THE USE OF THE BIO-PHOTOMETER IN DETERMINING THE DARK ADAPTATION OF PRE-SCHOOL AGE CHILDREN

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THESIS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Figure | Page

CHAPTER I

INTRODUCTION

The degree to which the normal eye can be adapted to the dark is related to or dependent upon the eye's ability to regenerate visual purple. The relationship of vitamin A to the visual cycle as found by Tansley[1] has caused much development in improved methods of detecting vitamin A deficiency. For the most part these new methods have been applied to adults and school age children.

Recent studies have verified the bio-photometer tests as a reliable means for measuring vitamin A stores in both adults and school children. Jeans, Zentmire, and Blanchard[2] were the first to report the successful use of this means of testing school children, and their reports were confirmed by Jeghers[3], 1937.

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[1]Katherine Tansley, "The Regeneration of Visual Purple, Its Relation to Dark Adaptation and Night Blindness," Journal of Physiology, LXXI (1931), 442-458.

[2]P. C. Jeans, Evelyn Blanchard and Zelma Zentmire, "Dark Adaptation of Vitamin A," Journal American Medical Association, CVIII (1937), 451.

[3]Harard Jeghers, "The Degree and Prevalence of Vitamin A Deficiency in Adults," Journal American Medical Association, CVIII (1937), 751.

Steininger and Roberts[4], 1939, used the bio-photometer tests as a means of measuring vitamin A stores in adults and children, and they report that the test is reliable.

There was some divergence of opinion, however, in regard to the use of the bio-photometer as a method of measuring the variations in dark adaptation in children. Snelling[5], 1938, reported an investigation which shows the method to be unsatisfactory with the use of children. Baum and McCoord[6], 1940, reported no correlation with blood vitamin A values and the bio-photometric readings.

Lewis and Haig[7], 1940, carried out a dark adaptation test on two pre-school children, ages three and five years. These children could not distinguish between the right and left hand; so a luminous vial was fastened by adhesive tape to the index fingers, and they were asked to point in the position of the test light. The investigators reported they were able to obtain threshold values with this technique.

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[4]Grace Steininger and Lydia Roberts, "Biophotometer Test as Index of Nutritional Status for Vitamin A," Archives Internal Medicine, LXIV (1939), 1170.

[5]C. E. Snelling, "The Biophotometer in Testing Vitamin A Deficiency," American Journal of Diseases of Children, LVI (1938), 939.

[6]W. S. Baum and Augusta B. McCoord, "The Relationship Between Biophotometric Tests and Vitamin A Content of the Blood of Children," Journal of Pediatrics, XVI (1940), 409.

[7]J. M. Lewis and Clark Haig, "Vitamin A Status of Children as Determined by Dark Adaptation," Journal of Pediatrics, XVI (1940), 285.

The apparatus for the study was devised in their laboratory. In an earlier study Lewis and Haig[8] carried out a successful dark adaptation test with infants. The investigators used their own specially devised apparatus.

A comparison of two methods of measuring dark adaptation was made by Eckardt and Johnson[9], 1941. They compared the bio-photometer and the Hecht and Schlaer Adap-o-meter. As a result of this study, the bio-photometer was recommended as more suitable for use in a practitioner's office because of the simplicity in operation and calculation of its results. In conclusion, it was recommended that the bio-photometer is valuable in giving a true picture of dark adaptation.

Palmer and Blumberg[10], 1937, found the bio-photometer sufficiently simple to be applied to six year olds. If, then, Lewis and Haig[11], 1940, were able to obtain dark adaptation

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[8]J. M. Lewis and Clark Haig, "Vitamin A Requirements in Infants as Determined by Dark Adaptation," Journal of Pediatrics, XV (1939), 812.

[9]Robert E. Eckardt and Lorand V. Johnson, "A Comparison of Two Methods of Measuring Dark Adaptation," Journal of Pediatrics, XVIII No. 2 (1941), 195.

