A STUDY OF THE RELATIONSHIP OF HUMIDITY, TEMPERATURE, AND LIGHT TO THE AFTERNOON SLEEP OF CHILDREN IN THE MICHIGAN STATE COLLEGE NURSERY SCHOOL

Thesis for the Degree of M. S.
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Helen Elizabeth Campbell

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THESIS

This is to certify that the

thesis entitled

A STUDY OF THE RELATIONSHIP OF HUMIDITY, TEMPERATURE, AND LIGHT TO THE AFTERNOON SLEEP OF THE CHILDREN IN THE MICHIGAN STATE COLLEGE NURSERY SCHOOL

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has been accepted towards fulfillment
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Shirley Newsom
Major professor

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CHAPTER I

INTRODUCTION

When young children stay at a nursery school or child care center for a longer period of time than two or three hours, it is necessary to plan facilities for sleeping. Very few nursery schools have space enough to provide each child with a separate room for sleeping, therefore most of them arrange for a group nap situation. Nursery school naps tend to be shorter than naps at home, according to Foster (9), although some children revive the nap habit which has been dropped at home.

Authorities advise that fresh air, cool temperature, and comparative quiet are important factors in putting children to sleep. For example, Rose Alschuler (1, page 67) tells us that:

> "Shades should be drawn so that light is subdued. Good ventilation without draft is important..... The temperature of the sleeping room should be between fifty and sixty degrees. Individual cots should be placed sufficiently far apart so that one child cannot touch the bed of another. Light but warm blankets are desirable."

In most nursery schools, the actual practice varies considerably from the suggested measures. Some rooms for sleeping are difficult to darken satisfactorily. Those schools using canvas cots find it necessary to maintain a

higher temperature than that advised. In many cases the space is too limited to place the cots the desired distance apart and therefore screens are used between the cots to reduce the social and visual influences. Canvas cots, because of ease of storage, are used in nursery schools that have to use the nap room for other purposes, but some have small beds with mattresses.

With many factors influencing group naps, it is very difficult to determine which ones are important in giving optimum conditions for sleep. Previous studies give information as to positions and motility during sleep, the influences of group nap versus sleeping in rooms alone, the effect of food on sleep, and age in relation to sleep duration. It is the purpose of this study to investigate the relationship of temperature, humidity and light in the sleeping room to the duration of presleep[1]. and afternoon nap of young children.

1. Throughout this study the term "presleep" refers to the interval elapsing from the time the child gets into bed until he falls asleep.

CHAPTER II

REVIEW OF THE LITERATURE

General Findings

Children's sleep has long been an object of concern among parents, pediatricians, and authorities on child care. Since it is such an important factor in the health and well-being of an individual, a number of studies have been made to investigate the function of children's sleep and the factors involved. For many years authorities have been advancing theories on the various aspects of children's sleep, but it has been only during the last twenty-five years that careful studies have been made of the sleep of preschool children in order to check the validity of these recommendations.

Several methods of investigation have been used, one of which is the analysis of records kept by parents. This method enables investigators to study large numbers of children in their regular sleep situation, but has the disadvantage of possible inaccuracies because of the dependance upon untrained observers. Another way of securing data on sleep is by direct observation of children in either of two situations, one being a twenty-four hour child care institution and the other the afternoon nap in nursery schools or child care centers where the children attend

during a six to eight hour day. Since group care of normal young children in a twenty-four hour institution is decreasing, most studies have dealt with the afternoon sleep in nursery schools. While both of these situations permit observation by trained observers and some control of the variables, the number of children that can be studied is limited. There is the advantage of observing children in a group sleeping situation, thus enabling the study of the effects of the children upon each other. The findings of studies on this aspect would be of little value to parents but are of real interest to nursery school teachers who conduct group naps.

Some phases of children's sleep that have been studied include the duration of sleep (both day and night); length of presleep; factors affecting sleep such as age of the children, sex differences, intelligence, routine habits of the children, and such environmental influences as the number of children in the room, teachers in charge, temperature, humidity and light, all of which may affect sleep in varying degrees. A large number of studies have been made of these various factors, but conclusive information about some of them is yet to be obtained.

Findings on Total Sleep

A number of early studies have compared the recommendations of authorities regarding the amount of sleep needed

by children at various age levels with the amount actually taken by them. Quoting authorities at the time of their study (1928), Anderson, Foster and Goodenough (2 p.202) said:

> "Between the ages of two and three, various standards given are: fourteen hours (McCarthy), fourteen (Reed), twelve (Lucas),..... Between the ages of three and four McCarthy recommends thirteen hours, Lucas twelve, Reed fourteen. Between the ages of four and five the standards given are: twelve to thirteen hours at night and half an hour to one hour in the daytime (McCarthy), eleven hours (Lucas), and thirteen hours (Reed)."
>
> "It appears obvious that the mother who desires to rear her child according to scientific methods will find it very difficult to resolve these conflicting standards into any sort of useful guide."

Langdon (13), writing in 1931, said that a child from two to three years of age should have fourteen to sixteen hours of sleep out of twenty-four, and a child three to five years of age needs between 11 to 14 hours of sleep.

An early study done by Ravenhill (1908) which might have been available to these authorities would have influenced their conclusions. This study, quoted by Kleitman (12), was done in England and involved 6,000 children from three to thirteen years of age. It was found that the average sleep for three to five year olds was about eleven hours which is less than the findings of some more recent studies.

Erwin (7), whose study was published in 1934 analysed records kept by parents and found the daily sleep average of two to five year olds to be 12 hours and six minutes. Reynolds and Mallay (17), studying the children whose mothers were attending the Euthenics Institute at Vassar, found that two to five year olds slept about eleven hours and thirty-six minutes. In this study, observers recorded day sleep and the mothers kept records of the night sleep in the dormitories where they slept with their children. The findings from all of these studies showed on the average that children were not receiving the amount of sleep that was recommended for them by the early authorities. At the present time studies have changed the opinions of authorities and recommendations are more in keeping with the amounts of sleep actually taken by children.

