DOCUMENT RESUME

ED 081 882 UD 013 832

AUTHOR	Smith, Jack L.
TITLE	Nutrient Supplementation and Learning.
PUB DATE	8 Aug 73
NOTE	37p.; Paper presented at the Sixth Annual Meeting of the Society for Nutrition Education, Atlanta, Ga., August 8, 1973
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Breakfast Programs; Cognitive Development; Hunger; Individual Development; *Intelligence Differences; Intelligence Tests; *Intervention; *Kindergarten Children; *Learning Processes; Lunch Programs; *Nutrition; Perceptual Motor Coordination; Physiology; Preschool Children; Reaction Time; Task Performance
IDENTIFIERS	Kahn Intelligence Test; KIT

ABSTRACT

The nutritional status of Kindergarten children has been studied in relation to performance in behavioral tests and the effects of several types of nutritional intervention in nutrition and behavior have been evaluated. In a study in 1969-70, children who received breakfast and lunch at school showed significant improvement in hemoglobin concentrations. Children who received lunch alone improved but not to an extent that was statistically significant. Children with high hemoglobin levels showed better performance in the Kahn Intelligence Test(KIT) and, in the youngest age group, in simple and disjunctive reaction time tests. Improvement in KIT occurred in children who received breakfast and lunch. In studies the next year, the nutritional status of kindergarten children was found to be better than in the previous year. Children who received breakfast and lunch did not improve significantly as compared to the control children who also improved. Children who received breakfast and lunch improved significantly in performance in the disjunctive reaction time and in continued trials of associative reaction time. Improvement was greater in subjects whose initial hemoglobin values were low. These studies indicate a relationship between mild levels of nutrient deficiency and performance tasks demanding attentiveness and alertness. (Author/JM)

NUTRIENT SUPPLEMENTATION AND LEARNING

Presented for the 6th Annual Meeting of
the Society for Nutrition Education

Atlantic, Georgia
August 8, 1973

Jack L. Smith, Ph.D.

Associate Professor
Biochemistry and Nutrition
School of Public Health and Tropical Medicine
Tulane University Medical Center
New Orleans, Louisiana

Today I wish to summarize some of the studies we have been pursuing for the past several years in an attempt to determine if there is a relationship between the nutritional status of an individual and learning. There is neither time, nor is this the place to attempt to review all of the vast amount of literature in this field.

First, however, I think I should modify the title a little since we really did very little to measure learning per se. What we did attempt to measure was the different kinds of behavior which might be affected by nutritional factors. These included measures of individual performances on specific tasks involving such things as short-term memory, reaction time, and attention span. (This aspect of the investigation was under the direction of Dr. Jefferson Sulzer). There are two ways primarily in which nutrition can effect these. One is through changes in motivation and the other is via an alteration in the actual physiological mechanisms involved. It is extremely difficult, if not impossible, for us to distinguish which of these two basically different factors is more important. However, if adequate nutrition affects either of these functions, the end result should be a child with increased capabilities which can be drawn on for the rest of his life That is to say that even though providing adequate nutrition may increase the performance in a particular task, the beneficial effects are most likely to be seen in long-term intellectual performance and lifetime productivity. In fact, the Russians are approaching the effect of nutrition on performance from an alternate point of view. That is, if adequate nutrition promotes "normal" performance, what nutritional factors might promote exceptional performance?

Before I discuss our work, I wish to briefly mention some of the experimental approaches which are available to study the relationship between nutritional status on either mental development or learning. Primarily either severe protein-calorie malnutrition or mild to moderate malnutrition have been studied.

One approach is the chemical and anatomical evaluation of the effects of malnutrition on the chemical constituents of the brain such as DNA, protein, RNA, or the number and types of brain cells. The influence of varying degrees of malnutrition on the rate of differentiation and migration has been studied. These investigations have been carried out in experimental animals such as rats, pigs, and sub-human primates, and to a limited degree, in humans. This work is summarized quite effectively by Wennick, et. al.,[(1),(2)] in which he shows that there is a decrease in the number and size of cells in certain portions of the brain as well as a decreased rate of cellular migration, which relates to the rate of development. Intuitively, we feel that a decrease in the number of cells, the cell size, or a delay in their migration should affect mental performance and function. However, as yet there has not been unequivocal data to substantiate this.

Another very common approach in human research if to examine two "comparable" populations of children for their performance on certain tests such as I.Q. or development tests and observe a difference. Unfortunately, in most of these studies, nutrition has not been the only independent variable. These other variables include what have been called the "sociocultural factors". It is very difficult to obtain any group of individuals who differ only in nutritional status. Evidence has been presented by many workers, including Kline at INCAP, Cravioto Kallen of Michigan State and others that there are many factors relating to the environment of the child other than his nutrition which affect behavior and learning. Many of these factors such as socioeconomic status, the presence of a male in the household, the interaction between mother and child and siblings and child are all correlated with the nutritional status, and these in turn correlate with performance on certain development tests.

