NON-ATTENDING BEHAVIORS IN FIRST GRADE STUDENTS UNDER THREE FLUORESCENT LIGHTING CONDITIONS

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE DEGREE OF DOCTOR OF EDUCATION IN

THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

COLLEGE OF EDUCATION

BY

JANE HARTWELL NORRIS, M.ED.

DENTON, TEXAS

AUGUST, 1979

ABSTRACT

NON-ATTENDING BEHAVIOR IN FIRST GRADERS UNDER THREE DIFFERENT FLUORESCENT LIGHTING CONDITIONS

Jane Hartwell Norris, Ed. D.

Texas Woman's University August 1979

The purpose of this study was to demonstrate effects of different fluorescent lighting conditions on the degree of non-attending behavior exhibited by children in regular school classrooms. Eleven first grade classrooms in three elementary schools in three suburban school districts near a large metroplex were used in the research.

One classroom from each school was randomly assigned to each of the three experimental lighting conditions. The two remaining classrooms were used as control groups. Ninety-seven percent of the first grade students in all three schools were included in this study. A nested design was used to eliminate teacher variables and to allow one experimental condition to be applied to each group.

An activity sampling list of thirteen non-attending behaviors was compiled. Student non-attending behaviors were collected for tabulation through the video taping of the classrooms for fifteen minutes during reading. The initial data collection occurred under the cool white fluorescent lights masked to the intensity of the natural light bulbs.

The statistical method used the difference scores of group means in a one-way analysis of variance. There was a decrease in the frequency of all thirteen non-attending behaviors. Five of these behaviors showing the greatest change were analyzed. These five behaviors were: vocalizes without teacher permission, eye contact to task broken without teacher direction, chair balanced on two legs, out of seat without permission, and teacher reprimands student (verbal or non-verbal).

Eye contact to task broken without teacher direction was significant at $p < .01$. Behavior data collected was reliable due to inner rater reliability correlations which ranged from .955 to .992.

ACKNOWLEDGEMENTS

I wish to express my thanks to the many people who helped to make this project possible. There are too many to acknowledge all of them personally, but I would like to say a few extra thank yous to some of these people. First to Dr. Michael J. Wiebe, my committee chairman, without whose encouragement and support this dissertation might never have been completed. To the other members of my dissertation committee; Dr. Marnell Hayes, Dr. Virginia Jolly, Dr. Margaret Noyes, Dr. Juanita Prater, and Dr. Ed Wylie, for their belief that this study could be done and had the possibility of containing educational merit.

A very special thank you to Mr. William J. Lally and Mr. Bill Craig, engineers for Westinghouse Electric Corporation. They supplied technical assistance on lighting and arranged for the lightbulbs to be available to me. Thank you to the Superintendents and Principals in Coppell, Grapevine and Lewisville, Texas who offered their school districts and schools for this study.

Last but by no means the least in this project's support are the fellow doctoral students, friends and my parents, Mr. and Mrs. J. Frank Norris, who helped when things were tough. These people all gave of their time, energy, moral support, and a never failing encouragement that everything would work out.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS ii

LIST OF TABLES iv

CHAPTER

I. INTRODUCTION 1

Statement of the Problem 1

Purpose of the Study 2

Definitions 2

II. REVIEW OF THE RESEARCH 4

III. METHOD 18

Subjects 18

Measuring Instruments 21

Procedure 24

Analysis of Data 26

IV. THE RESULTS 29

V. DISCUSSION 37

Summary 37

Conclusions 41

Implications 42

REFRENCES 43

APPENDICES

Appendix A -- Human Research Review Committee Forms, Texas Woman's University 46

Appendix B -- Activity Sampling List 53

Appendic C -- Energy Emission of F40 Lamps in Arbitrary Color Bands in Watts 55

Appendix D -- Levels of Illumination Currently Recommended for Performing Visual Tasks in School (In Footcandles . . .) 57

Appendix E -- Assorted Correspondence 59

LIST OF TABLES

Page

TABLE 1 20

TABLE 2 22

TABLE 3 31

TABLE 4 32

TABLE 5 33

TABLE 6 33

TABLE 7 34

TABLE 8 35

TABLE 9 35

TABLE 10 36

TABLE 11 36

CHAPTER I

INTRODUCTION

During the fall of 1976, a film entitled "Exploring the Spectrum" was viewed. One sequence in the film utilized time lapse photography to record activities in a first grade classroom under two different lighting conditions. While the classroom was illuminated with "cool-white" fluorescent lighting, several students appeared to be very active in the time lapse sequences. When the lighting conditions were changed to "full-spectrum" light, the same students were noticably calmer than in the first sequence.

This film presented significant questions regarding the effects of lighting on activity levels in children. A search for further information was begun.

Problem

There has been limited research in the area of lighting as it affects the degree of attending behavior in children attempting to complete school related tasks. To date, research has not clearly demonstrated the effects of lighting as a factor contributing to hyperactivity or non-attending behavior.

Purpose

The purpose of this study was to demonstrate effects of different fluorescent lighting conditions on the degree of non-attending behavior exhibited by children in regular school classrooms. The null hypothesis for this study is: there is no significant difference in non-attending behaviors of first grade students performing academic tasks under three different types of fluorescent lighting.

Definitions

Little agreement for the definition of "hyperactivity" is found in educational and psychological literature. Rather, hyperactivity is described by a general list of behaviors or activities observed in some individuals. In most definitions, hyperactivity refers to non-attending behavior, or an inability to consistantly perform a given task. Keogh (1971) states:

> Hyperactivity is a general and emotionally laden word; it is a catchall for many descriptive terms, a construct lacking in precision or in specificity of defining parameters. Most investigators focus on the symptomatology of the condition without defining the construct. Definitions and descriptions emphasize two major aspects of symptom patterns: first, those which have to do with the extent and kind of motor activity; second, those which have to do with associated behavioral, social, and psychological characteristics. (p. 101).

In order to determine attending and non-attending behaviors, this study incorporated both activity analysis and activity sampling. English and English (1958) define activity analysis as a: "list of the acts actually performed by a given person or in a given type of situation or job (p. 9)." This definition served as the basis for the development of a list of non-attending behavior to be observed during the study:

> Activity Sampling: a technique for determining exactly what a person does at a given task or during a given time. Emphasis is upon objective and relatively detailed descriptions, often including the time order in which the responses are made (English & English, p. 10).

Video taping the subjects of this study under three different fluorescent lighting conditions constituted a permanent record of the activity sampling of defined behaviors.

CHAPTER II

Fluorescent bulbs were devised by engineers at Westinghouse Electric Corporation in 1936. They have been refined over the years and are designed for various uses. The color reflections of various types of bulbs make some of them more appropriate for certain types of commercial use. The Chief Engineer for the Fluorescent Planning Division of Westinghouse related that fluorescent bulbs were used in schools and businesses because they generally take about 1/3 of the energy necessary for incandescent lighting of the same candle power (Lally, 1977).

Mayron, Ott, Nations and Mayron (1976) presented an early report based on the film "Exploring the Spectrum". This was a pilot study of the effects of full-spectrum lighting on school-aged children. This study used four first grade classrooms in Sarasota, Florida. Two classrooms were used as the control while the two other rooms were considered experimental. In the experimental classrooms, the type of fluorescent lighting was manipulated. Discussing the Sarasota study, Arehart-Treichel (1974) stated "Several children in each of the rooms were hyperactive and close to being transferred to a special school (p. 258)." There was no indication of how the classes were selected or how the subjects

were assigned to the classrooms.

In the two Sarasota experimental classrooms the light bulbs were changed to what the authors termed "full-spectrum" light bulbs. Cathode elements at each end of the bulbs were shielded with lead foil shields and the light fixture recesses were covered with a grounded aluminum mesh screen. The plastic diffusers were changed in all four rooms to cubic plastic louvers.