Duration of the Afternoon Nap

Quite a number of studies have investigated the length of the afternoon nap in nursery schools. A variation of almost a full hour within one age grouping is seen when examining the data reported by the different authors. A summary of these findings is given in Table I.

Probably many factors caused the differences in these figures, one of which may have been the routine schedule in the nursery schools where some of the children may have been wakened to go home, thus limiting the total afternoon sleep picture.

Table I

AFTERNOON SLEEP IN MINUTES
(Ranked in order of duration)

INVESTIGATOR	NUMBER OF CHILDREN	YEARS OF AGE 2 - 5	2½ - 5	2 - 3½
Shinn (Honolulu)	79	52.7		
Chant and Blatz	13	65.0		
Shinn (Vassar)	27	72.27		
Dales	128	73.3		
Scott	27	73.5		
Reynolds	77	74.3		
Beckman	18		74.4	
Staples	30		75.8	
Boynton and Goodenough	56	79		
Sherman	22			89.0
Wagner	30	97.6		
Flemming	78	114.9		

Presleep for the Afternoon Nap

Most studies of the afternoon sleep of children included a record of the length of time required to go to sleep. The data reported by these investigators varies in a range of about fifteen minutes which is reasonable considering the differences in the conditions under which these studies were done. A summary of these findings is given in Table II.

In Reynold's study (16) it was found that all of the children required more time to go to sleep than the twenty minute time limit set by the authorities of that time. The fallacy of this time limit is easily seen upon examining the figures quoted in the studies, all of which exceed the twenty minute time limit in their averages.

Table II

AFTERNOON PRESLEEP IN MINUTES
(Ranked in order of Duration)

INVESTIGATOR	NUMBER OF CHILDREN	YEARS OF AGE 2 - 5	YEARS OF AGE 2½ - 5
Wagner	30	24.14	
Staples	30		29.6
Beckman	18		29.6
Shinn (Honolulu)	79	31.0	
Reynolds	77	33.0	
Boynton and Goodenough	56	34.8	
Shinn (Vassar)	27	36.8	
Scott	27	38.2	

Scott (18), studying the afternoon sleeping habits of twenty seven children at Vassar College Nursery School, found no significant relationship between presleep and length of nap. This is in agreement with the findings of Beckman (3) and Chant and Blatz (5).

Presleep at Night

A few studies have considered the presleep time at night. In general the results indicated that most children take longer to go to sleep at night than they do in the afternoon. The night presleep of Reynold's (16) two to five-year olds averaged one hour as compared to the half-hour presleep at nap. Shinn(20) reported a range of presleep at night of 25 to 75 minutes at Vassar, and 5 to 25 at Honolulu as compared with nap figures of 25 to 45 and 15 to 45 respectively. Wagner recorded presleep at night to be 43.9 minutes to 118.6 minutes as compared with 30 minutes in the afternoon.

Factors Influencing Sleep

Among the many factors believed to be directly related to the sleep of children that have been studied are the individual factors such as age, sex, intelligence, and habits of the child. Another group of factors thought to be influences on sleep are the daily routines, for example, the amount and kind of food eaten, the length of sleep at night as well as in the daytime, and the type of activity in which the child engages.

Then, too, some environmental factors which may enter in are the number of children in the nap room, or the atmospheric conditions such as temperature, humidity and light.

Studies have been done on most of these factors and the findings are conclusive in varying degrees.

Individual Sleep Patterns

Research on sleep reveals that most children have a regular sleep pattern though it may be recognizable only over a period of several days. Giddings (11), studying older children between the ages of nine and fourteen, found that children have a definite sleep pattern rarely disturbed except through illness. Reynolds (16) reported that the amount of sleep taken by preschool children varies considerably from day to day, but there is a fairly constant average over several weeks' time.

> "The data pointed to the conclusion that over a longer period of time than 24 hours, most of the children maintained an acceptable consistency in the amount of sleep they took.. Daily fluctuations (in amount of sleep) were great, but weekly, biweekly, and triweekly averages were in close agreement." (16,p.349)

Age as a factor in presleep and sleep. Practically all investigators have noted a change in the amount of sleep taken by children as they grow older. The studies by Anderson, Foster and Goodenough (2), Dales (6), Erwin (7), Chant and Blatz (5) and others concluded that the total sleep actually taken by children decreases with advancing age. The decrease in the amount of sleep from thirteen or fourteen hours in the second year to twelve in the fifth

year is due mainly to the shortening, and later abandonment of the afternoon nap, according to Anderson, Foster, and Goodenough (2). Reynolds and Mallay (17) said the results of their study indicate that both night sleep and nap were responsible for the decrease in total sleep, not merely the nap alone. Chant and Blatz (5) and Flemming (quoted by Kleitman - 12) noted that afternoon naps decrease to one hour and then drop out on the all or none principle as the age of the child increased. The studies of Shinn (20) and that of Reynolds and Mallay (17) are in agreement with these findings.

There have been very few studies done of presleep as it is influenced by age. Dales (6), studying afternoon sleep, reported that there is an increase in presleep as age increases. White (25), who studied presleep at night, found that two to three year olds required an average of twenty-seven minutes to go to sleep and that three to four year olds went to sleep, on the average, within twenty minutes. Shinn (20) concluded from her findings that the mean time to go to sleep at nap does not show any tendency to increase or decrease during the preschool period.

Sex differences in children's sleep. It has long been felt that there are sex differences in the sleep habits of young children, but results of studies on this point are not

conclusive. Garvey's (10) study of children in the University of Minnesota Nursery School showed that boys went to sleep more promptly and slept more quietly than girls. McCoy and Fowler (14) found no sex differences in the time to go to sleep, but did find that girls slept longer than boys. Scott (18) also found no marked differences between boys and girls in the time they required to go to sleep. Anderson, Foster and Goodenough (2), Chant and Blatz (5), and Flemming (quoted by Kleitman - 12) found very slight sex differences at the preschool age level. Erwin (7) also found slight sex differences showing a tendency toward longer sleep for girls.