As someone who was at one time used to working primarily with experimental animals, the most obvious experiment, of course, would be to take one population and restrict its intake to cause malnutrition at a defined degree and observe the development of the children coming out of that society after trying in every way to provide both populations with equivalent social stimuli. The only difference then would be nutritional factors and in this way we might learn the true effect of nutritional status on mental development, growth and productivity. Of course, no one really could perform that experiment on humans. However, and experiment is underway at INCAP in

Guatemala which, if effective, will provide this.

The approach we have taken has been to attempt to change the nutritional status of kindergarten children without affecting their social or cultural environment. This was done by supplying supplementation as either a micronutrient supplement, lunch, or breakfast and lunch to a group of kindergarten children in the New Orleans Public School System. These children, I might add, would not have received any kind of nutritional supplement in kindergarten, which is a half-day program in New Orleans.

The initial study in this series of experiments began in 1968, when an interdisciplinary team began to investigate relationships between nutritional status and intellectual function and attentiveness in children. The results of three years of study in kindergarten children, in whom nutritional intervention programs were instituted, will be summarized here.

During the first year, approximately 500 children enrolled in Operation Headstart and followed through their kindergarten years, showed a relationship between low hemoglobin levels and behavior. In this early investigation a variety of measures of behavior were tested and subjected to analysis. The results suggested that the most reliable differences in behavior between children with low and acceptable hemoglobin levels were found in some performance measures of intelligence and in tasks measuring different kinds of reaction times. In subsequent research, only these more promising measures were used. The measurements used to determine nutritional status are shown in Table 1. In subsequent years, serum iron and iron binding capacity, percent saturation of transferrin and serum folacin levels were also performed on subsamples of each of the groups of children under investigation.

During this first year, a significant percentage of the children were found to have hemoglobin levels of less than 11 grams per dl. and serum Vitamin A concentrations of less than 20 mcg per dl. - values considered to be less than acceptable.

The tests used for behavioral measurement included the Van Alstyne Picture Vocabulary Test, the Kahn Intelligence Test (KIT) and the Leiter International Performance Scale (Table 2). The last two tests were designed to provide performance measures of intelligence relatively free of verbal skill. The Leiter Performance Scale, which has been in use for more than 30 years, measures the child's mastery of concepts in a situation where he copies or continues arrangements of blocks made by the examiner. The Kahn Intelligence Test, which is still in experimental form, also measures mastery of basic concepts in a series of age-graded tasks. Both tests provide estimates of intelligence quotient (I.Q.) based upon published performance norms and both show a fairly strong correlation with the Stanford Binet test. The Van Alstyne Picture Vocabulary Test provides an estimate of verbal intelligence based upon the child's ability to point to pictures illustrating different vocabulary items. It was included as an indirect index of variations in the environment of the subjects since other research has shown important relationships between verbal ability and socioeconomic factors. More direct assessment of the child's social environment was obtained through interviews with the mother in the home.

The reaction time group of tests was comprised of three different tasks all conducted with the same apparatus (Figure 1). This device consists of a row of four windows at the top which display pictures of familiar objects when they are lighted, and of four response panels of different colors arranged in a square below. Each window can be lighted independently by the person who conducts the test. Response time is measured electrically from the time a window light is turned on until the child presses the correct panel below to turn it off. Before testing begins, all children are given a trial block of tests which they are told is a game, the purpose of which is to see how fast they are. In the first task, simple reaction time, one of the colored windows is lighted and the child presses that lighted panel below to turn it off. In the second task, disjunctive reaction time, either of two colored windows lights up and the subject presses the lighted panel to turn it off. In the third test, paired associative reaction time, the child must learn to associate each of the colored response panels with one of the stimulus picture windows in the row at the top. When one of the pictures lights up, the child presses response panels until he chooses the correct one which will also light up. This is the only task in this group of tests that involves a significant amount of learning.

The behavioral testing was scheduled separately from nutritional assessment clinics to avoid time conflicts and potentially distracting association of the medical and behavioral examiners. All behavioral tests were conducted by black female adults who had been extensively trained in the use of the tests. The examiners had no information concerning the nutritional status of the children. Pretreatment testing was conducted just before the nutritional intervention program was instituted and post-treatment testing was carried out after approximately five to six months of therapy.

In 1969-70, approximately 700 kindergarten in six schools in the New Orleans Public School System were examined relative to nutritional status and about half of these children were given behavioral tests. The purpose of this research was to study relationships between nutritional status and behavior as well as to determine the effectiveness of dietary and micronutrient intervention.

The experimental design of this study is shown in Table 3. Three kinds of nutritional intervention were devised. Group 1, which included kindergarten children in each of two schools was given the standard class A school lunch, which furnished approximately one-third of the daily Recommended Dietary Allowances (RDA) for most nutrients, and also a breakfast which consisted of milk or orange juice, ceral and sometimes meat. A second group of children in each of two schools received the school lunch only. A third group of children, again in each of two schools, was supplied with micronutrients in amounts approximating one-fourth of the RDA with the exception that 10 mg. of iron was included (Table 4). The micronutrients were prepated in the form of a Nutricube which was dissolved in a fruit-flavored drink. A control group of children in each of the six schools was given four ounces of canned orange juice daily. In the four schools in which breakfast and lunch or lunch only was provided, and in one school in which the Nutricube was supplied, the test children attended morning sessions and the control children afternoon sessions. In the second school that received the Nutricube, the test children attended the afternoon session and the control group the morning session. Behavioral testing was not performed in the schools which received the Nutricube or its control.