The lights placed in the experimental classrooms were designed by Ott to include ". . . long ultraviolet wave lengths (from 2,900 to 4,000 angstroms) (Aerhart-Treichel, 1974, p. 258)." These are the natural sunlight wave lengths that are reported to be missing from most fluorescent lighting. "With the help of his son, Henry, Ott has designed fluorescent lighting that meets these specificiations (Arehart-Treichel, 1974, p. 259)."

A hidden time lapse camera was installed into an upper corner of each room. These cameras recorded classroom activity ". . . four to five times throughout the semester of January to June, 1973 (Mayron, et al., 1974, p. 34)." Each film segment covered a thirty minute period.

The authors then observed student behavior with a stopwatch to time hyperactive behavior. Hyperactivity was calculated as a percent of the total observation time for each

film segment. A comparison of change in hyperactivity in individual students was made. The authors considered only variations of significant magnitude in their comparisons between the rooms.

Ages of the observed students were considered as maturational influences on behavior and no significant differences between the classrooms were determined. Mayron et al. (1974) stated that sex did not seem to play a part in the differences but the authors did not present the number of subjects of each sex in the classrooms. The authors did concede that the small number of subjects might well make differences non-observable.

Academic achievement was tested three times during the semester. Although there was the possibility of test learning taking place during the semester, achievement was used as a criterion for assessing the effects of lighting.

Mayron, et al. (1974) claimed significant differences among the rooms in terms of the number of students starting at a particular test level they recorded an achievement level with significance beyond $p \leq 0.005$ on a Chi square comparison at three degress of freedom but attributed variation in the classrooms to teacher differences.

Academic achievement levels were compared for age and sex differences in the four classrooms. Each classroom

showed different improvement patterns based only on age, but each effect was so different that no overall statement could be made.

The film analysis of activity levels in the groups indicated greater activity in the control groups than in the experimental groups. Because there were no major differences in activity levels in the two control rooms or the two experimental rooms, Mayron et al. (1974) combined the two control and experimental rooms for statistical analysis. A Chi square value of 2717 with one degree of freedom resulted and probability of obtaining a value of 12.1 with one degree form freedom is less than 0.0005. The authors also treated their data by dividing the groups by age and sex. No significant differences were determined in either analysis.

The authors plotted the change-in-activity against the achievement levels in rooms 3 (control) and 4 (experimental), which contained the largest number of double level achievers. This was done to test a correlation between academic achievement and a decrease in hyperactivity. There seemed to be no significant correlation between learning and hyperactivity.

Mayron, et al., (1974) stated, "The change-in-activity data shown here are highly significant and are clearly attributable to the experimental conditions (p. 43)." The authors also stated that the academic data are significantly

different among the various rooms even though the reasons for the differences cannot be clarified.

The study's final paragraph reads:

> It has been demonstrated that the use of full-spectrum fluorescent lighting and radiation shielding decreased hyperactive behavior of students in two first-grade rooms as compared to the students in two control rooms with standard cool white fluorescent lighting ($p < .0005$). Academic achievement also was shown to be significantly different among the four classrooms ($p < .00005$), but in such a way that it was unclear whether the differences resulted from the experimental conditions or from teacher differences. There appeared to be no relationship between academic achievement and hyperactive behavior (Mayron, et. al., 1974, p. 44).

Ott (1976) reported on the same study conducted in Sarasota, Florida. Ott stated that in the classrooms with standard fluorescent lighting the children were observed and described as ". . . fidgeting to an extreme degree, leaping from their seats, flailing their arms, and paying little attention to their teachers (1976, p. 22)." In the experimental room, the first graders were described as settling down more quickly and as being less nervous. Their attention to their teachers was greater and overall performance was found to be better.

Ott (1976) stated that the original control classrooms had the full-spectrum shielded lighting installed. After a lapse of two or three months these classrooms were photographed. In the analysis of these time lapse photographs

these students appeared to be calmer and more interested in their work.

This study suggests that hyperactivity is partially due to radiation stress from the initial cool-white lighting. "Improvement in the children's behavior occurred when we eliminated excessive radiation and supplied part of the visible spectrum which is lacking in standard artificial light sources (Ott, 1976, p. 23)." Ott compared the stress of the classroom to the stress reactions of laboratory rats raised under ". . . narrow bands of wavelengths within the total light spectrum (1976, p. 25)."

While Ott claimed that soft x-rays are emitted from the ends of fluorescent tubes, a representative of the Westinghouse Electric Corporation in Dallas indicated that there are no measurable x-rays from fluorescent light bulbs (Sharp, 1977). The Dallas office of the Environmental Protection Agency (E.P.A.) was questioned regarding the x-ray emissions of fluorescent light bulbs. A representative of their research department was unable to recall any research on this topic (Korp, 1977).

Mayron, et al., (1976) expanded their first study to include first and second graders. The children were assigned to low and high groups within both the experimental and control populations.

The testing procedures for the 1976 study were the same as for the 1974 study. Testing was done at the end of each quarter resulting in four test grades to measure achievement for each group. However, subject grouping created difficulties with data interpretation and no conclusions were drawn by the authors.

Mayron, et al., questioned whether or nor the grounded aluminum screening placed on the light recesses might account for some of the decrease in hyperactivity. Mayron, et al., (1976), stated:

> Whatever the involvement of light and its brightness, . . . , current knowledge implicates electromagnetic radiation in the radio frequency wave lengths as an etiology of hyperactivity and perhaps lower academic achievement, whereas light is not so implicated, unless psychological factors due to color are involved, of which very little is known (p. 405).

Painter (1976) reported a decrease of 32.3 percent in hyperactivity when incandescent lights were substituted for fluorescent lights. Painter counted incidents of hyperactive behavior or activity for a one week period. The observations were made for one hour, at the same time each day. Hyperkinetic activity was described as:

> ". . . jumping up and walking around inappropriately; standing on chairs; yelling; inappropriate clapping, hitting teachers, classmates or self; grabbing another's possessions; or behaving in a disruptive manner that elicited a reprimand from the teacher (Painter, 1976, p. 182)."

At the end of the first week, incandescent lamps were substituted for the fluorescent lights. No other changes were made in order to allow the students to adjust to the light change.

The second week the incandescent lights were in use, hyperkinetic activity was again observed for the same one hour period for one week. Painter (1976) reported a decrease of 32.3 percent in hyperkinetic activity in the class.

After two weeks of incandescent lighting being used in the room the fluorescent lights were used again. The original level of hyperactivity seemed to return, although no count data was taken at this time. The results of this experiment in one of the Santa Cruz schools, had resulted in the design of a new school with incandescent lighting.

Two classes in the Santa Cruz district were transferred to older classrooms with incandescent lighting. The teachers noted there were fewer complaints of headaches, nausea and irritability than in previous years with fluorescent lighting.

A letter to Painter requesting further information on the school that was mentioned in the study brought a response that the Santa Cruz School District had indeed designed and built a school building that contained a dual track lighting system. The purpose of this design was to allow for more study in the area of lighting. Painter said that the school district had

not been able to obtain state or federal funds to conduct the research, but that the district was still interested in the project.

Mass, Jayson, and Klieiber (1974) conducted a study designed to explore the relationship between spectral differences in environmental illumination and general and perceptual fatigue in humans performing mental activity. Thirty-one students were chosen randomly from a larger pool of introductory psychology students who had volunteered to participate in research. The subjects were asked to bring enough study materials to occupy four hours a day for a period of four days. The change of light bulbs was the only change made. One half of the bulbs were "Vita-Lite", the other half were cool-white fluorescent lights. The illumination was stabilized and the foot candles were equal. The subjects spent two days studying under each of the lighting conditions. "To control for ordering and position effects, a counterbalanced design was used that alternated the lighting conditions from cw-v-v-cw to v-cw-cw-v across subjects (Mass, et al., 1974, p. 524)."