The relationship of total sleep to intelligence. According to White (25) preschool children with higher intelligence quotients slept less than children with lower I.Q.s. Shinn's (20) study of the two groups of children of the same age, 30 at Vassar College and 136 in Honolulu, showed that the Vassar children slept less, and their mental age was higher. She felt that the higher intelligence may have been a factor in the shorter sleep. Wagner (24) found a negative correlation between mental age and total sleep, which she felt indicated that the decrease in the amount of sleep as the child grows older depends more upon the increase in mental age than upon the increase in chronological age. Kleitman (12) says that a negative correlation between intelligence quotient

and total sleep is not true of older children.

Postural habits during sleep. Some work has been done on the study of postural habits of children while sleeping. Beckman's (3) findings agreed with Boynton and Goodenough (2). They found that children whose positions during presleep were most uniform tended to go to sleep more quickly. Kleitman (12) stated that young children are less completely relaxed while asleep than older children, but did not give any age range to clarify the limits of his statement. Sherman (19) reported that an habitual thumb-sucker cannot go to sleep unless his thumb is in his mouth.

Variations in the Daily Routine Which Influence Sleep

Most persons feel that the quantity and quality of their sleep is directly influenced by their activities during their waking hours. Many of these influencing factors are not known, but among those recognized are the effects of routine habits. Children as well as adults respond differently when their routine is disrupted by changes in meal time or place, and in bed time or place.

Relatively few attempts have been made to study these influences on the sleep of preschool children. Findings pertaining to these variables in relation to sleep are reported in the following paragraphs.

Relationship of night sleep to day sleep. Few investigators have had the advantage of a twenty-four hour nursery school situation in which to study the night sleep in relation to the day sleep of children. Among those who did, Wagner (24) found that in the majority of cases there was a tendency for a longer nap to be followed by a shorter night sleep, or the shorter afternoon sleep to be followed by a longer night sleep.

Erwin (7), using records made by parents, said that children who slept relatively long in the daytime, slept relatively long at night. Chant and Blatz (5) are of the opinion that the afternoon nap reinforces the night sleep in early years of life, but later interferes with it. Anderson, Foster and Goodenough (2), reported a slight negative correlation between the length of the nap and the amount of night sleep taken by two to five year olds. Below two years the correlation was zero. Anderson, Foster, and Goodenough (2, page 214) say:

> ".....the slight tendency toward longer night sleep in the case of children who sleep little during the day is not sufficiently marked to compensate for the loss of the day nap. In practically every instance there is a regular falling off in the total amount of sleep with decrease in the amount of sleep during the day".

The influence of play activities. How much does the variation and amount of the day's activities affect the

total sleep pattern? Several investigators have studied the influence of outdoor activities on the length of the afternoon nap of preschool children. According to Sherman (19) there was no marked influence of the intensity of outdoor play on the amount or character of the nap. After indoor play, however, the children went to sleep more quickly and slept longer than after outdoor play. According to this study a direct relationship between the length of the presleep period and the intensity of the morning activity appeared. That is, the less the degree of activity the more quickly the child fell asleep. Staples (22) found little or no relationship between outdoor play and nap.

The effect of food eaten before sleep. The effect of food eaten on the sleep of children is rather difficult to measure. Staples (22), using calories consumed during the meal in relation to sleep, found that there was little if any interrelationship between the noon meal and the nap or presleep time. Giddings (11) reports in his study of older children that a heavy night meal produced restlessness in the night sleep, and that warm milk taken at bed time resulted in quiet sleep. Also, a beverage containing three-fifths of a grain of caffiene taken at bedtime caused no more restlessness than did orange juice.

Environmental Factors Influencing Sleep

There are very few studies on the environmental factors which influence the sleep of children. The one upon which most study has been done is the effect of the number of children in the naproom on the sleep and the number of naps taken. Another group of influences which have been studied are the atmospheric variables which are rather hard to measure and control.

Number of children in the room. A considerable number of studies have been done on the influence of the number of children in the sleeping room. Reynolds and Mallay (17) found that it required nursery school children about the same length of time to fall asleep in a group nap as when they slept in rooms by themselves; and that more naps were taken when there were several children in the same room. However, the mean length of nap was greater when a child slept in a room by himself. Among younger children, the optimum situation for sleep is in a room with other children according to Erwin's (7) findings. Dales (6) recorded that whether children slept in a room with others or alone had little or no effect on the afternoon sleep.

It is believed by the writer that the fact of adult supervision in the nap, together with the type of rapport maintained by the teacher in charge of the nap room, have considerable influence when children sleep in a group and

may account for the variation in these findings. Staples (22, p.227) states that:

> "The particular adult in charge of the children during the afternoon nap may influence both the length of time required by the children to go to sleep and the number of naps missed."

Temperature, humidity and seasonal variations. Relatively few studies have considered temperature and humidity in relation to sleep. Garvey (10) studied eight girls and fourteen boys between the ages of two and five years by means of kinetographs which recorded the motility of the children during sleep. The children slept in standardized beds in their own homes. The findings stated that room temperature read at the child's bedtime showed no relationship to the quietness of sleep. Renshaw, Marquis and Miller (15) studied 107 children, ages six to sixteen, at the Ohio Bureau of Juvenile Research. The beds were equipped with hypnographs to record the movements of the children during sleep. Although this study investigated many phases of children's sleep, the ones most pertinent here are the findings on the hourly motility in relation to temperature and humidity. They concluded that even within wide limits, temperature and relative humidity were not important factors in influencing hourly motility.

Scott (18) recorded the temperature of the nap room and found little significant relation of temperature to

presleep or total nap time. The range of temperature in Scott's study was 68.5° F. to 82.5° F. Boynton (4), studying the nap of nursery school children, found that extremes of room temperature were unfavorable for the continuity of sleep although the tendency was for longer sleep on cooler days.

Shinn (21) found that variations in humidity did not influence the sleep of the children she observed. The humidity readings for this study were not made in the nap room, but were the readings taken by the weather bureau in New York City, 72 miles from Vassar College where the experiment was conducted.

Related to humidity and temperature are the studies done on seasonal variations and their effect on sleep. Dales (6) found little or no influence of seasonal variation on the duration of afternoon sleep. On the other hand, Erwin (7) found that night sleep was longer in fall and winter.