The nutritiona findings in this study have been reported previously.( ) Determinations of hemoglobin, hematocrit and Vitami A were carried out in the in the entire sample while transferrin saturation and serum folacin were measured in a subsample which consisted of children with the 10% highest and the 10% lowest hemoglobin values. Initial mean values for all of the tests were essentially the same in the four groups that were studied. Following nutritional int rvention, a significant increase was observed in the group receiving breakfast and lunch in hemoglobin levels when compared with the control group (Table 5). There was also a greater weight gain in the test group although the increase was not statistically significant. In the group that received only lunch, changes were smaller but in the same direction. However, they were not significantly better than the control group.

In the group receiving the micronutrients, serum Vitamin A levels of a number of children moved into an acceptable range, namely, greater than 20 mcg per 100 ml (Table 6) and, in the low hemoglobin subgroup, more children had acceptable transferrin saturation than before supplementation. A significant increase in serum folacin levels was observed.

All treatment and control groups showed an increase in height and weight during the experimental period but there were no significant differences among the groups.

In summary of the above findings, children who received both breakfast and lunch showed more nutritional improvement than did those who received lunch alone. Children who received the Nutricube showed significant improvement only in serum folacin concentration. It seems likely that the Nutricube formula, based on one-fourth of the RDA, was too low to induce other significant changes within the allotted time span.

In studying relationships between iron deficiency and behavior, comparisons were make between subjects with low hemoglobin values and those with acceptable values. Pretreatment data were analyzed first to see if there was an initial relationship between anemia and performance. When the group with hemoglobin levels below 10 gm/dl was compared with the group with levels abouve 11 gm/dl, after matching for age, sex, and family size, significant differences were found. Subjects with the higher hemoglobin levels showed a better performance in the Kahn Intelligence Test, but not in the other tests related to intelligence quotient. In measures of reaction time, a significant difference was found in simple and disjunctive reaction time in subjects in the youngest age group, only, (the lowest third in age), in which slower reaction time was observed in children with low hemoglobin concentrations. No significant pretreatment difference associated with hemoglobin levels was found in performance in the associative reaction time task.

In evaluating the efects of the dietary intervention on performance, comparison was made between the pre and post-treatment findings for the following groups: those who received breakfast and lunch, lunch only, and the control. The only evidence of dietary impact on performance in the intelligence tests was with the KIT. Mean IQ increased by two points in the breakfast and lunch group, one point in the lunch group, and declined slightly in the control group. The usual finding is that IQ gradually declines in this population in the early school years. Accordingly, performance was apparently improved slightly in the groups receiving meals at school.

The simple and disjunctive reaction time tasks showed no differences between groups following nutritional intervention. However, significant effects were noted in the associative reaction time test. (Fiqure 2). The vertical axis shows the mean reaction time in which lower scores indicate better (faster) performance. In the pretreatment phase, all groups showed improvement over trials, but performance was somewhat better in the control group (broken line). After six months of nutritional intervention, all three groups started with faster response times but, with repeated testing, the breakfast and lunch and the lunch groups (solid lines) were significantly faster than the control group. Since the subjects were learning which response panel was associated with each stimulus window in this phase of the test, these results could reflect either differences in learning ability or differences in attentiveness which became greater as the task continued. To assess this, the subjects were given four test trials on all associations after the training phase was over. (Figure 3). The similarity of performance at the beginning of the test does not indicate differences in prior learning but, as testing continued, performance differences emerged in favor of the groups which had received breakfast and lunch or lunch at school. These results suggest that the control children became more fatigued or were less attentive as testing continued.

These findings were supported by the teachers' ratings of the children's behavior at school. The teachers had no knowledge of the nutritional status of the children. They rated anemic children as less attentive, hyper or hypo-active, and less confident in their performance than children with acceptable hemoglobin levels.

A few children who received micronutrient supplementation were tested with the behavioral measures and were found to show less improvement in performance than did the children who received meals at school.

In 1970-71, additional studies were carried out with a slightly different experimental design, (Table 7), which attempted to minimize differences among schools. Approximately

400 children were included in this study. The purpose of this experiment was to examine in more detail the effect of micronutrient intervention on nutritional status and behavior. One group of children received breakfast and lunch, as in the previous study. Two groups of children received micronutrients supplied as a Nutricube in a fruit-flavored drink. The formula for this preparation is shown on Table 8 in comparison with the formula used in 1969-70. The new formula supplies the RDA for all nutrients included, with the exception of iron which furnished 1.5 RDA, plus the essential amino acids lysine and tryptophan. One group of children received the formula as shown, a second group the formula without the amino acids. A fourth group of children received only iron, at the same level as it the Nutricube group, namely, 15 mg of ferrous gluconate. A fifth group of children (the control) was given a flavored drink containing 20 gm of sucrose. The children attended eight schools, both morning and afternoon sessions, with the exception of the breakfast and lunch group in which children attended only morning seesions. Nutritional intervention and control groups were based on classroom assignments in each school, except that it was not possible to have all types of intervention in each school.