The subjects were tested for fatigue during the first and last 15 minutes of each four hour session. Subjective and objective measures were used in the pre- and post-treatment measures.

> The objective measures used were based on perceptual tasks, since vision is the sense most often affected by study and environmental illumination. The Critical Flicker Fusion test was used to assess both visual and central nervous system fatigue (Mass, et al., 1974, p. 525).

The objective variables of the flicker fusion test and visual acuity showed significant differences under "Vita-Lite". Mass, et al. (1974) stated there was also a statistically significant difference in one of the subjective measures (lively-lethargic). There seemed to be a tendency for the subjects to become more lethargic after four hours under the cool-white light.

Mass, et al., (1974) state, "It is clear that this line of experimentation should be expanded; other light spectors should be experimentally manipulated; tasks should be changed, and individual differences should be considered (p. 256)."

Wartman (1973) discusses the various effects of light on the human system. Some effects of natural sunlight are tanning, sunburn, synthesis of Vitamin D, and skin cancer after prolonged exposure. Wartman's major topic deals with how exposure to sunlight is necessary for the body to absorb Vitamin D, which is necessary for proper calcium absorption. Sunlight also appears to be quite important in the rate that bilirubin is destroyed in a test tube as well as in infants whose livers are immature. Wartman (1973) also states that there are a number of medications which are activated by

light. Some people develop rashes after taking these medications and being exposed to sunlight.

Indirect effects of light seem to include sexual maturation and the penal gland's influences on biological rhythms. Biological rhythms associated with light are the times of the year various animals bear their young, the maturation rates of rats under different lighting conditions, and the salivary flow and rhythm of body temperature in humans.

Information was sought from the American Printing House for the Blind and the American Foundation for the Blind to determine if light could be an environmental factor in hyperactivity. All responses indicated that no such information was available.

Computer searches of ERIC, Psychological Abstracts, Exceptional Children, and MEDLARS using the descriptors of hyperactivity and blindness, resulted in no research recorded by these descriptors. It is quite possible that hyperactive behavior in blind children has been investigated under the general descriptor of blindisms.

Arehart-Treichel (1974) concluded:

> Ott's work with fluorescent lights and hyperactivity obviously has to be not only expanded but confirmed by other investigators before conventional fluorescent lights can be indicated as a cause of hyperactivity. But if the results do lead to an indictment, the clinical value could be enormous - not just to help a million hyperactive youngsters but perhaps help for persons with other kinds of diseases.

> Hyperactivity is just one of the medical problems, Ott believes, that is caused or at least aggravated by inadequate or harmful artificial lighting conditions (p. 259).

O'Leary, Rosenbaum, and Hughes (1978a) conducted a study using seven first grade children with conduct disorders and/or hyperactivity in the State University of New York at Stony Brook Laboratory School. Special broad-spectrum daylight-simulating lamps were designed by General Electric Company which had the same color, temperature and spectral emissions as the standard cool white fluorescent lamps.

The lamp fixtures were fitted with a 15-watt black light lamp and a radio frequency suppression unit. During the eight week study the lamps were changed weekly. During odd-numbered weeks the room was illuminated by the standard cool white fluorescent bulbs. During the even-numbered weeks the room was illuminated by the broad-spectrum daylight-simulating lamps, using the black light lamps and radio frequency suppression units.

Each child in the study was observed for 12 minutes a day while the child was assigned quiet, individual desk work. "The child was rated as either on or off task in each observational block (O'Leary et al., 1978a, p. 287)." Also, "Each day, each child was rated by the observers for his global activity level, which included fidgeting, motor activity, and facial, leg, hand, and body movements (p. 287)."

> A final measure involved a test of Critical Flicker Fusion (CFF). CFF refers to that frequency of flicker at which an oscillating light source is perceived by a subject as a continuous, nonflickering light. The frequency at which the subject fuses is sentitive to physiological variables and possibly fatigue (O'Leary, et al., 1978a, 287-288).

There were no significant differences found in the analysis of the task data of the activity rating scale. The Critical Flicker Fusion data analyzed in "a treatment-by-week interaction was significant. . ., indicating that subjects fused at lower frequencies in the broad-spectrum lighting condition across weeks, where as subjects fused at higher frequencies across weeks in the standard fluorescent condition (O'Leary et al., 1978a, p. 288)." ". . . it appeared that broad-spectrum lighting was associated with sensory visual fatigue (O'Leary et al., 1978a, p. 289)."

The preceeding study appears to be a systematic replication as defined by Sidman (1960): "Systematic replication occurs when an experiment is not repeated as done originally, but is executed with different types of subjects, varied lengths of interventions, and procedural differences such as varied dependent measures (p. 111)."

In a response to Mayron's commentary on their work, (O'Leary et al., 1978b), stated:

> In sum, our study differed from Mayron et al., (1974) in important ways, and it is possible that subject, procedural, or experimental design differences in the two studies account for our

failure to obtain behavioral differences purported to be associated with the two lighting conditions. The subject differences and the length of interventions appear to be the most important differences in the two studies. It might be advisable to ascertain whether lighting differences like those reported by Mayron et al., would occur with normal children, but we did not even see any trends in our data which would prompt us to pursue such research with conduct disorder and/or hyperactive children. Further, given the unspecified observational methodology, the complete absence of recorded reliability of observations, the teacher confound, and the small sample of teachers in the Mayron et al. (1974) group design study, we welcome further systematic replications (p. 297).

CHAPTER III

METHOD

This project was developed to study non-attending behavior exhibited in normal first grade students during reading and mathematics classes. The null hypothesis was that there was no significant differences in first grade students under three different fluorescent lighting conditions.

Subjects

The cooperation of three elementary schools in three suburban school districts was enlisted. These districts included Coppell, Grapevine, and Lewisville, Texas. These suburban communities are on the fringes of the greater Dallas-Fort Worth metroplex. These communities are composed of people who commute into the metroplex to work, are involved in small businesses in their community, or are employed in farming and ranching.

The largest number of students enrolled in the schools included in this research study were Caucasian. There were fewer than 10 students who were Mexican-American. There were no Black students in the classes studied.

In the Coppell Independent School District (I.S.D.) all three first grade classrooms in one elementary school were

included in this study. In the Grapevine-Colleyville I.S.D, an elementary school containing four self contained classrooms was included in the research. The elementary school included from the Lewisville I.S.D. had four self contained first grade classrooms.

The eleven first grade classrooms were randomly divided into three experimental groups of three classrooms each and the two remaining classes were used as a control group. First the lighting conditions were randomly coded using a table of random numbers. The codings were: 1-warm white, 2-daylight, 3-natural, and 4-cool white. Once the lighting conditions were coded, a teacher's name was selected from School 1 and then the table of random numbers was entered and systematically read until a number assigned to a lighting condition was encountered. The second teacher's name was noted and the table was systematically read until another lighting condition number was reached. This occurred until the rooms in School 1 were assigned to an experimental or control group. The same procedures were used to assign the classes in School 2 and School 3.

First grade classes were selected as the experimental subjects as they are the grade level of students who are most likely to be randomly placed with the various teachers in a particular school. Once the first grade is completed, some students are separated at teacher or parent request, and then

the remainder of the students are assigned to complete the class rolls.

The students in the first grade classes studied ranged in age from 6 years 5 months to 9 years 8 months. The majority of students were between the ages of 6 years 7 months and 7 years 6 months, as would be expected of an average first grade class in the spring of the school year. See Table 1 for the chronological ages of the students in this study.