At the time of this study the writer was unable to find reports of any studies having been done on the relationship of light intensity in the room to presleep and total sleep either in the afternoon or night sleep or preschool children.

CHAPTER III

PROCEDURE

The subjects used in this study were the children of the younger group in attendance at the Michigan State College Nursery School during the fall term of 1946. At the beginning of the period studied, the ages of the six boys ranged from two years three and one-half months to three years seven months, and the ages of the six girls ranged from two years ten months to three years six months.

Although none of the studies of the nursery school nap situation previously reviewed gave any clue as to how long a period was allowed for the children in the study to become accustomed to their cots and to the nap routine, Renshaw, Marquis, and Miller (15) in their study of the night sleep of older children stated that five nights were required for the children to adjust to their sleeping conditions. The actual recordings of the present study were begun during the fourth week of the nursery school so that these children were well accustomed to the nap procedure. Even those who had been absent for a time had at least ten days in the nursery school nap routine before the actual readings began.

The conditions under which this study was made were controlled only to the extent of establishing an optimum

sleeping environment in accordance with the recommendations of persons experienced in conducting a group nap situation. The variables of temperature, humidity, and light fluctuated as the weather conditions influenced them.

Description of the Nap Situation

The room used for the afternoon nap in the nursery school was a playroom used by the four and five year olds in the morning and adapted for sleeping in the afternoon for the younger children by moving the toys to one corner and surrounding them with screens. Moveable wooden screens were used to separate the cots, which were arranged in a hollow square about the room. The cots consisted of a wooden frame over which a canvas was stretched and held in place by lacings. Each child used the same cot, placed in the same location in the room, every day throughout the study. The blankets used were furnished by the parents, and although they were not uniform for all the children, that used by each child was the same throughout the study.

The tan treated-fabric shades in the room were drawn at nap time, admitting a dim diffused daylight, the intensity of which varied according to the weather conditions outside. One-half hour before nap began, the room was aired by opening the windows. The windows that remained open during the nap period had glass screens to direct the air upward into the room, thus preventing drafts on the children.

The personnel in the nap room was the same throughout the study. Occasionally when a child needed special attention an assistant sat near him to help him to relax, but at all other times the experimenter was the only adult in the room. She made readings of the instruments and recorded all of the necessary data with the exception of the time the children awakened on Tuesdays and Thursdays when the experimenter had to be absent after two o'clock. On those days the assistant recorded the time of the children's awakening.

Preparation for the Nap

In preparing for nap the children came upstairs from the dining room and went directly to the bathroom where they went to the toilet, rinsed their hands, and removed their outer clothing down to their undershirts and panties. Shoes and socks were removed and bedroom slippers were worn to the nap room. When ready for bed the children entered the nap room quietly, went to their cots, removed their slippers and were covered by the assistant if they were unable to cover themselves without too much commotion. They came to the nap room as they were ready, and by one o'clock all of them were on their cots.

The Preliminary Study

For one week preceding the study, recordings were made to standardize the technique in handling the instruments.

All of the readings were begun at 12:30 and the last readings were made at 2:00 o'clock.

The dry bulb thermometer on the sling psychrometer was used for the temperature readings. This reading was taken at the level of the children's heads in the same central location in the room each day. During the preliminary study, readings were taken at ten and fifteen minute intervals and it was found that in the period of one and one-half hours the temperature did not vary more than two degrees. The average of the records taken at fifteen-minute intervals equaled the averages taken at the ten-minute intervals. Since these preliminary readings varied so little, two temperature readings were made during the actual study, one at 12:30 and one at 2:00 o'clock. If these differed, an average of the two was taken.

The humidity readings were made by the use of a sling psychrometer, and the readings were then interpreted for relative humidity from a Bulkley Psychometric chart. During the preliminary study these readings were taken at 30 minute intervals, rather than more frequently, because the operation of the instrument required considerable movement (it was necessary to whirl it for five minutes to insure accurate reading). Since no variation in relative humidity during the nap period was noted in the week of preliminary recording, only one humidity reading per day was felt to be necessary.

This was taken at 1:30 after most of the children were asleep and in a section of the room screened from view.

A Weston Illumination meter model 603 was used to take the reading of the light intensity. The readings were taken with the sensitized plates of the meter turned to the optimum source of light, the windows on the south side of the room. The meter was located in the approximate center of the room at about the level of the children's heads. In testing it was found that the light intensity in the different areas of the room varied as much as one foot-candle from one place to another. However, the light intensity in these different areas in the room was relative to the trial at the central location. As the light varied in the central location, the variation in the other areas was in direct relationship. Care was taken to see that readings were made in the same place every day. In comparing the averages of readings made at ten and fifteen minute time intervals a variation of 0.08 foot-candles was noted. Therefore the light meter readings were made at fifteen minute intervals throughout the study, and the average of these readings was used as the light reading for the day.

Record Keeping

The time in bed, time asleep and time awake were recorded daily for each child for a period of 34 days. All of the time records were made to the nearest five minute interval

because it was impossible to determine the exact minute that a child fell asleep or awakened. The criterion for sleep was the same used by all of the experimenters in previous studies, namely: eyes closed, cessation of body movement, and slow even breathing.

Daily records of temperature, humidity and light were made as previously described. Notations of the amount of night sleep, as reported by the mother on the child's daily report from home, amount of outdoor play and weather conditions during the morning activity, any unusual occurrences during nap or during the day which might have influenced the nap were also recorded each day.

Statistical Method

The statistical method chosen for dealing with the data in this thesis problem is that of analysis of variance and covariance.

The data were recorded on charts (See Appendix A and B) and then sorted by means of evaluating the record according to the factors considered in the notation column on chart B. For example, on some days a child may have had a normal presleep, but his afternoon sleep was interrupted by sudden waking due to coughing, enuresis, loud noise or another uncontrollable factor. Therefore the presleep record was retained but the total sleep record was not retained for that

day. Occasionally a child was removed from the room because he was disturbing the others and then later returned to his cot, thus disrupting his presleep. His afternoon sleep was recorded unless it was felt that the incident disrupted both presleep and afternoon sleep, then both records were discarded.