[10]C. E. Palmer and Harold Blumberg, "Use of Dark Adaptation Technique in the Measure of Vitamin A Deficiency in Children," Public Health Report, LII (1937), 1403.

[11]J. M. Lewis and Clark Haig, "Vitamin A Status of Children as Determined by Dark Adaptation," Journal of Pediatrics, XVI (1940), 285.

thresholds on pre-school children by one method, and Palmer and Blumberg[12], 1937, could use the bio-photometer with six year olds, it was reasonable to relieve that the bio-photometer could be adapted to use with pre-school children.

The question of a "learning factor" is involved with the use of the bio-photometer in determining dark adaptation of children. Palmer and Blumberg[13], 1937, attributed a gain in dark adaptation with school children to the "learning factor." However, in a later study, Palmer[14], 1938, made no such report.

Silk[15], 1940, in a study of second and third grade children obtained successful results with no learning factor involved when repeated tests were made using the bio-photometer. Eckardt and Johnson[16], 1941, previously mentioned, also found no learning factor involved when using the bio-photometer.

Evidence points to the fact that there is a relationship

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[12] Palmer and Blumberg, op. cit.

[13] Ibid.

[14] C. E. Palmer, "The Dark Adaptation Test in Vitamin A Deficiency," American Journal of Public Health, XXVIII (1938), 309.

[15] M. R. Silk, "Vitamin A Administration and Dark Adaptation of Second and Third Grade Children," (Unpublished Thesis for Master's Degree, Department of Home Economics, North Texas State Teachers College, 1940), 26.

[16] Eckardt and Johnson, op. cit.

between age and dark adaptation. Hecht and Mendelbaun[17], 1937, reported that an investigation shows that age has some influence on dark adaptation. The cone threshold was found to slowly resist with age, because of the yellowing of the color media. Steininger and Roberts[18], 1939, found that adults over thirty with an optimal intake of vitamin A had significantly poorer dark adaption than did children or young adults. However, Rohrer[19], 1940, in a study of dark adaptation in primary children found no relationship between these young ages and dark adaptation.

Because of the paucity of evidence with regard to dark adaptation and the vitamin A status of pre-school children, this study is made. The purpose, therefore, is to add to the available data on this subject through an investigation of the bio-photometer as a means of detecting vitamin A deficiency in pre-school children.

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[17] Selig Hecht and Joseph Mendelbaun, "The Relation Between Vitamin A and Dark Adaptation," Journal American Medical Association, CXII (1939), 1910-1916.

[18] Steininger and Roberts, op. cit.

[19] Lois Rohrer, "Dark Adaptation of Second and Third Grade Children," (Unpublished Thesis for Master's Degree, Department of Home Economics, North Texas State Teachers College, 1940), 31.

CHAPTER II

PROCEDURE

A photometer such as was described by Jeans and co-workers[1], 1937, was used in this study. The instrument was a Frober-Faybor[2] Bio-photometer No. A. 25. It was installed in a dark room. The only light present was the flashing of a small, covered red bulb for the purpose of reading the meters at the timed intervals during the testing period. The long testing technique as described by Jeans was used in this study.

A total of twenty-three minutes comprised each testing period - a ten minute fore period in the dark, exposure to the bright light for three minutes, and then another ten minute period in the dark. Readings were made at the beginning, end, and in the middle of the fore period, and at the end of the exposure to the bright light. This reading was made within twenty-seconds by a stop watch. Three readings were made during the recovery period.

Readings were made in terms of the setting of the rheostat dial controlling the lighting, these values being converted

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[1] P. C. Jeans, Evelyn Blanchard, and Zelma Zentmire, "Dark Adaptation of Vitamin A," Journal American Medical Association, CVIII (1937), 451.

[2] Frober-Faybor Bio-photometer, Cincinnati, Ohio. Purchased November, 1939.

subsequently to the light values by means of a conversion table prepared by calibration of the instrument. The values obtained represented the least amount of light required to see the test object. Since the amount of light required normally decreased throughout the test period, a curve was obtained when the light threshold values were plotted against time.