TABLE 1

BIRTHDAYS OF SUBJECTS

C.A.	RANGE	LEWISVILLE	COPPELL	GRAPEVINE
6-00	6-03	0	0	0
6-04	6-07	8	6	9
6-08	6-11	29	7	17
7-00	7-03	36	14	24
7-04	7-07	16	19	22
7-08	7-11	4	3	9
8-00	8-03	0	1	6
8-04	8-07	1	1	1
8-08	8-11	0	0	0
9-00	9-03	0	1	0
9-04	9-07	0	0	0
9-08	9-11	0	0	1

The collection of data through video taping required the use of parential permission signatures for members of each class used in the experiment, (see Appendix A). Two hundred forty-nine students received permission to participate in this study. This represented 97% of the first graders enrolled in all three

of the school districts included in this study. There were 121 boys and 121 girls enrolled in all eleven first grade classrooms.

It was not possible to make this a totally blind experiment since parental permission was required, but it was anticipated that only the school principal would know what was being controlled, and that the experiment could be arranged in such a fashion that even the principal would not know when the light bulbs were changed in the rooms. The experimental variables were known by the principals, but they did not know which experimental conditions were in which rooms.

Instruments

According to lighting experts, cool white fluorescent bulbs are most commonly found in classrooms. Examination of the selected classrooms lighting revealed that cool white bulbs were in use. The experimental lamps were selected because of their availability in the sizes needed and because of the spectral differences in the light rays emitted. The experimental light bulbs selected were Westinghouse Warm White, Daylight, and Natural. Appendix C of this study explains the spectral differences exhibited by these bulbs.

Cooperation of the Dallas office of Westinghouse Electric Corporation and the engineering staff located in Bloomfield, New Jersey, resulted in the selection of their lamps for use

in this research project. Table 2 contains the lamp descriptions and illumination levels.

TABLE 2

LAMP DESCRIPTIONS, LENGTHS, AND ILLUMINATION LEVELS

Lamp Watts	Description	Nominal Length (in.)	Approximate Initial Lumens
40	Cool White	48	3150
40	Warm White	48	3200
40	Daylight	48	2600
40	Natural	48	2080
75	Cool White	96	6300
75	Warm White	96	6400
75	Daylight	96	5350
75	Natural	96	4250

The difference in wattage refers to the amount of electricity used to run the lamp and has no bearing on the illumination generated by the lamps. The length of the lamps and the lumen ratings are in direct proportion to each other.

General information on fluorescent lights includes the following information:

> . . . cool white light (rich in yellow and orange waves), warm white light (stronger in yellow and orange than cool white is) and daylight white (which has more blue in it than the cool and warm white do) (Arehart-Treichal, 1974, p. 259).

The availability of school districts willing to participate in this lighting study, based on the constraints of design limitations, necessitated the use of the different lamp lengths.

Data on classroom behavior was collected through use of video taping the selected classrooms under cool white fluorescent light bulbs and under the experimental light conditions. Video taping occured in 15 minute segments taken both in the morning and afternoon. The academic subjects of reading and mathematics were selected for the taping procedure.

An Activity Sampling List on non-attending behaviors exhibited by first graders was developed through classroom observation and reports of first grade teachers, (see Appendix B). English and English (1958) defines Activity Sampling as a technique for determining exactly what a person does at a given task or during a given time (p. 10)." Initially a list of observable classroom behaviors was made. These behavior descriptions were then condensed and defined as the Activity Sampling List in Appendix B. All behaviors were defined in such a way as to reduce ambiguity in the behaviors being observed and counted. For example "talking out" was defined as vocalizes without permission and "hitting, poking, and fighting" were defined as forcefully slaps or touches another person.

Procedure

A table of random numbers was used to determine experimental groups and the type of lighting to be used in each room. Design consideration included such items as self contained classrooms and randomized populations. Seven of the classrooms included in the study had minimal outside illumination. In those rooms with windows, window blinds were closed for the duration of this study. Actual illumination was controlled at 2080 lumens measured at desktop levels in all of the rooms.

One difference in the classroom that was not under design control was the difference in the color of the walls in the various buildings and rooms. In School 1, all of the walls were an off white color and each of the rooms had nine recessed light fixtures which contained four bulbs each. In School 2, two of the rooms were in an older section of the building and these rooms had only four light fixtures containing four bulbs each. The remaining rooms had eight fixtures containing four bulbs each. In School 3, all of the rooms contained six light fixtures containing two 96 inch light bulbs.

Each building was controlled independently for the foot candle levels of the natural lamp intensity since such factors as the number of lamp fixtures and the bulb size

were not consistent in all buildings. Possibly some changes in student behavior resulted in the lowering of the lamp intensities in all buildings, although control procedures were completed prior to the collection of data.

The video taping equipment was introduced into the classrooms at least once before the initial taping was done. The rationale for this was to provide the students and teachers a chance to feel more comfortable with the equipment and the person doing the taping. After some tape was obtained in these initial visits, the students were allowed to see themselves and questions were answered. The students were told that, with this special equipment, the participants were the only ones who would view the tape. It was explained that this was quite similar to the cassette recorders in their classrooms except that this machine recorded pictures as well as voices.

The classrooms were video taped under the cool white light masked to the intensity level of the natural lamps. This entailed removing the lights in each room, and installing natural lamps in at least one fixture. The cool white lamps were replaced in the fixtures and masked with masking tape, plastic tape, and/or aluminum foil to achieve the same intensity, or illumination, level as the natural lamps. This procedure was carried out in each room to counteract such factors as other objects in the rooms. Once initial

observation data was collected, the lamps were changed from the cool white to one of the experimental light conditions. The experimental lamps were also masked to the intensity of the natural lamps. After a lapse of three weeks, the rooms were again video taped, after the experimental lighting condition, for analysis of differences in non-attending behaviors. A General Electric Type 214 Light Meter was used to equalize all light intensities.

Three weeks was the selected time span as previous research suggested that frequent changes in the lighting did not show significant differences, and longer time spans might include more maturational differences than would be expected for the shorter experimental study. This time lapse of three weeks also allowed for a natural progression of initial observation, experimental condition, and then final student observation.

Analysis

A one-way analysis of variance was used to test the null hypothesis that there was no significant difference in non-attending behaviors in first grade students under three different types of fluorescent lighting. Analysis of the data used the Dayton (1970) "nested design with unequal numbers of observations (p. 232)." Nesting eliminated the classroom or teacher variables from the treatment dimensions to be

studied. Nesting also allowed for a single experimental condition to be applied per group rather than all experimental conditions to be applied to all groups.

After the initial observation tapes were recorded, the number of non-attending behaviors exhibited by the students were analyzed. An interval timer set at three seconds was used while viewing the tapes. If a student was involved in a non-attending behavior, he or she received one count on the activity sampling list. If the same student was engaged in this behavior at the next interval, the behavior was again counted. This technique allowed for measurement of duration of the defined behaviors.

Initial observation of some of the tapes, using the three second interval originally planned, required over three hours to count the thirteen behaviors included in the Activity Sampling List (Appendix B). Also some of the behaviors counted in this manner resulted in large numbers of incidence in a fifteen minute tape segment. Both time and frequency counts became potential areas for design error.

To reduce this possible error in data collection, the recording of behaviors was changed to fifteen second intervals to make the data more managable. All tapes were then analyzed by pausing or freeze framing the video recorder at fifteen second intervals and counting the observable non-attending behaviors in progress at that time.

A second observer was used to determine non-attending behavior reliability. The second observer independently selected three tapes made during the study, at random. The observer then counted non-attending behaviors, using the interval timer and the fifteen second intervals.