When the data were assembled, the variables of temperature, humidity, and light were the y's and these were correlated against the x's of presleep and afternoon sleep.

In a group nap situation there is seen a considerable difference between individuals in the way in which they respond. This difference between children is a disturbing factor and should be eliminated. To prove the significance of these factors an initial analysis of variance was made of the presleep and afternoon sleep records. Snedecor's (21) F test was used. (See Table III.)

TABLE III

INITIAL ANALYSIS OF VARIANCE

Presleep

	D.F.	Σ^2	M.S.
Between Children	11	6,162.92	560.265
Within Children	300	5,353.75	17.845

$F = 31.39^{**}$

Total Afternoon Sleep

	D.F.	Σ^2	M.S.
Between Children	11	5,892.7	535.7
Within Children	299	8,643.7	28.91

$F = 18.53^{**}$

We assume for each child that some relationship exists between sleep and the variable considered. However, individual defferences are so great that the relationship is clouded. Therefore, the analysis of covariance is used to remove the individual differences and obtain the "average" correlation of the group's response to the variable. Table IV shows the interrelationship of the formula used.

TABLE IV

ANALYSIS OF COVARIANCE

	Σx^2	Σxy	Σy^2	r
A	Entire Group	$\Sigma x'^2 - \frac{(\Sigma x')^2}{\Sigma n}$	$\Sigma xy' - \frac{(\Sigma x)(\Sigma y)}{\Sigma n}$	$\Sigma y'^2 - \frac{(\Sigma y)^2}{\Sigma n}$	$\frac{\Sigma x'y'}{\sqrt{(\Sigma x'^2)(\Sigma y'^2)}}$
B	Between Children	$\frac{(\Sigma x_1')^2}{n_1} + \frac{(\Sigma x_2')^2}{n_2} + \cdots - \frac{(\Sigma x_{1,2}')^2}{n_{1,2}} - \frac{(\Sigma x')^2}{\Sigma n}$	$\frac{\Sigma x_1'y_1'}{n_1} + \frac{\Sigma x_2'y_2'}{n_2} + \cdots - \frac{(\Sigma x')(\Sigma y')}{\Sigma n} - \frac{(\Sigma x_{1,2}'y_{1,2}')^2}{n_{1,2}} - \frac{(\Sigma y')^2}{\Sigma n}$	$\frac{(\Sigma y_1')^2}{n_1} + \frac{(\Sigma y_2')^2}{n_2} + \cdots - \frac{(\Sigma y_{1,2}')^2}{n_{1,2}} - \frac{(\Sigma y')^2}{\Sigma n}$	
C	Within Children	difference of above	difference of above	difference of above	$\frac{\Sigma x'y'}{\sqrt{(\Sigma x'^2)(\Sigma y'^2)}}$

First the entire group was correlated, taking each child in relation of one of the variables. This gave 311 readings for the duration of the nap and 310 for presleep after eliminating the absences. The formulae in blocks A show the way in which the figures were computed.

The next procedure was to compute the variances and covariances due to differences between children, that is, as child one differed from child two and three, etc. These

were then subtracted from those of the total group (A - B = C) and the figures which remained represented the average individual's reaction to the variable under consideration. This is known as the variance and covariance "within children" eliminating the effect of individual differences. The correlation coefficient was computed by substituting the data in blocks C for r.

The significance for the correlation coefficient was interpreted from the table in Snedecor. (21, p.149)

CHAPTER IV

THE RESULTS OF THE STUDY

The findings of this study, the purpose of which was to investigate the interrelationships of presleep and afternoon sleep with temperature, humidity and light, are summarized in the following chapter. In addition to the findings on these interrelationships, there are some interesting comparisons and observations that can be gleaned from the data.

The average presleep of the group of actual sleepers during the period of the study was 31.47 minutes, which seems to be in line with the averages of others who studied children's sleep. Although the averages from other studies varied from 24.14 to 38.2 minutes, all of them, including the present study, found the twenty minute norm suggested by some writers to be exceeded. See table II, page 8 which gives the summary of the findings of the other studies.

Dales' study was the only one which considered presleep in relation to the day of the week. Table V. shows how the results of the present study compare with those of Dales.

Table V

PRESLEEP AVERAGES FOR EACH DAY OF THE WEEK

	Present Study	Dales
Monday	34.32	30.1
Tuesday	31.11	
Wednesday	32.67	
Thursday	29.43	
Friday	29.24	30.5

The longest presleep fell on Monday which was in keeping with the beliefs of others who feel that it is difficult to get children back into the routine of nursery school after a weekend at home. The fact that Fridays had the shortest presleep also bears out the reasoning that by Friday the children have become accustomed to the routine.

It appeared to the writer that most of the children observed in this study had a certain position in which they fell asleep, and it has been her experience that encouraging a child to assume this position after getting into bed promoted his going to sleep in a relatively short time. This observation is in agreement with the findings of Boynton and Goodenough (2). It was also noted that one of the children had such a regular sleep pattern that, regardless of other influences or variations in environment or routine, he fell asleep regularly within fifteen minutes after getting into bed, and always slept at least sixty minutes. This indicates that sleep pattern may be a definite influence on the sleep of some individuals, outweighing the effect of other variables.

The afternoon sleep average for the actual sleepers of the group was 76.03 minutes. Averages given by other investigators vary from 52.7 to 114.9 for two to five year olds. Dales (6), and Beckman (3) whose studies were done under circumstances similar to those of the present study

found the average afternoon sleep for their 2½ to 3½ year olds to be 77.3 and 78.2 respectively. Anderson, Foster and Goodenough (2), and Flemming (quoted in Kleitman - 12) who relied upon parents' records for their data, gave averages, for 2½ to 3½ year olds, of 109.4 and 131 minutes respectively. These children were sleeping in their own beds at home, had less adjustment to the environment to make than those who slept at nursery school, and thus slept longer.

It is believed that the children in this study slept as long as they wanted to except in a very few cases when a child had to be wakened to go home. Those children who had been awakened at three o'clock to go home were usually ones who fell asleep late in the nap period. Those whose presleep was relatively short usually awakened of their own accord before three o'clock.