Initial nutritional assessment showed mean values for hemoglobin, hematocrit, serum Vitamin A, serum folacin and transferrin saturation to be essentially the same in all groups of children. An unexpected finding was a sharp rise in mean hemoglobin levels from previous studies amounting to about 1 gm/200 ml, which were completed three months earlier. Hematocrit and Vitamin A levels had increased slightly, also. This improvement in nutritional status of the population being investigated hampered the second intervention experiment due to the relatively small number of children with low hemoglobin levels. This decreased the sensitivity of statistical comparison. Nevertheless, some significant intervention effects were observed.

A summary of the changes that occurred in the breakfast and lunch group is shown in Table 9. Mean hemoglobin level showed a small increase whereas the mean hematocrit value decreased slightly. A small increase was noted, also, in the levels of serum Vitamin A, serum folacin and percent saturation of transferrin. There was an increase in the number of subjects with values in the acceptable range for hemoglobin (>11gm/dl), serum Vitamin A (>20ug/dl), and serum folacin (>5ng/ml). None of these changes were statistically significant.

In children who received the Nutricube with the amino acids lysine and tryptophan, an increase in mean hemoglobin concentration was observed and a larger number of individuals had values in the acceptable range. (Table 10). Mean serum levels of Vitamin A and folacin increased significantly and more values were in the acceptable range for both of these vitamins.

Results in the group of children who received the Nutricube without the amino acids are shown in Table 11.

Mean hemoglobin and ..tamin A levels increased but not significantly. However, the increase in levels of serum folacin was statistically significant and a greater number of values were in the acceptable range.

In the children who received only iron (Table 12), mean hemoglobin concentration increased and more values were found in the acceptable range as compared to the control group. A significant increase in serum Vitamin A levels was observed. An interesting finding was a significant decrease in serum folacin levels and a marked decrease in the number of individuals with values for folacin in the acceptable range. This might be a reflection of active hematopoieses when sufficient folacin was not available.

Findings in the control group of children are shown in Table 13. Slight increases in the levels of hemoglobin, Vitamin A, percent transferrin saturation and serum folacin were observed and more values were found in the acceptable range for each of these tests. This nutritional improvement in the control group affected the significance of findings in the test groups.

In summary, no significant changes were noted in the breakfast and lunch group as compated to the controls There was a significant increase in serum Vitamin A in the group that received micronutrients with amino acids and a significant increase in serum folacin in both groups that received micronutrients. A significant increase in serum Vitamin A and decrease in serum folacin was noted in those children who received only iron.

The behavioral measurements indicated that there was a greater improvement in the Van Alstyne IQ test in the control group than in the breakfast and lunch group or the groups that received the Nutricube. In the reaction time tasks, children who received breakfast and lunch showed significantly greater improvement in performance in disjunctive reaction time and in continued trials of associative reaction time than did those in the control group. Children in both Nutricube groups and, also, those who received only iron supplements showed greater improvement than did the control group in these tasks. These findings are more striking when only those subjects with initially low hemoglobin values are considered. Statistical comparisons are weakened, however, by a reduction in sample size.

The results of our studies indicate that there is a relationship between mild levels of nutritional deficiency and performance tasks demanding attentiveness or alertness. Evidence from home interviews showed no strong relationship between hemoglobin levels and traditional indices of socioeconomic status, such as parent's education, male or female head of household, number of children, etc. Some dietary differences were found in association with hemoglobin values. In addition, more of the families of the anemic children participated in the Food Stamp progaam. Since eligibility for this program is based on income, this may indicate that the anemic children came from poorer families, but this evidence is indirect. Even if there is a relationship between social factors and hemoglobin, which might account for some of the observed relationships between hemoglobin and performance, this would not seriously weaken the results of the intervention studies reported here.

CONCLUSION

It is apparent that different types of nutritional supplementation or intervention are capable of producing significant improvement, not only in nutritional status but also in certain behavioral areas. Our results indicate that both dietary and micronutrient supplementation are capable of improving performance in tasks demanding attention. However,,this effect is not observed in all individuals. More detailed analysis of the data is continuing to enable us to identify the characteristics of those subjects who appear to be most influenced by intervention so that the underlying factors responsible for the observed changes can be elucidated. I would like to stress that our data would indicate that providing a breakfast and lunch in the school system showed the largest differences in both nutritional and behavioral measures. However, the supplementation with micronutrients also made significant changes. Unless a significant difference can be shown between these two methods, a tremendous contrast in the relative cost of each method will promote the more economical one.

SUMMARY

The nutritional status of kindergarten children has been studied in relation to performance in behavioral tests and the effects of several types of nutritional intervention on nutriture and behavior have been evaluated. In a study in 1969-70, children who received breakfast and lunch at school showed significant improvement in hemoglobin concentrations. Children who received lunch alone improved but not to an extent that was statistically significant. Children who were given one-fourth of the Recommended Dietary Allowances of certain vitamins and minerals (with 10 mg iron) in a Nutricube were found to have a significant increase in serum folacin and there was an increase in the number of children (with low hemoglobin levels initially) in whom transferrin saturation moved into an acceptable range.