The retina possesses two kinds of receptors: rods for vague colorless vision at low intensities, and cones for acute color visions at high intensities, and they are distributed over the retina in a definite and characteristic manner. This makes the retina a structure of a very complex type. Dark adaptation is accomplished by both rods and cones. The measurement of this visual threshold in pre-school children is the concern of this study.

In order to become more familiar with the instrument and to gain some skill in manipulation, it was necessary to do some preliminary testing. Seventeen college students were used as subjects.

Seventeen pre-school children from the summer play school of North Texas State Teachers College were used in this study during June, July, and August, 1940. The ages of these children ranged from three to five years. Twelve were given only one test each, three were given two tests, one was given three tests, and another was given four tests. Where more than one test was made on a subject, there was, usually, a period of one week between each test.

Jeans, Zentmire and Blanchard[3] state: "There is no need for the eyes to be closed in a dark room." However, each child wore dark glasses during the rest periods.

To be sure these small children did not confuse the right with the left hand, the sides were named or the operator would touch the child's knee on the right side.

It was necessary in the beginning for the operator to gain the confidence and cooperation of each child before taking him into the dark room. Since the operator was a stranger to each child, in the beginning of the study, the time required to become sufficiently acquainted to obtain cooperation was from thirty minutes to an hour. This time was spent in walking about the campus, observing the birds and the fish pond, walking to the store for some needed purchase, or riding in the car for a few minutes. The experimental rats in the research laboratory served as a drawing card to lure the children to the test room, the usual procedure being to see the rats and then go to the test room. In most instances, after friendship was established between the operator and the child, this procedure worked satisfactorily.

It was discovered by the operator if she called at

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[3] P. C. Jeans, Evelyn Blanchard, and Zelma Zentmire, "Dark Adaptation of Vitamin A," Journal American Medical Association, CVIII (1937), 451.

the child's home and took him to the laboratory that the time needed to obtain cooperation was much less than if he was accompanied by his mother or some one else in charge. If he was willing to leave his home in company with a stranger, it took only a short time to establish a companionship necessary for complete cooperation and confidence.

One four year old child, accompanied by her mother, was finally persuaded to go into the test room, but readings could not be taken because the operator could not get her to follow instructions.

Another four year old child, accompanied by her mother, was satisfactorily tested only after the mother was urged to leave the child for the operator to manage alone. Another child, age three, never became reconciled to the dark room for the length of time necessary for testing.

It was necessary to keep a child pacified at intervals between readings during the twenty-three minute test period. The operator used songs and stories to entertain the subject and keep him in a cooperative mood. Each child was told about the bright light in advance of the time for the exposure. In preparation for this, the idea of an imaginary picture show was created in his mind and he looked forward to its appearance. When it did appear, the operator described scenes of interest to each individual child that would be "fun to see" if the instrument should suddenly turn into a "picture show machine."

This playing upon the child's vivid imagination was successful in all but the two cases already described in which no readings could be obtained.

All children used in this study were from professional homes.

In order to further study the reliability of the biophotometeric readings of these pre-school children, permission to feed vitamin A supplement to three children was obtained from the parents. Each capsule contained not less than ten thousand U. S. P. vitamin A and one hundred forty-five U. S. P. vitamin D. Parents cooperated in seeing that these capsules of Haliver Oil were administered regularly.

CHAPTER III

DISCUSSION

The results of the bio-photometric readings obtained in this study from fifteen pre-school children are shown in figures plotted with Jeans'[1], 1937, normal curve for school age children. Jeans, Zentmire and Blanchard[2], 1937, refer to the exposure to the bright light as the "critical" reading. They consider all curves which contain a "critical" reading of 0.49 millifoot candle or less within the normal range, while those greater than o.70 millifoot candle are in the clinical or sub-normal range.

In Figure 1, which shows the plotted curves of the initial readings of the fifteen pre-school children, seven of the subjects fall within the normal range and eight subjects fall within the sub-normal range. From the results of these initial readings it is reasonable to accept the fact that children of this age may be measured reliably for dark adaptation with the bio-photometer.