In comparing the averages of each day of the week there did not seem to be any consistent relationship of length of nap to the day of the week. See Table VI. In this study there did seem to be a tendency toward longer sleep on Thursdays, as is the case in the study of Chant and Blatz (5), and that of Scott, all of whom found Fridays to have a lower sleep average than Thursdays. Dales (16) found no significant difference in the duration of the afternoon sleep on Mondays and Fridays. Chant and Blatz (5)

pointed out the importance of individual differences in relation to day to day variation.

Table VI

AFTERNOON SLEEP AVERAGES (IN MINUTES) OF EACH DAY OF THE WEEK

	Present Study	Scott	Dales	Chant and Blatz
Mondays	71.44	74	74.4	62
Tuesdays	76.66	75		67
Wednesdays	70.98	75		67
Thursdays	84.43	75		65
Fridays	78.47	73	73.06	64

Although records of the total night sleep of each child were kept, the data were not considered reliable enough to use because many of the parents recorded the time in bed but failed to observe the time the child fell asleep. In the nap records of the children who made up this group a wide range of individual response was apparent. These individual differences are shown in Table VII. Presleep averages varied from 11.5 to 43.3 minutes, and afternoon sleep averages varied from 58.3 to 95.0 minutes.

Table VII

THE SLEEP AVERAGES OF EACH CHILD RECORDED IN MINUTES

Child	Age	Average Presleep	Average Total Nap
Eddie E.	3 yr. 7 mo.	31.7	56.7
Sandy S.	3 yr. 6 mo.	39.6	80.1
Rosalind T.	3 yr. 5 mo.	43.3	65.4
Linda D.	3 yr. 3 mo.	33.1	87.7
Kenny C.	3 yr. 3 mo.	42.6	91.6
Teddy P.	3 yr. 1 mo.	40.0	86.6
Beth B.	3 yr. 1 mo.	31.7	68.6
Libby A.	2 yr. 11 mo.	27.0	69.6
Thomas R.	2 yr. 10 mo.	25.7	89.3
Julie B.	2 yr. 10 mo.	31.4	58.3
John C.	2 yr. 5 mo.	40.9	74.4
Albert R.	2 yr. 3 mo.	11.5	95.0

The six boys of the group had a shorter presleep and a longer nap than the six girls during the time of the study, the averages for the boys being 32.6 minutes presleep and 82.27 minutes nap, and for the girls 34.35 minutes presleep and 71.6 minutes nap. Scott (18) found no marked sex differences in presleep time. In McCay and Fowler's (14) study of night sleep the girls were found to sleep longer than the boys. The figures for the present study can not be considered conclusive as showing a sex difference because the number of children studied was so limited.

The findings indicated a relationship between the length of presleep or duration of nap and some of the variables studied. Table VIII gives a complete summary of these findings.

Presleep correlated with temperature gave a coefficient of 0.071 which failed to indicate a relationship within the temperature range of 69° to 79° F. When temperature was correlated with afternoon sleep it gave a coefficient of 0.027 again showing no relationship. These findings are in agreement with those of Shinn (20), whose temperature range was comparable (66° to 82.5° F. at Vassar, and 74° to 80° F. at Honolulu). Boynton and Goodenough (2) stated that extremely low and extremely high temperature were alike unfavorable for the duration of sleep. The

temperature range for their study was 54° to 58° F.

During the period of this study the relative humidity in the nap room ranged from 26 per cent to 60 per cent. The negative correlation of -0.106 found between presleep and relative humidity was not significant, but the tendency which it implies was toward a shorter presleep with increasing humidity up to 60 per cent. The correlation for relative humidity and afternoon sleep was 0.219 which was significant at the one per cent level[1], indicating that a higher relative humidity (within the range of 26 to 60 per cent) was as conducive to a longer sleep. This finding differs from Shinn (20) who reported that humidity did not seem to influence the amount of total sleep in her study of nursery school naps at Vassar and at Honolulu. The humidity range was 56 to 94 per cent in New York and 66 to 89 per cent in Honolulu in Shinn's study.

Light intensity during the period of the present study varied from 0.1 to 4.4 foot-candles. The correlation coefficients of light in relation to both presleep and nap were significant at the one per cent level[2], that for presleep being 0.180 and for nap duration -0.195. This indicated

1. Snedecor, G.W., Statistical Methods, (21) p.149.
2. Loc. cit.

that subdued light or dark sleeping rooms encouraged a shorter presleep and a longer total nap, which has been the assumption but has not been reported as being tested in the literature reviewed.

From the findings of this study it appeared that variation in temperature, within the usual range for comfort, did not seem to affect the presleep or length of nap of the children. Although the correlations between humidity and nap duration, light and nap duration, and light and presleep were significant,[1] they were low. This indicated that other factors existed which were probably of greater influence on the sleep duration than those that were studied. Since the amount of sleep taken by young children over the twenty-four hour period is so important to their health and well being, it seems wise to plan the best possible environment for promoting sleep. Therefore, it would seem desirable to darken the nap room as much as possible, and to maintain a relative humidity as high as 60 per cent, in order to control these two factors which do appear to influence the duration of presleep and nap to some extent.