Some behaviors did not occur with sufficient frequency to be adequately analyzed. Those behaviors that reached frequencies for analysis included: vocalizes without permission, eye contact to task broken without teacher direction, chair balanced on two legs, out of seat without permission, and teacher reprimands (verbal and non-verbal) student.

The count for each behavior tabulated for the initial observation during reading or mathematics was divided by the number of students in attendance that day. The data tabulated for the experimental condition taping was also divided by the number of students present on the day of taping. The experimental data was then subtracted from the baseline data and the type of lighting used in each room in order to remove teacher variability from the treatment effects.

For all analyses, the alpha level was defined at .05. At this level, Critical $\underline{F}$ with 3 and 7 degrees of freedom is 4.3468 (Dayton, 1970, p. 395). When the Critical $\underline{F}$ is exceeded, actual levels of significance will be stated.

CHAPTER IV

THE RESULTS

A second observer was used to determine non-attending behavior reliability. This second observer independently observed and analyzed three randomly selected video tapes. When a Pearson Product Moment Correlation was conducted on all thirteen non-attending behaviors counted by the first and second observers, the following correlations resulted. For teacher D in School 1, and under cool white lights, the correlation between the observers was +.955. For teacher C in School 3 and under the natural lamps, the correlation between the two observers was +.963. Finally, for teacher A in School 2, and under cool white lights, the observers obtained a correlation of +.992.

Only five of the original thirteen non-attending behaviors included in the Activity Sampling List (Appendix B) occurred with sufficient frequency for statistical analysis. The observed student behaviors were: vocalizes without permission, eye contact to task broken without teacher direction, chair balanced on two legs, out of seat without permission, and teacher reprimands (verbal and non-verbal) student.

Table 3 contains the frequency of the five behaviors for the initial observation period. The teacher column and the school column indicate the nesting factor of the design. The student column contains the number of students present on the day of taping. The remaining columns contain the frequencies tabulated during the analysis of the tapes.

Table 4 contains the frequency of the five analyzed behaviors as observed under the experimental lighting conditions. Identification codes for teachers, school, lighting conditions, and behaviors are the same as presented in Table 3. Discrepancies in the number of students included in the experimental data were due to students being present in the morning sessions but absent during the afternoon taping sessions.

An analysis of variance (ANOVA) was computed for changes in frequency, or count, for each of the five behaviors which occured with sufficient frequency to be adequately analyzed.

For all analyses, the alpha level was defined at .05. At this level, Critical F for 3 and 7 degrees of freedom is 4.3468 (Dayton, 1979, p. 395). The ANOVA Summary Tables for each of the analyzed behaviors follow.

TABLE 3

INITIAL OBSERVATION BEHAVIOR FREQUENCY

Teacher	School	Light	Students	Vocalizes Without Permission	Eye Contact	Chair Balanced	Out of Seat	Teacher Reprimand
A	1	4	23	66	89	5	75	5
A	2	4	15	13	34	6	68	0
A	3	4	22	57	100	21	16	0
B	1	4	22	31	24	4	30	2
B	2	4	12	12	32	1	23	2
B	3	4	24	11	25	13	55	0
C	1	4	25	37	33	15	73	0
C	2	4	16	7	31	3	40	5
C	3	4	23	8	60	18	9	0
D	1	4	20	45	59	13	25	0
D	3	4	19	15	54	8	33	2

Teachers: Identified by letter only
Schools: 1 - Lewisville, 2 - Coppell, 3 - Grapevine
Lighting Conditions: 1 - Warm White, 2 - Daylight, 3 - Natural, 4 - Cool White
Students: Number of students present on the day of taping

TABLE 4

EXPERIMENTAL CONDITION BEHAVIOR FREQUENCY

Teacher	School	Light	Students	Vocalizes Without Permission	Eye Contact	Chair Balanced	Out of Seat	Teacher Reprimand
A	1	1	25	21	58	15	19	1
A	2	1	17	7	33	1	19	1
A	3	1	22	41	74	8	39	1
B	1	2	22	12	27	1	20	0
B	2	2	12.5	0	39	10	7	0
B	3	2	22	17	43	15	44	0
C	1	3	22	19	52	15	29	0
C	2	3	14	4	30	5	9	2
C	3	3	21.5	9	69	6	20	5
D	1	4	24.5	30	49	3	30	0
D	3	4	19	23	67	4	21	3

Teachers: Identified by Letter Only
Schools: 1 - Lewisville, 2 - Coppell, 3 - Grapevine
Lighting Conditions: 1 - warm white, 2 - daylight, 3 - natural, 4 - cool white
Students: Number of students present on the day of taping

TABLE 5

VOCALIZES WITHOUT PERMISSION

Source	df	Sum of Squares	Mean Squares	F Ratio
Treatment	3	2.97	.99	1.60
Within	7	4.32	.62	
Total	10	7.28		

For the non-attending behavior, vocalizes without permission, the null hypothesis was retained. There was no significant difference determined for this non-attending behavior in first grade subjects observed under three different fluorescent lighting conditions.

TABLE 6

EYE CONTACT TO TASK BROKEN WITHOUT TEACHER DIRECTION

Source	df	Sum of Squares	Mean Squares	F Ratio
Treatment	3	4.47	1.49	8.43
Within	7	1.24	.177	
Total	10	5.71		

The null hypothesis of no significant difference in non-attending behavior, eye contact to task broken without teacher direction, was rejected. The Critical $\underline{F}$ with an alpha level of .05 and with 3 and 7 degrees of freedom, was 4.3468. The

F Ratio obtained for this ANOVA was greater than a Critical F at an alpha level of .01 with 3 and 7 degrees of freedom, (8.4513) (Dayton, 1970, p. 395).

Since the null hypothesis of no significant differences in eye contact to task, broken without teacher direction, was rejected, ANOVA was computed on the difference scores for reading and mathematics separately.

TABLE 7

READING

EYE CONTACT TO TASK BROKEN WITHOUT TEACHER DIRECTION

Source	df	Sum of Squares	Mean Squares	F Ratio
Treatment	3	3.96	1.32	2.98
Within	7	3.09	.441	
Total	10	7.05		

The F Ratio for reading alone did not reach the Critical F level at the alpha level for .05 for 3 and 7 degrees of freedom. The null hypothesis of no significant differences in non-attending behavior, eye contact to task broken without teacher direction, for reading tasks only, was retained.

TABLE 8

MATH

EYE CONTACT TO TASK BROKEN WITHOUT TEACHER DIRECTION

Source	df	Sum of Squares	Mean Squares	F Ratio
Treatment	3	.613	.204	1.40
Within	7	1.02	.145	
Total	10	1.63		

The F Ratio for mathematics alone was not significant as the Critical F remains 4.3468. The null hypothesis of no significant differences in non-attending behavior (eye contact to task broken without teacher direction, for mathematics tasks only) was retained.

TABLE 9

CHAIR BALANCED ON TWO LEGS

Source	df	Sum of Squares	Mean Squares	F Ratio
Treatment	3	.288	.096	.48
Within	7	1.41	.201	
Total	10	1.70		

There was failure to reject the null hypothesis of no significant difference in non-attending behavior, chair balanced on two legs, in first grade students under three different types of fluorescent lighting.

TABLE 10

OUT OF SEAT WITHOUT PERMISSION

Source	df	Sum of Squares	Mean Squares	F Ratio
Treatment	3	2.44	.81	.38
Within	7	14.65	2.08	
Total	10	17.1		

There was acceptance of the null hypothesis that there was no significant differences in non-attending behavior, out of seat without teacher permission, under the three different types of fluorescent lighting.

TABLE 11

TEACHER REPRIMANDS STUDENT (VERBAL OR NON-VERBAL)

Source	df	Sum of Squares	Mean Squares	F Ratio
Treatment	3	.0402	.0134	1.64
Within	7	.0571	.00815	
Total	10	.0973		

There was acceptance of the null hypothesis of no significant difference in non-attending behavior, teacher reprimands student, in first grade students under the three different types of fluorescent lighting.

