	22-3560	25-2670
		21-3760	53-	1550	57-	0959	11-380	25-3160	33-2250
		30-1750	53-	1550	37-	0959	17-528	24-2910	38-1470
		35-1140	42-	0265	44-	0528	19-445	32-1470	41-0682
		38-0880	42-	0625	49-	0346	24-291	34-1240	42-0625

TABLE 11--Continued

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 3 min.	2nd 3 min.	End of 10 min. period
J. W.	7	4/30/40	30-.1750	34-.1840	42-.0695	10-.066	20-.4000	20-.2000	31-.1800
		5/7/40	40-.0744	44-.0528	50-.0316	19-.445	25-.2870	35-.1180	40-.0744
		5/14/40	44-.0520	46-.0446	48-.0376	20-.409	37-.0959	44-.0528	53-.0846
		5/21/40	44-.0526	48-.0376	55-.0206	22-.346	40-.0744	49-.0346	55-.00206

A.J. D. was absent May 21; so he was fed and treated the next week at his regular time.

B.Z. P. had a very light case of chicken pox and missed one testing, but his feeding was continued and he was tested at his regular time the next week.

TABLE 12
FOLLOW-UP BIOPHOTOMETRIC READINGS OF ROBERT E. LEE SCHOOL
DURING ADMINISTRATION OF HALIVER OIL

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright light	1st 5 min.	and 3 min.	End of 10 min. period
R. B.	10	3/13/40	21-.3760	30-.1750	35-.1140	3-.175	9-1-.0400	20-.4080	24-.2910
		3/20/40	31-.1600	35-.1140	38-.0880	5-1-.470	18-.4850	25-.2870	30-.1750
		4/5/40	34-.1240	37-.0959	42-.0625	14-.682	29-.1880	35-.1140	40-.0744
		4/10/40	37-.0959	44-.0528	48-.0576	26-.525	30-.1750	40-.0744	46-.0445
		4/17/40	37-.0959	45-.0435	48-.0376	24-.291	40-.0744	46-.0445	50-.0316
R. G.	8	3/20/40	9-1-.0400	15-.6250	32-.1470	7-1-.240	9-1-.0400	14-.6820	25-.2470
		4/2/40	25-.2870	50-.0316	54-.0225	15-.625	32-.1470	40-.0744	46-.0485
		4/8/40	35-.1140	51-.0281	55-.0206	13-.445	34-.1240	44-.0598	47-.0409
		4/30/40	35-.2870	38-.0380	41-.0682	23-.316	42-.0625	48-.0367	50-.0316
R. J.	9	22-	3460	25--.2460	41--.0588	6-1-.350	12--.8100	25--.5160	28--.2160
		27-	3250	37--.0959	47--.0409	17--.586	23--.5160	28--.2060	34--.1260
		30-	1750	45--.0485	49--.0546	20--.408	43--.0575	46--.0409	52--.0267
		34-	1240	40--.0744	45--.0485	24--.291	37--.0959	47--.0409	52--.0267
R. K.	9	23-	3160	35--.1140	38--.0680	5-1-.470	14-.6820	25-.3160	28-.1890
		25-	2870	39--.0810	42--.0625	14-.682	23-.3160	30-.1780	30-.0910
		34-	1240	41--.0682	49--.0546	19-.445	28-.2060	36--.0810	44--.0528
		4/15/40	56-.1040	44-.0528	49--.0346	22-.546	55-.1140	45-.0575	51-.0221
E. J. L.	8	3/18/40	20-	4090	25--.2670	28--.2060	5-1-.470	14-.6820	20-.4090
		4/1/40	23-	3160	32--.1470	38--.0880	14-.682	25-.2670	38--.0880
		4/8/40	32-	1470	39--.0810	43--.0575	19-.445	33-1.3500	41--.0682
		4/15/40	33--.1350	43--.0575	46--.0445	24--.291	34--.1240	42--.0625	52--.0267