1. Snedecor, G.W., Statistical Methods, (21) p.149.

Table VIII

SUMMARY OF THE ANALYSIS OF VARIANCE AND COVARIANCE

Temperature Correlated with Presleep

	$\Sigma x'^2$	$\Sigma x'y'$	$\Sigma y'^2$	r
Total Group	11,516.67	311.71	2,784.10	.055
Between Children	6,162.92	70.20	29.57	
Within Children	5,353.75	241.51	2,154.43	.071

Temperature Correlated with Afternoon Sleep

	$\Sigma x'^2$	$\Sigma x'y'$	$\Sigma y'^2$	r
Total Group	14,536.4	63.16	2,735.40	.010
Between Children	5,892.7	-67.80	27.89	
Within Children	8,643.7	130.96	2,707.61	.027

Relative Humidity Correlated with Presleep

	$\Sigma x'^2$	$\Sigma x'y'$	$\Sigma y'^2$	r
Total Group	11,516.67	-1,261.63	24,989.68	-.074
Between Children	6,162.92	- 43.01	433.28	
Within Children	5,353.75	-1,218.62	24,556.40	-.106

Relative Humidity Correlated with Afternoon Sleep

	$\Sigma x'^2$	$\Sigma x'y'$	$\Sigma y'^2$	r
Total Group	14,536.4	3,628.91	25,335.75	.189
Between Children	5,892.7	411.78	436.36	
Within Children	8,643.7	3,217.13	24,899.39	.219

Light Correlated with Presleep

	$\Sigma x'^2$	$\Sigma x'y'$	$\Sigma y'^2$	r
Total Group	11,516.67	207.65	240.00	.124
Between Children	6,162.92	3.50	2.24	
Within Children	5,353.75	204.15	237.76	.180

Light Correlated with Afternoon Sleep

	$\Sigma x'^2$	$\Sigma x'y'$	$\Sigma y'^2$	r
Total Group	14,536.4	-302.58	239.63	-.162
Between Children	5,892.7	- 23.12	2.07	
Within Children	8,643.7	-279.46	237.56	-.195

CHAPTER V

SUMMARY AND CONCLUSIONS

This study deals with the relationship of such environmental factors as temperature, humidity and light to the duration of presleep and afternoon sleep of nursery school children.

The study was conducted in the nursery school at Michigan State College for a period of 34 school days during the fall term of 1946. The subjects were six boys and six girls in the younger group of children with ages ranging between two and one-half and three and one-half years.

The room used for nap is a playroom during the morning and is rearranged for sleeping in the afternoon by placing cots and screens in a hollow square around the room. The shades are drawn and three windows with draft screens are opened for ventilation. There was no attempt to control the three variables studied except the usual procedures followed in establishing comfortable sleeping conditions. The variables fluctuated as the weather conditions influenced them.

Records of time in bed, time asleep, and time awake were kept, from which the duration of presleep and sleep were computed. In addition, daily records were made of the temperature, relative humidity, and light intensity through-

out the first hour and a half of the nap period. Notations were also kept of the morning activity and unusual occurrences during the day which might have influenced the nap.

Certain records were eliminated on the basis of unusual occurrences or interruptions of the presleep or nap. The time records which remained were correlated with each of the variables by means of analysis of variance and covariance.

1. The six boys in this study had a slightly shorter presleep and a slightly longer nap than the six girls. no definite conclusions as to sex differences can be drawn because of the small number of either sex studied.

2. Presleep was longer and total nap was shorter on Mondays than on the other days of the week during the 34 days of the study.

3. Temperature, within the range of 69° to 79° F. was found to have no significant influence on the length of presleep or total afternoon sleep.

4. Although no significant relationship appeared between presleep and relative humidity, a significant, though low, positive correlation was found between relative humidity and the length of nap, which implies (within the range of 26 per cent - 60 per cent) some tendency

toward the relative humidity, the longer sleep with increased relative humidity (within the range of 26 per cent to 60 per cent).

5. A low positive correlation exists between light and presleep; and a low negative relationship between light and the duration of nap. This would imply that increasing the light within the range of 0 to 4 foot-candles has some influence toward shortening the nap and lengthening the time to go to sleep.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Alschuler, Rose H. Children's Centers. National Commission for Young Children. Wm. Morrow, New York, N.Y., (1942).

2. Anderson, John E., Foster, J. C., and Goodenough. The sleep of young children. J. Genetic Psychol., 35:201-218, (1928).

3. Beckman, W.B. Daytime sleep of nursery school children, Unpublished Theses, University of Chicago, (1932).

4. Boyton, B., and Goodenough, F.L. The posture of nursery school children during sleep. Amer. J. of Psychol., 42:270-278, (1930).

5. Chant, N., and Blatz, W.A study of sleep habits of children. Genetic Psychology Monographs., 4:13-43, (1928).

6. Dales, Ruth J. Afternoon sleep in a group of nursery school children. J. of Genetic Psychology, 58: 161-180, (1941).

7. Erwin, Doris An analytical study of children's sleep. Pedegogical Sem. and J. of Genetic Psychol., 45:199-226, (1934).

8. Fisher, R.A. Statistical Methods for Research Workers. Oliver and Boyd, London, (1934).

9. Foster, J., and Mattson, M. Nursery School Education, D. Appleton-Century Co.

10. Garvey, C. R. Activity of Young Children During Sleep. University of Minn. Press, (1939).

11. Giddings, G. Normal sleep patterns for children. J. of American Medical Assoc., (1939).

12. Kleitman, Nathanial, Sleep and Wakefulness, University of Chicago Press, Chicago, (1939).

13. Langdon, Grace, Home Guidance for Young Children. John Day Co. New York, N.Y., (1931).

14. McCay and Fowler, M.B. Some sex differences observed in a group of nursery school children. Child Development, 12:75-79, (1941).

15. Renshaw, Miller and Marquis, Children's Sleep, McMillan Co., New York, N.Y., (1933).

16. Reynolds, M.M. The sleep of young children in a 24 hour nursery school. Ment. Hygiene, (1935).

17. Reynolds and Mallay, The sleep of young children. J. of Genetic Psych., 42-43:322-351, (1933).

18. Scott, E. A study of the sleeping habits of twenty-nine children of preschool age. Child Development 2:326-328, (1931).

19. Sherman, M. The afternoon sleep of young children: some influencing factors. J. of Genetic Psych., 38:114-126, (1930).

20. Shinn, A. V. A study of the sleep habits of two groups of preschool children, one in Hawaii and one on the Mainland. Child Development, 2:159-169, (1932).

21. Snedecor, G. W., Statistical Methods, Iowa State College Press, Ames, Iowa, (1946).

22. Staple, R. Some factors influencing the afternoon sleep of young children. J. of Genetic Psych., 41:222-228, (1932).

23. Staples and Anderson, A.C. A study of outdoor play, appetite, and afternoon sleep of young children. Child Development 4:191-195, (1933).