During the three minute exposure to the bright light the visual purple is being bleached and regenerated at the

[1] Jeans, Zentmire and Blanchard, _op. cit._

[2] _Ibid._

same time, accoring to Jeans[3], 1937. If there is an adequate supply of Vitamina A present, there will be rapid regeneration even in the presence of light. If a subject could regenerate visual purple as fast as it is being bleached, it would require no more light for the last reading of the recovery period than for the last reading of the fore period. This reaction, however, differs greatly with individuals. This fact is exemplified in Figure 1, previously mentioned, which shows curves of various degrees resulting from the plotting of the initial readings of fifteen pre-school children.

The fact that small children offer more difficulty in a study of this nature than do young adults or school children necessitates much preliminary preparation. The children are easily distracted, they are often afraid of the dark, and they sometimes refuse to follow instructions. They cannot always make rapid decisions as to what they see. One incident to show that the operator has carefully managed to alleviate these difficulties is illustrated in Figure 2, which is the result of the retesting of subject N. D., age five years. The figure shows the curves plotted as the result of the readings made on two successive days at the same hour. The result shows

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[3] _Ibid._

the "critical" reading to be the same on both days, although some of the other readings vary as little as .03, which is insignificant in considering the relationship of the several readings of a test period. The threshold of N. D. was .4, which is normal according to Jeans, Zentmire, and Blanchard[4], 1937.

Figure 3 explains further investigations with a subject, B. P., four years of age. This subject is cooperative and easily adapted to the dark room. The first curve plotted on Figure 3 is the result of the initial reading, and it shows a "critical" reading of 2.2. This result classifies the subject as decidedly sub-normal according to Jeans, Zentmire, and Blanchard's[5], 1937, norm. The second curve is the result of a reading taken one week later after daily administration of capsules containing not less than ten thousand U. S. P. of vitamin A concentrate. The "critical" reading at this point is .3 which is within Jeans, Zentmire, and Blanchard's[6], 1937, normal range. A third reading one week from the date of the second reading is shown in the third curve of the above mentioned figure. The "critical" reading here shows .6, which is considered borderline. Still a fourth reading is shown, having been made one week later than the third reading. This

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[4] Ibid.

[5] Ibid.

[6] Ibid.

fourth reading is .7, which is still borderline. No vitamin A concentrate was administered after the second reading. The poor dark adaptation shown after the withdrawal of the vitamin A is further proof that the readings are reliable. The results obtained in this case show that the four year old subject, B. P. is capable of a rapidly lowering threshold in the presence of vitamin A supplement. The dosage, in this instance, was not less than ten thousand U. S. P. daily. Lewis and Haig[7], 1939, report a study in which two infants were given thirty thousand and fifty thousand U. S. P. at a single dose, which caused the threshold to return to normal, after complete dark adaptation, in forty to sixty-five minutes respectively. These authors used a method of their own device to measure the dark adaptation. If these investigators obtain valid results with their method of measuring the lowered threshold in infants, it is within reason that the results obtained on the bio-photometer with subject B. P. are equally as valid. Additional proof of the reliability of these tests with subject B. P. is observed in the rise and subsequent reversal of the visual threshold in relation to the vitamin A supplement. The threshold, after the supplement, reaches normal but begins a consistant rise immediately following the omission of the supplement as shown in the curves of the third and fourth "critical" readings,

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[7] J. M. Lewis and Clark Haig, "Vitamin A Requirements in Infants as Determined by Dark Adaptation," Journal of Pediatrics, XV (1939), 812.

already described, in Figure 3. The results herein presented lead to the conclusion that there is a direct relationship between the vitamin A stores and the bio-photometric readings of subject B. P. since it is an accepted fact that vitamin A deficiency brings about an elevation of the final threshold.