Children with high hemoglobin levels showed better performance in the Kahn Intelligence Test (KIT) and, in the youngest age group, in simple and disjunctive reaction time tests. Improvement in KIT occurred in children who received breakfast and lunch. Similar findings were noted in performance of the associative reaction time test. It was concluded that control children were less attentive or fatigued more readily.

In studies the next year, the nutritional status of kindergarten children was found to be better than in the

previous year. Children who received breakfast and lunch did not improve significantly as compared to the control children who also improved. A significant increase in serum folacin was noted in two groups who received micronutrients (one RDA with 1.5 RDA of iron) in a Nutricube. In one of these groups, a significant increase in serum Vitamin A was observed, also. In children who received 15 mg of iron only, a significant increase in Vitamin A and decrease in folacin in serum were noted.

Children who received breakfast and lunch improved significantly in performance in the disjunctive reaction time and in continued trials of associative reaction time. Improvement was greater in subjects whose initial hemoglobin values were low. These studies indicate a relationship between mild levels of nutrient leficiency and performance tasks demanding attentiveness and alertness.

Nutritional intervention through diet or micronutrient supplementation can improve performance in tasks demanding attentiveness. Micronutrient supplementation through the use of a Nutricube should be a valuable addition to applied health programs in improving nutritional and behavioral status.

REFERENCES

1. Wennick, Myron, et. al. Nutrition and Mental Health Development. Medical Clinics of North America, Vol. 54, 1413, 1970.

2. Nutrition and Development. Edited by Myron Wennick. New York: John Walling and Son, 1972, 49.

3. Smith, J.L. and W.G. Unglaub. The Use of Specific Micronutrient Intervention for Treatment of Malnutrition. J. Ag. and Food Chem. 20:526, 1972.

TABLE 1

NUTRITIONAL ASSESSMENT

Hemoglobin - Packed Cell Volume

Serum Vitamin A - Vitamin C

Serum Protein & Electrophoresis

Serum Cholesterol

Urinary Thiamine, Riboflavin & Creatinine

Height - Weight

Triceps & Subscapular Skinfold

Head Circumference

TABLE 2

BEHAVIORAL MEASURES

Van Alstyne Picture Vocabulary Test

Kahn Intelligence Test (KIT)