CHAPTER V

DISCUSSION

Summary

It is interesting to note that of the five behaviors analyzed with the Analysis of Variance technique, the only significantly different behavior was eye-contact to task being broken, without teacher direction. The count for this behavior decreases from the initial taping to the final taping. This is of particular interest since the taping took place between spring vacations and the end of school, in all classes involved. During the holidays for the students, the lights were masked to the lowest intensity level of the experimental lamps.

With the time frame involved in this study, had there been no change in environmental conditions, it would have been expected that the students would exhibit more, rather than fewer, non-attending behaviors. In general, all of the classes showed some reduction in the number of incidents of non-attending behavior in all thirteen behaviors counted, but only eye-contact to task broken, without teacher direction, decreased at significant levels.

The Critical F for eye contact to task being broken, without teacher direction, reached the level in which such a

statistical difference would be expected to occur by chance only 1 in 100 times. When the ANOVA was computed on the math and reading individually, no significant changes were determined. The computations would seem to indicate that some type of interaction exists between the subject areas which is not apparent in this analysis.

Using the Newman-Kuels comparisons of means on the eye contact to task broken without teacher direction, there were significant differences in some of the means: natural white ≠ cool white; daylight ≠ warm white; and warm white ≠ natural light. The mean change from cool white to warm white was greater than the mean change of cool white to daylight. The mean change of cool white to warm white was greater than the mean change from cool white to natural light. The mean change from the cool white control group was greater than the mean change from cool white to natural light.

All of the teachers in the study had at least three years experience in the classroom. Differences in classrooms could not be attributed to lack of experience by any of the teachers.

The walls in one room in school 2, which had eight fixtures, were painted "a pea-soup" green. By random selection this room was lighted using warm white bulbs as the experimental lighting condition. The longer yellow and orange wave lengths emitted by the warm white bulbs gave the walls the

appearance of being almost a "black-light" fluorescent green.

When the experimental bulbs were replaced by the cool white bulbs that were originally in the room, several experimental lights were interchanged in different fixtures to make an observational point of the differences in the bulbs. The fixtures in this room were positioned in a row of three across the front of the room and a row of three across the back of the room. On each side of the room there was one fixture between the front and back row of light fixtures. In the back row of light fixtures, natural bulbs were put in the fixture by the door. The next fixture was left empty. In the third fixture in that row the warm white bulbs were left in place. In the next two fixtures placed at right angles to the warm white lights, the cool white bulbs were installed. In the corner with natural lights, the wall had the appearance of a turquoise green. The warm white lights in the opposite corner made the wall a harsh, unpleasant green. The wall next to where the cool white lights were placed looked as if it were painted with pea soup. In school 3, the room which drew the warm white lights also happened to be painted a shade of green. The changes in the wall colors were not so evident, but the teacher in that room said that another teacher in the building remarked that every time she entered that room she felt highly agitated. Color psychology combined with lighting factors must be considered in future research studies regarding the lighting

of educational settings.

The number of fixtures that were in each of the eleven school rooms included in the study was not under experimental control. All four rooms in School 1 had nine light fixtures which contained four bulbs each for a total of 36 bulbs in each of the rooms. In School 2, two of the rooms had four light fixtures containing four bulbs each and the third room had eight fixtures each containing four bulbs. In School 3, each of the rooms had 6 light fixtures containing 2 bulbs each. The illumination level at desk top was controlled in each of the schools according to the natural lamp intensity for that school.

The teachers in School 1 became aware that the lights were being manipulated when they returned from their spring breaks. All of the teachers compained that the lights in the rooms were too dim for school work. The foot candle levels were dropped from 170 at desk top level to 90 foot candle level at desk top level. This was done by removing one half of the light bulbs in use in the rooms. The light levels were much less than what the teachers were used to using, but the light levels were not excessively low according to the light levels defined by the American National Standard Guide for School Lighting.

In School 2, the footcandles were lowered to 60 or 65

footcandles measured at desk top level. This lowered level was due to the fact that two of the rooms had only four fixtures, containing four bulbs each.

In School 3, the footcandles were lowered to approximately 60 to 65 footcandles at desk top level. School 3 classrooms contained the eight foot light bulbs, for a total of 12 bulbs in each room.

Conclusions

The thirteen behaviors found in the Activity Sampling List (Appendix B) had decreased frequencies in almost all categories. There were five behaviors that decreased with sufficient frequency to be analyzed. These behaviors were: vocalizes without permission; eye contact to task broken, without teacher direction; chair balanced on two legs; out of seat without permission; and teacher reprimands student (verbal or non-verbal). The analyzed behavior that reached statistical significance in the change data was eye contact to task broken, without teacher direction. This change achieved a statistical significance of chance occurance less than 1 in 100 times.

All of the behaviors on the Activity Sampling List (Appendix B) have a motoric observable component. The eye contact to task broken, without teacher direction, also contains a sensory input which is not apparent in the other

behaviors listed. This behavior may also be interrelated with the coloring of the walls, furniture and rugs in the room.

Implications

The raw data of this study should be further analyzed using three second intervals to determine if the differences in time produces changes other than just the increase in behavior count. It would be of interest to conduct this study again with blind students, those with no light perception, to see if the environmental lighting is a factor inducing increases in motoric behavior. As indicated by previous research, the Critical Flicker Fusion may be a factor of enough importance to warrant more consideration in lighting studies.

The length of time of this study does not seem to reject the possibilities of lighting as an interaction variable in the environment. Significance may be affected if this study could be replicated in the fall or early spring of the year rather than in the last six weeks of school.

Another factor for consideration is that other types of academic activities other than mathematics and reading might show differences which were not apparent with the subject areas chosen for this study.

REFERENCES

American national standard guide for school lighting, Lighting Design and Application, February 1978, 17-42.

Arehart-Treichel, J. School lights and problem pupils. Science News, April 20, 1974, (105), 258-259.

Dayton, C. M. The design of education experiments. New York: McGraw-Hill Book Company, 1970.

English, H. B. & English, A. C. A comprehensive dictionary of psychological and psychoanalytical terms. New York: David McKay Co., Inc., 1958.

Keogh, B. K. Hyperactivity and learning disorders: Review and speculation, Exceptional Children, October 1971, 38(2), 101-109.

Korp, H. Personal Communication. Environmental Protection Agency. Dallas, Texas, September 26, 1977.

Lally, W. J. Personal Communication. Fluorescent Lighting Engineer, Westinghouse Electric Corporation, Bloomfield, New Jersey, October 1977 to present.

Mass, J. S., Jayson, J. K., & Klieiber, D. A. Effects of spectral differences in illumination on fatigue. Journal on Applied Psychology, 1974, 59(4), 254-256.

Mayron, L. W., Mayron, E. L., Ott, J. & Nations, R. Light radiation, and academic achievement: Second year data. Academic Therapy 1976, 11(4), 397-407.

Mayron, L. W., Ott, J., Nations, R. & Mayron, E. L. Light radiation, and academic behavior. Academic Therapy, 1974, 10(1), 33-47.

O'Leary, K. D., Rosenbaum, A, & Hughes, P. C. Fluorescent lighting: A purported source of hyperactive behavior. Journal of Abnormal Child Psychology, 1978, 6(3), 285-289. (a).

O'Leary, K. D., Rosenbaum, A. & Hughes, P. C. Direct and systematic replication: a rejoinder. Journal of Abnormal Child Psychology, 1978, 6(3), 295-297. (b).

Ott, J. N. Influence of fluorescent lights on hyperactivity and learning disabilities. Journal of Learning Disabilities, August 1976, 9(7), 22-27.