The disability to see when coming into a dark room after having come from a brightly illuminated one is an accepted pheromenon among adults, but a small child is usually astonished if not frightened by his visual obscurity upon entering a dark room such as is used in this study. Subject R. B., age five years, after being enticed into the dark room, complained that she could not see. The operator held her hand to insure confidence, and after the completion of the test period the child still complained that she could not see. The "critical" reading of this subject was 2.2. This reading shows an extremely high threshold. A second testing is recorded for this subject taken one week later after the daily administration of capsules containing not less than ten thousand U. S. P. vitamin A concentrate. The "critical" reading of the second testing is .9, which is in the Jeans, Zentmire, and Blanchard's[8], 1937, subnormal range. As a result, the fact that the threshold of subject R. B. was lowered from 2.2 to .9 in one week after

[8] Jeans, Zentmire and Blanchard, op. cit.

administering vitamin A supplement tends to support the validity of the tests.

The results obtained from another subject, J. H., age five, is shown in Figure 4. The "critical" reading at the first testing is 1.1, which is sub-normal according to Jeans, Zentmire, and Blanchard[9], 1937. The second "critical" reading, as shown in the curve of Figure 4, is .6. This reading, which is considered borderline, is made one week later after daily administration of capsules containing not less than ten thousand U. S. P. vitamin A. The third reading is made one week later after a continued administration of the supplement. The third test shows the "critical" reading to be .2, which is within Jeans, Zentmire, and Blanchard's[10] norm. The consistency with which the threshold lowers, in this case, after the administration of the supplement is significant in supporting the validity of the test.

Lewis and Haig[11], 1940, in a study with two pre-school children, ages three and five, report that, with an instrument of their own device, they were able to obtain threshold values. If these values can be obtained on a five year old subject by one means, it is reasonable to accept the results of subject J. H., obtained by the bio-photometric method, as conclusive evidence of the validity of the method.

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[9] Ibid. [10] Ibid.

[11] J. M. Lewis and Clark Haig, "Vitamin A Status of Children as Determined by Dark Adaptation," Journal of Pediatrics, XVI (1940), 285.

A continuation of these case studies is made on subject L. G., age four. The initial reading illustrated in Figure 5 shows a "critical" reading of .4, which is accepted by Jeans, Zentmire, and Blanchard[12], 1937, as normal. The second curve is the result of a reading made three weeks later after the subject had been ill. The "critical" reading here is .6, which is borderline. The fact that this subject retains a borderline threshold, in spite of illness, is probably due to the fact that cod liver oil was being administered at the time of the test. The amount is not known. The case of subject L. G., together with the other cases, previously described, is offered as evidence of the reliability of the threshold values obtained with the bio-photometric readings.

No attempt is made in this study to bring any subject to normal, although vitamin A supplement is administered in three cases. A subject is tested for the plotting of each individual reading. Repeated testing on a subject is made for comparison only.

The Jeans, Zentmire, and Blanchard[13] normal has been questioned by Steininger and Roberts[14], 1939, and also by Baum and McCoord[15], 1940. They suggest that it is too high. Recent studies with the bio-photometer, however, by Jeans,

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[12] Jeans, Zentmire, and Blanchard, op. cit. [13] Ibid.

[14] Steininger and Roberts, op. cit.

[15] Baum and McCoord, op. cit.

Blanchard, and Statterthwaite[16], 1941, have proved Jeans' former findings to be valid.

The findings of the present study show that seven of the fifteen pre-school children tested fall within Jeans, Zentmire, and Blanchard's[17], 1937, norm at the initial readings, while the administration of vitamin A supplement to two of the other eight subjects lowered their threshold to the normal range. This indicates that the normal range for pre-school children is probably within that set for school age children which formed the basis for Jeans, Zentmire, and Blanchard's[18], 1937, norm. Although the threshold may rise with age, it is reasonable to believe that there would be negligible variance between the thresholds of pre-school children and school age children. The fact that Rohrer[19], 1940, found no relationship between age and dark adaptation in primary children is further evidence to justify this conclusion.