Leiter International Performance Scale

Simple Reaction Time

Disjunctive Reaction Time

Paired Associative Reaction Time

FIGURE 1

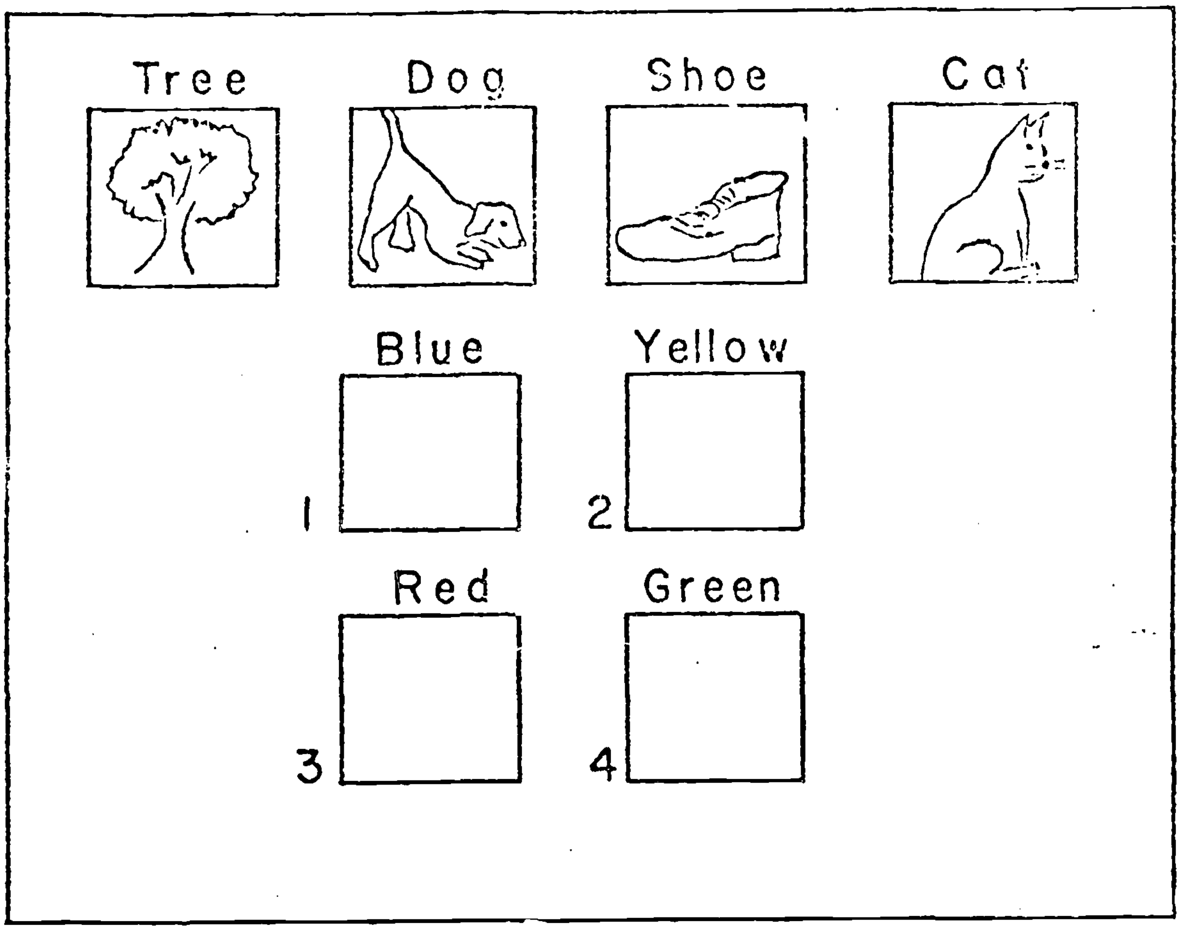


TABLE 3

DESIGN OF STUDY IN 1969-1970

INTERVENTION	NO. CHILDREN
Breakfast & Lunch	129
Lunch	159
Micronutrient - (Nutricube)	88
Snack - Control	330

TABLE 4

NUTRICUBE FORMULA 1969-1970

VITAMIN A, UNITS	825
RIBOFLAVIN, MG.	0.22
PYRIDOXINE, MG.	0.25
FOLIC ACID, MG.	0.05
ASCORBIC ACID, MG.	10.0
CALCIUM, MG.	200.0
PHOSPHORUS, MG.	200.0
IRON, MG.	10.0
L-LYSINE HCl, MG.	170.0
L-TRYPTOPHAN, MG.	70.0

TABLE 5

SUMMARY OF RESULTS OF BREAKFAST-LUNCH GROUP AND CONTROL, 1969-1970

	BREAKFAST-LUNCH		CONTROL	
	Mean Change	Change To Acceptable Range %	Mean Change	Change To Acceptable Range %
Hemoglobin (g/100 ml)	0.33*	12.8	0.19	4.4
Hematocrit (%)	0.16	3.2	1.02*	3.3
Vitamin A (ug/100 ml)	-0.88	-1.0	-1.47	3.4
Transferrin Sat. (Low Hb) (%)	-2.11	-12.5	2.34	25.0
Serum Folacin (Low Hb) (ng/ml)	2.90	12.5**	1.65	20.0

* $p < .01$

** All levels acceptable

TABLE 6

SUMMARY OF RESULTS OF NUTRICUBE GROUP

and CONTROL, 1969-1970

	NUTRICUBE		CONTROL	
	Mean Change	Change To Acceptable Range %	Mean Change	Change To Acceptable Range %
Hemoglobin (g/100 ml)	-0.17	-1.1	-0.12	-5.0
Hematocrit (%)	-0.42	1.1	-0.43	5.1
Vitamin A (ug/100 ml)	4.22	9.3	5.60	6.8
Transferrin Sat. (Low Hb) (%)	1.27	30.7	4.05*	30.0
Serum Folacin (Low Hb)	2.62*	70**	0.42	0.0