TABLE 12--Continued

Name	Age	Date	Min.			After bright light			2nd 3 min.			End of 10 min. period			
			0	5	10	10	15	20	10	15	20	10	15	20	
M. I., I.	7	5/12/40	6-1-3500	10-	9590	13-	7440	4-1-600	10-	9580	13-	7440	15-	6250	
	5/19/40	11-	9590	13-	4650	22-	3450	9-1-040	13-	7440	13-	4650	13-	4450	
	4/2/40	18-	4860	25-	2670	31-	1600	16-	435	25-	2670	29-	1800	42-	0625
	4/9/40	25-	2670	39-	0810	45-	0485	24-	281	33-	0810	46-	0445	53-	0246
M. L.	8	5/12/40	13-	7440	24-	2910	26-	2650	3-1-750	13-	7440	16-	5750	20-	4000
	5/19/40	15-	6260	26-	2460	28-	2050	5-1-470	17-	5280	19-	4450	25-	2670	
	4/3/40	29-	1890	34-	1260	41-	0682	18-	465	28-	3160	32-	1470	40-	0744
	4/10/40	50-	1750	40-	0744	45-	0435	24-	291	40-	0744	46-	0445	52-	0287
P. M.	8	5/15/40	3-1-7500	9-1-0400	14-	6620	2-1-630	10-	9590	13-	7440	15-	6250	15-	6250
	5/20/40	10-	9590	18-	4650	22-	3460	6-1-350	13-	7440	16-	4450	24-	2910	
	4/3/40	15-	6250	26-	2080	37-	0950	19-	465	28-	2060	35-	1350	40-	0744
	4/10/40	25-	3160	34-	1260	43-	0575	24-	291	30-	1750	46-	0435	50-	0316
E. R.	7	5/14/40	7-1-2400	10-	9590	13-	7440	3-1-750	6-1-1400	12-	8100	14-	6820	14-	6820
	5/21/40	8-1-1400	22-	3460	24-	2910	8-1-140	14-	6620	13-	4850	25-	2670	25-	2670
	4/5/40	18-	4860	26-	2460	28-	2060	15-	525	24-	2910	30-	17500	36-	1040
	4/12/40	28-	3060	40-	0744	47-	0409	24-	291	38-	0680	45-	0575	55-	0206
M. J. P.	7	5/13/40	14-	6820	20-	4090	26-	2460	6-1-350	10-	9590	18-	4850	20-	4090
	5/20/40	20-	4090	27-	2250	29-	1890	9-1-040	16-	5750	20-	4090	26-	2450	
	4/3/40	27-	2250	34-	1260	59-	0810	19-	445	27-	2250	33-	1350	40-	0744
	4/10/40	38-	1470	31-	0832	45-	0465	23-	316	55-	1140	44-	0520	53-	0246
C. M. P.	8	5/13/40	5-1-4700	8-1-0400	19-	6820	4-1-600	11-	8800	14-	6820	16-	4850	16-	4850
	5/20/40	16-	5750	19-	4450	24-	2910	9-1-040	13-	7440	16-	4450	20-	1990	
	4/3/40	25-	2670	29-	1890	36-	0860	20-	409	31-	1500	39-	0810	41-	05682
	4/10/40	28-	1860	38-	0880	42-	0625	26-	246	33-	1350	48-	0576	52-	0267

TABLE 12--Continued

Name	Age	Date	Min. 0	Min. 5	Min. 10	After bright	1st 5 min.	2nd 5 min.	End of 10 min. period
H. P.*	8	3/12/40	3-1-7500	3-1-1400	14-• 6300	4-1-600	11-• 3500	14-• 6600	17-• 5200
			6-1-3500	6-1-5750	19-• 6850	10-• 950	20-• 4000	25-• 3100	27-• 2400
			15-• 6250	20-• 4000	27-• 2250	15-• 625	25-• 2670	30-• 1750	39-• 0610
			24-• 3010	28-• 2060	39-• 0610	21-• 376	31-• 1600	37-• 0950	50-• 0516
			38-• 1030	40-• 0744	44-• 0538	25-• 267	30-• 1750	40-• 0744	50-• 0516
G. S.*	8	3/25/40	10-• 9500	19-• 4450	28-• 2060	6-1- 350	18-• 4850	22-• 3460	24-• 2000
			19-• 4450	32-• 1470	40-• 1744	16-• 575	26-• 2460	33-• 1550	40-• 0744
			44-• 2480	49-• 0528	49-• 0546	20-• 400	32-• 1470	42-• 0625	45-• 0405
			51-• 1600	46-• 0445	51-• 0291	23-• 316	32-• 1470	44-• 0526	53-• 0246
			54-• 2910	56-• 2460	56-• 2460	5-1- 470	11-• 6300	28-• 2060	29-• 1620
			58-• 0880	15-• 625	15-• 625	15-• 625	17-• 1750	56-• 1040	58-• 0610
			59-• 0810	19-• 445	55-• 1140	19-• 445	35-• 1140	41-• 1650	48-• 0376
			59-• 0810	23-• 316	35-• 1140	23-• 316	35-• 1140	42-• 0636	52-• 0267
H. S.*	9	3/18/40	9-1-0400	18-• 4850	29-• 1860	35-• 0880	15-• 625	21-• 1750	28-• 1620
			18-• 4850	35-• 1560	35-• 1560	19-• 445	35-• 1140	41-• 1650	48-• 0376
			28-• 2060	40-• 0744	28-• 0576	23-• 316	35-• 1140	42-• 0636	52-• 0267
F. S.*	7	3/20/40	30-• 1760	35-• 1140	37-• 0850	9-1- 040	15-• 6250	21-• 3760	30-• 1750
			35-• 1140	38-• 0880	41-• 0682	12-• 810	20-• 4000	34-• 1240	38-• 0880
			37-• 0960	40-• 0744	45-• 0485	19-• 445	36-• 1040	14-• 5230	16-• 0445
			41/10/40	37-• 0959	45-• 0675	46-• 0445	23-• 316	38-• 0880	46-• 0445
			41/10/40	37-• 0959	45-• 0675	46-• 0445	23-• 316	38-• 0880	46-• 0445
E. S.*	9	3/20/40	9-1-0400	20-• 4900	24-• 2010	5-1- 470	13-• 7440	19-• 4440	25-• 3160
			14-• 6800	26-• 3160	51-• 1600	14-• 682	21-• 3760	28-• 2060	32-• 1470
			20-• 2060	28-• 2060	32-• 1470	18-• 485	22-• 3460	29-• 1860	36-• 1040
			25-• 3870	32-• 1470	40-• 0744	24-• 201	28-• 2060	35-• 0610	50-• 0516

*These children had a two week feeding period before they were tested because the globe in the biophotometer had to be replaced.

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