The results as observed in this study are in keeping with other investigations in this field. They compare favorably with those obtained by Lewis and Haig[20], 1940, when they obtained

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[16] P. C. Jeans, Evelyn Blanchard, and F. E. Statterthwaite, "Dark Adaptation and Vitamin A," Journal of Pediatrics, XVIII (1941), 170.

[17] Jeans, Zentmire, and Blanchard, op. cit.

[18] Ibid.

[19] Rohrer, op. cit.

[20] J. M. Lewis and Clark Haig, "Vitamin A Status of Children as Determined by Dark Adaptation," Journal of Pediatrics, XVI (1940), 285.

threshold values for two pre-school children. In the present study threshold values are also obtained with pre-school children but with the use of the bio-photometer as a means of measuring dark adaptation. The results of this study compare favorably with the more recent studies of Jeans, Blanchard, and Statterthwaite[21], 1941, in which they prove conclusively that the former findings of Jeans, with the use of the bio-photometer, are valid. Their results compare with the present study because the same instrument is used and threshold values are obtained using the same normal range.

The result of this investigation reveals that, as judged by dark adaptation with the use of the bio-photometer, the threshold values of pre-school children can be obtained, thus indicating the vitamin A status.

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[21] Jeans, Blanchard, and Statterthwaite, op. cit.

CHAPTER IV

SUMMARY

This is an investigation of the dark adaptation of seventeen pre-school children from the 1940 summer play school of the North Texas State Teachers College. The results of the bio-photometric readings of fifteen of these children are studied.

Vitamin A supplement of ten thousand U. S. P. Haliver liver oil capsules was administered daily to three children, whose initial readings were extremely high, over periods from one to two weeks, and dark adaptation was improved in all three cases.

Results of the readings of one child, after the omission of vitamin A supplement, are consistent with her original readings in that as depletion started there was a continued rise in the dark adaptation threshold.

It appears that the normal threshold for pre-school children may be the same as that set by Jeans[1], 1937, and his associates, for school age children.

Definite evidence of a psychological factor is found in obtaining the cooperation of pre-school children in the

[1]Jeans, Zentmire, and Blanchard, <u>op. cit.</u>

following of instructions for the testing procedure with the bio-photometer.

Evidence that threshold values can be obtained in pre-school children with the use of the bio-photometer is presented.

APPENDIX

TABLE 1

THE BIO-PHOTOMETRIC READINGS WITH MILLIFOOT CANDLE CALIBRATIONS OF FIFTEEN PRE-SCHOOL CHILDREN

Name	Age	First Reading		Fore-Period: After Five Min.		Fore-Period: After Five Min.		After Bright Light: Three Minutes	
		D	M	D	M	D	M	D	M
C. P.	4	12	.810	19	.445	27	.225	10	.959
F. J. C.	5	32	.147	32	.147	35	.114	8	1.1
P. J. B.	5	19	.445	20	.409	24	.291	15	.625
N. D.	5	33	.135	37	.0959	43	.0575	19	.445
N. D.	5	30	.175	39	.0810	38	.0880	19	.445
M. G.	4	40	.0744	50	.0316	53	.1246	20	.409
B. I.	4	24	.291	38	.0880	38	.0880	14	.682
R. S.	4	24	.291	33	.135	40	.0744	11	.881
B. P.	4	18	.485	22	.346	36	.104	0	2.25
B. P.	4	12	.810	32	.147	29	.189	21	.376
B. P.	4	18	.485	24	.291	40	.0744	14	.682
B. P.	4	19	.445	41	.0682	46	.0445	13	.744
J. H.	5	27	.225	41	.0682	38	.0880	8	1.14
J. H.	5	30	.175	45	.0485	45	.0485	14	.682
J. H.	5	19	.445	44	.0528	42	.0682	24	.291
L. G.	4	23	.316	40	.0744	45	.0485	20	.409
L. G.	4	13	.744	30	.175	33	.135	15	.625
R. B.	5	9	1.04	38	.0880	32	.147	0	2.2
R. B.	5	14	.682	20	.409	26	.246	10	.925
A. S.	5	25	.267	28	.206	38	.0880	23	.316
B. D.	5	20	.409	23	.316	29	.189	11	.880
I. M.	4	18	.485	30	.175	25	.267	7	1.24
F. R.	4	34	.124	42	.0625	44	.0528	14	.682