* $p < .01$

**All levels acceptable

FIGURE 2

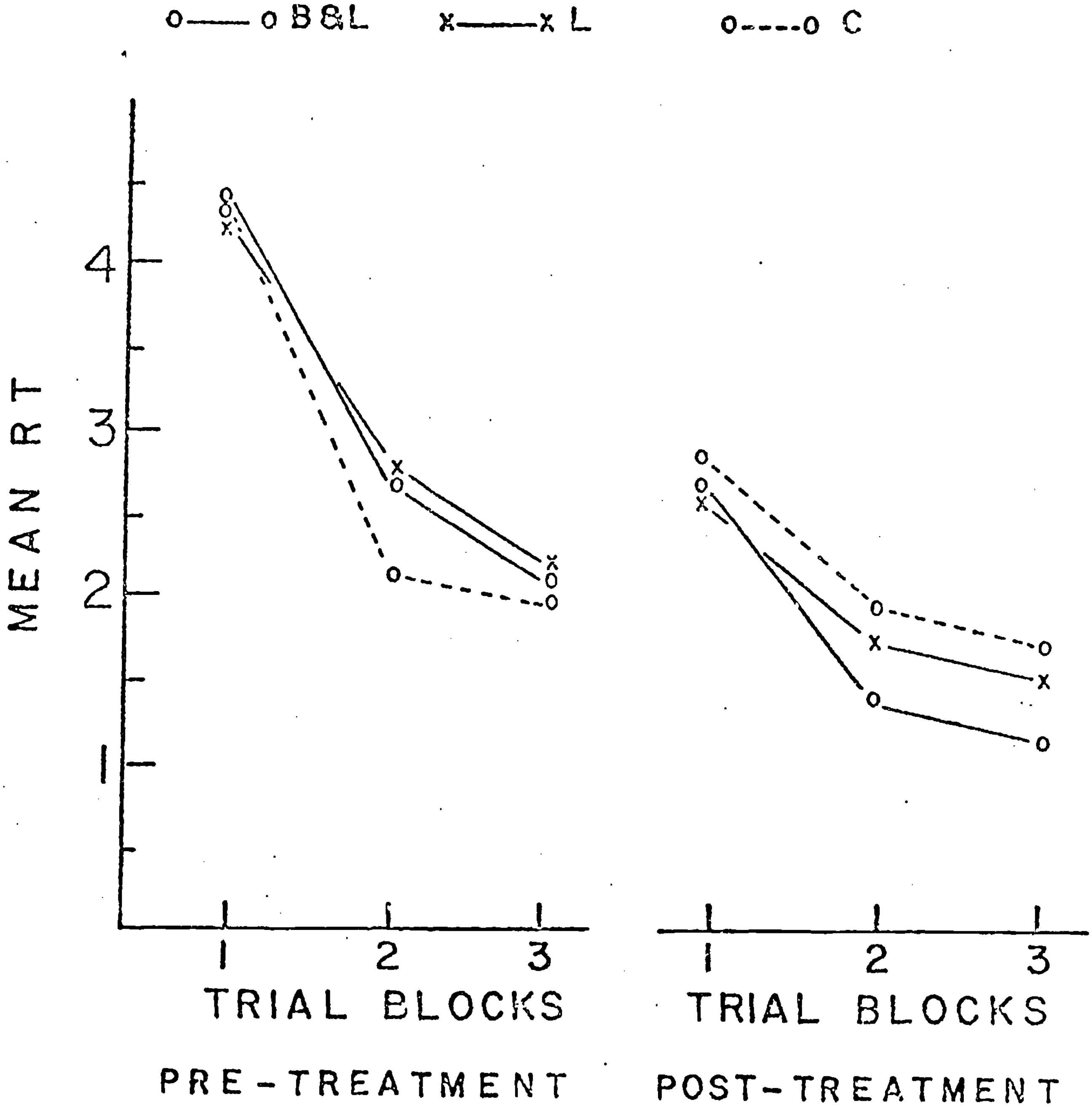
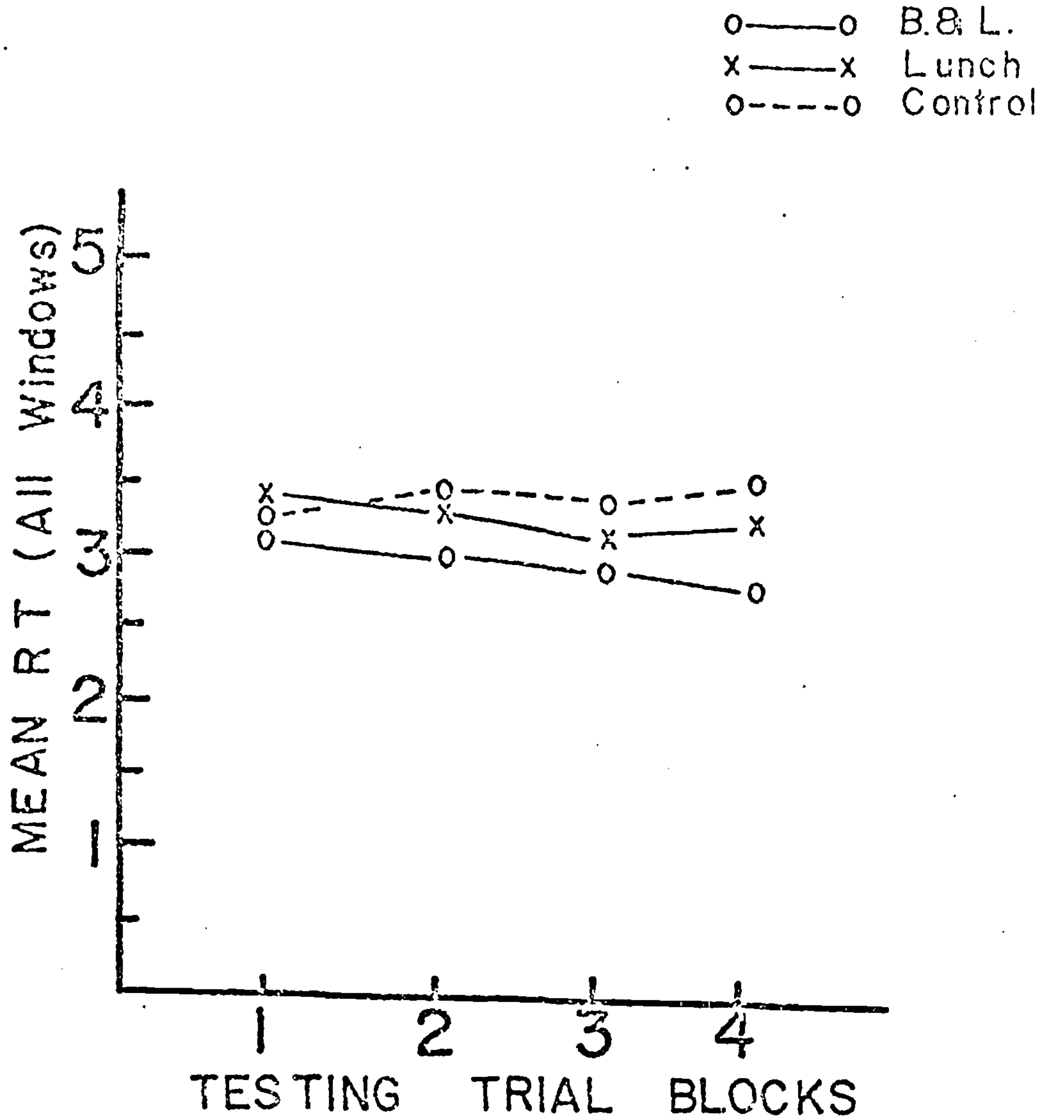