24. Wagner, Mary A. Day and night sleep in a group of young orphanage children. J. of Genetic Psych., 42:442-459, (1933).

25. White, M. R. Some factors affecting night sleep of children. Child Development, 2:234-235, (1931).

APPENDIX

APPENDIX A - SAMPLBE SLEEP RECORD

Michigan State College

SLEEP RECORD

Week of: 18 - 22 Oct.

Teacher Campbell

	NAME												
	Albert R.	John C.	Julie B.	Thomas R.	Libby A.	Beth B.	Ted P.	Kenneth C.	Linda D.	Rosalind T.	Sandy S.	Edward E.	
Monday		abs.	12:25	12:25	abs.	12:40	12:35	abs.	12:55	12:30	12:40	12:30	12:25	In Bed
		"	1:45*	12:50	"	1:00	1:00	"	0	12:45	1:20	1:00	1:15	Asleep
		"	2:55	1:45	"	2:15	1:45	"	0	2:00	2:00	2:25	1:50	Awake
		"	80	25	"	20	25	"	2:15	15	40	30	50	Pres.
		"	70	55	"	75	45	"	0	75	40	85	35	Min. Asleep
		"	150	110	"	75	100	"	80	105	95	115	110	Min. in Bed
Tuesday		abs.	12:35	12:40	abs.	12:45	12:45	abs.	1:05	12:40	1:00	12:45	12:30	In Bed
		"	12:55	1:10	"	1:05	1:05	"	1:15	1:00	1:40	0	1:35	Asleep
		"	2:15	2:10	"	1:55	2:20	"	2:50	2:25	2:50	2:15	2:40	Awake
		"	20	30	"	20	20	"	10*	20	40	0	65	Pres.
		"	80	60	"	50	75	"	95	85	70	0	65	Min. Asleep
		"	100	90	"	95	95	"	105	105	110	90	130	Min. in Bed
Wednesday		abs.	12:25	12:30	abs.	12:40	12:25	abs.	12:40	12:25	12:35	12:25	12:25	In Bed
		"	12:45	1:15	"	1:00	12:50	"	1:15	1:45	1:40	1:50	1:50	Asleep
		"	2:00	2:00	"	2:15	2:15	"	3:00	2:45	2:15	2:45	2:40	Awake
		"	20	45	"	20	25	"	35	80	65	85	85	Pres.
		"	75	45	"	75	85	"	105	60	45	55	50	Min. Asleep
		"	95	105	"	95	110	"	140	140	110	140	135	Min. in Bed
Thursday		12:30	12:25	12:25	abs.	12:30	12:40	abs.	12:40	12:20	12:30	12:35	12:35	In Bed
		12:35	0	12:50	"	12:50	1:50	"	0	12:40	0	12:45	12:55	Asleep
		2:15	0	1:40	"	2:00	2:25	"	0	2:15	0	2:05	2:00	Awake
		20	2:15	25	"	20	70	"	2:15	20	2:15	10	20	Pres.
		100	0	50	"	70	35	"	0	95	0	80	65	Min. Asleep
		120	110	105	"	105	105	"	95	115	105	100	100	Min. in Bed
Friday		12:30	12:35	12:30	abs.	12:45	abs.	abs.	12:45	12:30	12:40	12:35	12:30	In Bed
		12:35	2:00	1:45	"	1:00	"	"	0	12:50	1:15	1:20	1:00	Asleep
		2:15	2:40	2:30	"	2:10	"	"	0	2:40	2:10	2:40	2:00	Awake
		5	85	75	"	15	"	"	2:15	20	35	45	30	Pres.
		100	40	45	"	70	"	"	0	110	55	80	60	Min. Asleep
		105	125	120	"	90	"	"	90	130	90	125	105	Min. in Bed
	REMARKS		*Wet pants 1:30						* Teacher sat by Kenny					

APPENDIX B - SAMPLE DATA SHEET

Sleep	Monday Pre.	Tot.	N't.	Tuesday Pre.	Tot.	N't.	Wednesday Pre.	Tot.	N't.	Thursday Pre.	Tot.	N't.	Friday Pre.	Tot.	N't.
Edward E[illegible]	50	35	690	65	65	690	85	50	645	20	65	630	30	60	675
Sandy S[illegible]	30	85	---	90	0	630	85	55	---	10	80	660	45	80	675
Rosalind T[illegible]	40	40	---	40	70	660	65	45	---	105	0	630	35	55	---
Linda D[illegible]	15	75	660	20	85	600	80	60	660	20	95	610	20	110	600
Kenneth C[illegible]	80	0	615	10*	95	630	35	105	480	95	0	670	90	0	640
Ted P[illegible]	absent			absent			absent			absent			absent		
Beth B[illegible]	25	45	---	20	75	---	25	85	660	70	35	585	absent		
Libby A[illegible]	20	75	685	20	50	660	20	75	685	20	70	645	15	70	645
Thomas R[illegible]	absent			absent			absent			absent			absent		
Julie B[illegible]	25	55	660	30	60	720	45	45	650	25	50	690	75	45	---
John C[illegible]	80	70	715	20	80	675	20	75	---	absent			85	40	645
Albert K[illegible]	absent			absent			absent			5	100	---	5	100	---

	Monday	Tuesday	Wednesday	Thursday	Friday
Humidity	32	28	40	50	32
Temperatures	69.5 (70-69)	72 (72-72)	75 (76-74)	72 (72-72)	69.5 (70-69)
Light	1.8 2.0 1.2 1.4 1.8 1.8 | ave. 1.69	2.0 1.4 1.2 1.4 1.4 1.6 | ave. 1.49	.2 .5 .2 .1 .2 .2 | ave. .2	3.0 1.8 1.4 1.2 1.8 1.4 | ave. 1.57	.6 .3 1.0 .4 .4 .2 | ave. .41
Outdoor Play	x	x	x	x	x
Notes	John wet pants 1:30 Beth, Rosalind toilet 2:00	Restless night sleep reported for Eddie *Teacher sat by Kenny		Sandy retained spinach in her mouth throughout nap Beth, John, Albert wet beds	Windy, windows rattled

ROOM USE ONLY