* D - Dial
M - Millifoot Candle

TABLE 1 - Continued

Recovery Period						Remarks
Three Minutes		Three Minutes		Three Minutes		
D	M	D	M	D	M	
50	.0316	55	.0206	60	.0135	
34	.124	42	.0575	48	.0376	
33	.124	35	.114	39	.0810	
38	.0880	41	.0682	45	.0485	
35	.114	42	.0625	44	.0528	Second test one day later.
40	.0744	43	.0575	50	.0316	
33	.135	43	.0575	44	.0528	
31	.160	35	.114	37	.0959	
30	.175	30	.175	33	.135	
30	.175	37	.0959	50	.0316	One week later after Vit. A.
34	.124	35	.114	38	.0880	Second week later. No Vit. A.
42	.0625	42	.0625	40	.0744	Third week later. No Vit. A.
42	.0685	38	.0880	39	.0810	
34	.124	42	.0625	46	.0445	First week after taking Vit. A.
26	.246	44	.0528	42	.0625	Second week after Vit. A. Sup.
45	.0485	46	.0445	50	.0316	
35	.114	42	.0625	44	.0528	After three weeks illness. Had taken some cod liver oil.
10	.925	20	.409	33	.135	
24	.291	32	.147	30	.175	Week later after taking Vit. A.
33	.135	40	.0744	36	.104	
38	.0880	36	.104	35	.114	
24	.291	25	.267	23	.316	
34	.124	48	.0376	70	.00575	

BIBLIOGRAPHY

Baum, W. S., and McCoord, Augusta B., "The Relationships Between Biophotometric Tests and Vitamin A Content of the Blood of Children," Journal of Pediatrics, XVI (1940), 409.

Eckardt, Robert E., and Johnson, Lorand V., "A Comparison of Two Methods of Measuring Dark Adaptation," Journal of Pediatrics, XVIII No. 2 (1941), 195.

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

Instructions for Operating Bio-photometer, Frober-Faybor Company, Cleveland, Ohio.

Jeans, P. C., Blanchard, Evelyn, and Zentmire, Zelma, "Dark Adaptation of Vitamin A," Journal American Medical Association, CVIII (1937), 451.

Jeans, P. C., Blanchard, Evelyn, and Statterthwaite, F. E., "Dark Adaptation and Vitamin A," Journal of Pediatrics, XVIII (1941), 170.

Jeghers, Harard, "The Degree and Prevalence of Vitamin A Deficiency in Adults," Journal American Medical Association, CVIII (1937), 751.

Lewis, J. M. and Haig, Clark, "Vitamin A Requirements in Infants as Determined by Dark Adaptation," Journal of Pediatrics, XV (1939), 812.

Lewis, J. M. and Haig, Clark, "Vitamin A Status of Children as Determined by Dark Adaptation," Journal of Pediatrics, XVI (1940), 285.

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

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

Rohrer, Lois, "Dark Adaptation of Second and Third Grade Children," (Unpublished Thesis for Master's Degree, Department of Home Economics, North Texas State Teachers College, 1940), 31.

Silk, M. R., "Vitamin A Administration and Dark Adaptation of Second and Third Grade Children," (Unpublished Thesis for Master's Degree, Department of Home Economics, North Texas State Teachers College, 1940), 26.

Snelling, C. E., "The Biophotometer in Testing Vitamin A Deficiency," American Journal of Diseases of Children, LVI, (1938), 939.

Steininger, Grace and Roberts, Lydia, "Biophotometer Test as Index of Nutritional Status for Vitamin A," Archives Internal Medicine, LXIV (1939), 1170.

Tansley, Katherine, "The Regeneration of Visual Purple, Its Relation to Dark Adaptation and Night Blindness," Journal of Physiology, LXXI (1931), 442-458.