Painter, M. Fluorescent lights and hyperactivity in children: an experiment. Academic Therapy, 1976-1977, 12(2), 181-184.

Sharp, T. Personal Communication. Westinghouse Electric Corporation, Dallas Sales Office, September 26, 1977.

Sidman, M. Tactics of scientific research. New York: Basic Books, Inc., 1960.

Sylvania Lighting Center, Sylvania Engineering Bulletin 0-341 Fluorescent lamps. Danvers, Massachusetts.

Wertman, R. J. Biological considerations in lighting environments. Progressive Architecture, September 1973, 79-81.

Westinghouse Electric Corporation, Westinghouse large lamp specification guide (rev. ed.). U.S.A.: September 2, 1975.

APPENDIX A

HUMAN RESEARCH REVIEW COMMITTEE FORMS

TEXAS WOMAN'S UNIVERSITY

APPENDIX A

Jane H. Norris
1707 Dove Loop Rd.
Grapevine, Texas 76051
January 15, 1979

Dear Parents,

Your child's class has been selected to be included in a research study that is being conducted in several first grade classrooms in your school district. This research project has been approved by your district's Superintendent and the building Principal. It is being conducted under the supervision of Texas Woman's University in Denton, Texas.

Your child will be observed in his classroom doing his regular class activities. Your permission is requested for your child to be video taped as he or she is involved in normal class activities. The tapes will be used to reobserve the classroom behavior of the whole calss. No individuals will be identified in any class in the data obtained. Any tapes made will be erased once the data is obtained for the class.

Some additional information from you, the parents, will be necessary to see if the classes are similar for statistical analysis. Again, no individuals will be identified in the final data.

Your assistance and cooperation will be greatly appreciated. Please sign and return the form on the bottom of this page.

Sincerely,

Jane H. Norris
Doctoral Candidate
Texas Woman's University

You (may/may not) video tape my child, _____, in _____'s class.

_____(DATE)

_____
(Signature of parent or guardian)

I understand that I may request that my child's participation in this study be terminated at anytime.

_____
(Signature of parent or guardian)

TEXAS WOMAN'S UNIVERSITY

Human Research Committee

Name of Investigator: Ms. Jane H. Norris Center: Denton

Address: 1707 Dove Loop Rd. Date: December 1, 1978

Grapevine, TX 76061

Dear Ms. Jane H. Norris

Your study entitled ~~Attention to Task by First Graders Under Three~~ Different Lighting Conditions has been reviewed by a committee of the Human Research Review Committee and it appears to meet our requirements in regard to protection of the individual's rights.

Please be reminded that both the University and the Department of Health, Education and Welfare regulations require that written consents must be obtained from all human subjects in your studies. These forms must be kept on file by you.

Furthermore, should your project change, another review by the Committee is required, according to DHEW regulations.

Sincerely,

C. K. Rozier

Chairman, Human Research Review Committee

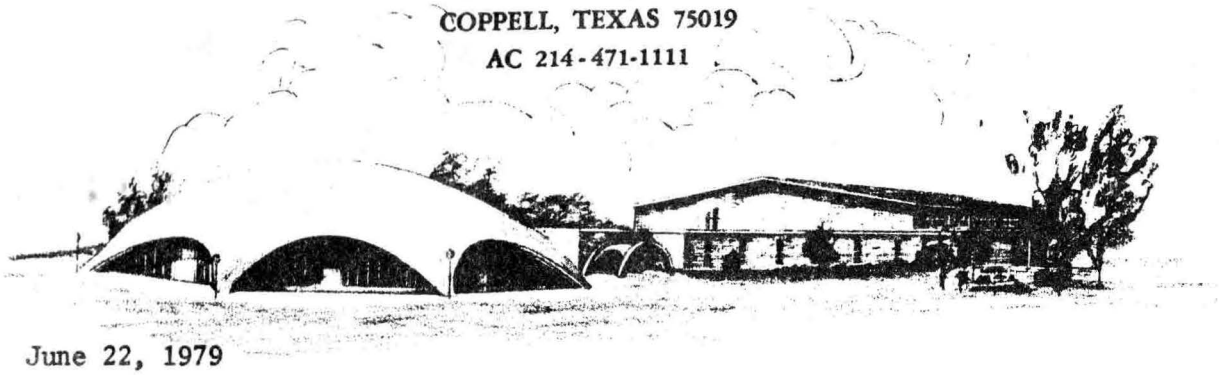
at ~~Denton~~.

COPPELL INDEPENDENT SCHOOL DISTRICT

James A. Mudd, Secondary Principal
High School Office Phone 471-2002

DR. WALTER BINGHAM, Superintendent
401 W. Cowboy Drive
COPPELL, TEXAS 75019
AC 214-471-1111

I. D. Thompson, Elementary Principal
Elementary Office Phone 462-0151



June 22, 1979

Jane Norris
1707 Dove Loop Road #2305
Grapevine, Texas 76051

To Whom It May Concern:

Jane Norris had my permission to conduct research at W. W. Pinkerton Elementary School in Coppell, Texas, in November of 1978.

Sincerely,

Dr. Walter Bingham
Superintendent of Schools

WB/ms

GRAPEVINE
Public Schools

3051 West Highway 121
Grapevine, Texas 76051
A/C 817-481-5575

June 22, 1979

Ms. Jane Norris
1707 Dove Loop Road Apt. #2305
Grapevine, Texas 76051

Dear Ms. Norris,

This is to formally state that you did contact my office and receive permission to do dissertation research in the Grapevine-Colleyville Independent School District at Cannon Elementary.

Sincerely,

Jo Ann Houston

Jo Ann Houston
Assistant Superintendent
of Curriculum

JAH/vg

From the office of:
DR. CLAYTON DOWNING

Lewisville Independent School District

P.O. BOX 217
1800 TIMBERCREEK ROAD
LEWISVILLE, TEXAS 75067
(214) 436-4551

June 28, 1979

TO WHOM IT MAY CONCERN:

Jane Norris contacted me in November, 1978, and at that time received permission to conduct a research program within the Lewisville Independent School District.

Clayton Downing

Dr. Clayton Downing
Assistant Superintendent

CD:ru

From the office of:
WALTON E. VINCENT, Principal

Lewisville Independent School District

TIMBERCREEK ELEMENTARY
1900 Timbercreek Road
Lewisville, Texas 75028
214/ 436-3558

June 22, 1979

Ms. Jane Norris
1707 Dove Loop Road
Apt. 2305
Grapevine, Texas 76051

Dear Jane,

Since my inital contact with you on November 6, 1978 concerning your study,(The effects of lighting on student behavior) I have been very interested in your findings.

I appreciate your courtesy and professional conduct in all our meetings and wish you the best.

I would like to get information on your final findings.

Sincerely,

Walton E. Vincent

APPENDIX B

ACTIVITY SAMPLING LIST

ACTIVITY SAMPLING LIST

1. Pencil or pen tapping surface of desk or book - two or more times in a three second interval.

2. Feet tapping on floor or desk - two or more times in a three second interval.

3. One or both feet in contact with desk, chair, or other student - two or more times in a three second interval.

4. Forcefully slaps or touches another person - one or more times in a three second interval.

5. Crayon placed in mouth - one or more times in a three second interval.

6. Vocalizes without permission - one or more times in a three second interval.

7. Throws object - one or more times in a three second interval.

8. One or both feet not resting on floor surface and in observable motion.

9. Eye contact to task is broken without teacher direction - one or more times in a three second interval.

10. Using equipment from desk (pencil, crayon, scissors, etc.) for purposes other than the equipment is designed for - one or more times in a three second interval.