o——o B&L
x——x L
o----o C
MEAN RT
4
3
2
1
1
2
3
TRIAL BLOCKS
PRE-TREATMENT
1
2
3
TRIAL BLOCKS
POST-TREATMENT

FIGURE 3



o——o B.& L.
x——x Lunch
o----o Control
MEAN RT (All Windows)
1
2
3
4
5
1
2
3
4
TESTING TRIAL BLOCKS

TABLE 7

GROUPS OF NEW ORLEANS KINDERGARTEN CHILDREN, 1970-1971

GROUPS	NO. OF CHILDREN	NO. OF SCHOOLS
Breakfast-Lunch	145	3
Nutricube	93	5
Nutricube-A.A.	101	5
Iron	114	6
Control	172	8

TABLE 8

NUTRICUBE FORMULA

	1969-70	1970-71
Vitamin A, units	825	2500
Riboflavin, mg.	0.22	----
Pyridoxine, mg.	0.25	0.9
Folic Acid, mg.	0.05	0.10
Ascorbic Acid, mg.	10.0	20.0
Calcium, mg.	200.0	400.0
Phosphorus, mg.	200.0	----
Iron, mg.	10.0	15.0
L-Lysine HCl,mg.	170.0	170.0
L-Tryptophan, mg.	70.0	70.0

TABLE 9

SUMMARY OF RESULTS IN BREAKFAST-LUNCH GROUP

1970-1971

	MEAN CHANGE	CHANGE TO ACCEPTABLE RANGE %
HEMOGLOBIN (g/100ml)	0.24	3.8
HEMATOCRIT (%)	-0.2	-0.7
VITAMIN A (µg/100ml)	2.2	14.4
TRANSFERRIN SAT. (%)	1.50	0.0
SERUM FOLACIN (ng/ml)	1.43	26.8

TABLE 10

SUMMARY OF RESULTS IN GROUP GIVEN NUTRICUBE WITH AMINO ACIDS

1970-1971

	MEAN CHANGE	CHANGE TO ACCEPTABLE RANGE %
HEMOGLOBIN (g/100ml)	0.47	5.0
HEMATOCRIT (%)	-0.5	0.0
VITAMIN A (μg/100ml)	5.0*	18.1
TRANSFERRIN SAT. (%)	1.72	-5.3
SERUM FOLACIN (ng/ml)	4.78*	39.5

* $p < .01$ Compared to Control

TABLE 11

SUMMARY OF RESULTS IN GROUP GIVEN NUTRICUBE WITHOUT AMINO ACIDS

1970-1971

	MEAN CHANGE	CHANGE TO ACCEPTABLE RANGE %
HEMOGLOBIN (g/100ml)	0.33	1.1
HEMATOCRIT (%)	-0.7	0.0
VITAMIN A (μg/100ml)	2.2	10.3
TRANSFERRIN SAT. (%)	2.66	13.8
SERUM FOLACIN (ng/ml)	4.26*	40.7

* $p < 0.01$ Compared to Control

TABLE 12

SUMMARY OF RESULTS IN GROUP GIVEN IRON

1970-1971

	MEAN CHANGE	CHANGE TO ACCEPTABLE RANGE %
HEMOGLOBIN (g/100ml)	0.45	5.7
HEMATOCRIT (%)	-0.4	1.0
VITAMIN A (ug/100ml)	3.2*	8.6
TRANSFERRIN SAT. (%)	1.95	10.8
SERUM FOLACIN (ng/ml)	-0.74*	-34.2

* $p<.01$ Compared to Control

TABLE 13

SUMMARY OF RESULTS IN CONTROL GROUP

1970-1971

	MEAN CHANGE	CHANGE TO ACCEPTABLE RANGE %
HEMOGLOBIN (g/100ml)	0.33	3.6
HEMATOCRIT (%)	-0.6	-1.4
VITAMIN A (µg/100ml)	0.4	6.1
TRANSFERRIN SAT. (%)	1.13	9.3
SERUM FOLACIN (ng/ml)	0.61	10.1