11. Chair balanced on two legs - one or more times in a three second interval.

12. Out of seat without permission - one or more times in a three second interval.

13. Teacher reprimands (verbal or non-verbal) student - one or more times in a three second interval.

APPENDIX C

ENERGY EMISSION OF F40 LAMPS

IN

ARBITRARY COLOR BANDS IN WATTS

ENERGY EMISSION OF F40 LAMPS IN ARBITRARY COLOR BANDS IN WATTS

Band	Nanometers	Cool White Watts	%	Warm White Watts	%	Daylight Watts	%	Natural Watts	%
Ultra-Violet	380	0.16	1.7	0.13	1.5	0.19	2.1	0.17	2.1
Violet	380 - 430	0.72	7.6	0.46	5.2	0.87	9.6	0.61	7.6
Blue	430 - 490	1.98	21.0	1.15	13.1	2.54	28.0	1.34	16.7
Green	490 - 560	2.35	24.8	1.80	20.6	2.49	27.4	1.68	20.9
Yellow	560 - 590	1.74	18.4	2.06	23.5	1.32	14.5	0.96	12.0
Orange	590 - 630	1.69	17.9	2.13	24.3	1.20	13.2	1.40	17.5
Red	630 - 700	0.81	8.6	1.03	11.8	0.47	5.2	1.87	23.2
	TOTAL	9.45	100.0	8.76	100.0	9.08	100.0	8.03	100.0

Sylvania Engineering Bulletin
0-341, p. 7

APPENDIX D

LEVELS OF ILLUMINATION CURRENTLY RECOMMENDED FOR PERFORMING VISUAL TASKS IN SCHOOL (IN FOOTCANDLES . . .)

LEVELS OF ILLUMINATION CURRENTLY RECOMMENDED FOR PERFORMING VISUAL TASKS IN SCHOOL (IN FOOTCANDLES . . .)

Area	Footcandles on Tasks
Tasks	
Reading printed material	30
Reading pencil writing	70
Spirit duplicated material	
Good	30
Poor	100
Drafting, benchwork	100
Lip reading, chalkboards, sewing	150
Classrooms	
Art rooms	70
Drafting rooms	100
Home economics rooms	
Sewing	150
Cooking	50
Ironing	50
Sink Activities	70
Note-taking areas	70
Laboratories	100
Lecture Rooms	
Audience area	70
Demonstration area	150
Music rooms	
Simple scores	30
Advanced scores	70
Shops	100
Sight-saving rooms	150
Study halls	70
Typing	70
Corridors and stairways	20
Dormitories	
General	10
Reading books, magazines, newspapers	30
Study desk	70

Minimum on the task at any time for young adults with normal and better than 20/30 corrected vision.

Lighting Design & Application February 1978, p. 21.

APPENDIX E

ASSORTED CORRESPONDENCE

OFFICE OF EDUCATION
DR. RICHARD R. FICKEL, SUPERINTENDENT

THE GREAT SEAL OF THE COUNTY OF SANTA CRUZ

COUNTY OF SANTA CRUZ

GOVERNMENTAL CENTER

701 OCEAN STREET SANTA CRUZ, CALIFORNIA 95060
TELEPHONE: 408 425-2241

November 30, 1977

Jane H. Norris
1707 Dove Loop Rd. Apt. 2305
Grapevine, Texas 76051

Dear Ms. Norris:

Thank you for your recent letter concerning "Fluorescent Lights and Hyperactivity," and please excuse the delay in responding.

Unfortunately we have been unable to conduct any further research in this area. The new special education facility you mentioned in your letter has been completed, and the dual track lighting system was installed at the time of construction. We did try to get some state funding to carry out a control study utilizing the new light system, but the project proposal was turned down.

We still have not given up hope, but further research seems to be in a kind of limbo right now. We would appreciate your telling us about any significant material on this subject that you might encounter in your studies, since our interest in the field has not waned.

When we made our project proposal to the state as mentioned above, I was asked to prepare some material for insertion in it. I am including a copy of that, in case it may be of interest to you. However I do not think the references cited are the best.

Once again, thank you for your interest, and I am sorry we could not have been of more help.

Sincerely,

RICHARD R. FICKEL, Superintendent

Marylyn Painter
Public Information Officer
Santa Cruz County Office of Education

MP/ss
Enclosure

PROJECT PROPOSAL re: CLASSROOM LIGHTING--BACKGROUND

The original impetus for this proposal was the experiment in Mrs. Lyons' classroom, described earlier. An equally compelling impetus, however, was the response the experiment elicited in the local educational community. A surprising number of people spontaneously reported their own aversion to the use of fluorescent lighting in the classroom. Examples:

--Teachers at Bonny Doon elementary school reported that two classes transferred to older rooms with incandescent lights exhibited fewer cases of headaches, eyestrain, fatigue, irritability and nervousness, than had been evident the previous year while occupying newer, fluorescent-lit rooms.

--At Santa Cruz Gardens elementary school, the teaching staff was polled by written survey to obtain ideas for the plans of new classrooms to be constructed on that campus this summer. One of the survey statements, with which the teacher might agree or disagree, was: "Fluorescent light has a negative effect on some children; incandescent light is preferable." Of the 14 teachers responding, 13 agreed; one had "no comment."

--It was reported that fluorescent lights are frequently switched off in the clinic conference room where weekly staff meetings of county school psychologists and therapists are held, because the staff claims to have noticed fewer conflicts during meetings at which those lights were out.

However, all these reports (and many similar ones that came to the attention of this office after a description of the Lyons' study was published) are of course subjective. While a negative reaction to fluorescent lighting might be more prevalent than commonly suspected, very few controlled experiments investigating the effects of such lighting on growth and health have been performed. Most research in this area, while thought-provoking, has been done with laboratory animals and plants. Only a minimal amount has been done with students in a classroom setting. Examples:

--In Florida, two first grade classrooms were equipped with full spectrum light fixtures, which had lead foil shields over their cathode ends to keep X-rays from escaping and a wire grid screen over their entirety to ground radio frequencies. These classrooms were compared to two control classrooms, lit by conventional cool-white fluorescent lights. The hyperactive behavior of students in the first two rooms was significantly decreased ($p<.0005$). (See: L. Mayron, J. Ott, et al, "Light, Radiation and Academic Behavior," Academic Therapy, Fall 1974; and also Science News, April 20, 1974.)

--The above experiment also tended to confirm findings of other experiments performed with rats and hamsters: the children in the fluorescent-lit room showed a significantly higher ($p<.005$) incidence of dental caries as compared with pupils in the experimental classrooms. (See Mayron, et al, "Light Radiation, and Dental Caries," Academic Therapy, Summer 1975.)

--An experiment was conducted at Cornell University, using 41 college students as subjects, to determine the effects of different spectra of room lighting on fatigue after a long period of studying. Using objective measures, significantly more ($p<.05$) perceptual fatigue and poorer visual acuity was noted under standard cool-white fluorescent lighting than under full spectrum lighting. (Incandescent lighting was not tested.) (See: J. Maas, D. Kleiber, et al, "Effects of Spectral Differences in Illumination on Fatigue," Journal of Applied Psychology, August, 1974.)

There are various theories as to which factor in fluorescent lighting might be causing adverse effects, if that indeed is the case. Briefly, the differing theories now prevalent could be summarized as follows:

--The "strobe effect." Some speculate that the 60 cycle-per-second flicker of the fluorescent light may have some subliminal effect on the neural system or brain wave patterns of some individuals. It is known that EEG patterns may be altered by light flashing rapidly and at regular intervals--though 60 cps is generally considered too rapid a rate to

most individuals. (It may be noted that one study showed that such alteration of pattern by strobe light was significantly supressed [p=.0041] in a group of hyperkinetic children after they were given stimulant drugs--drugs now commonly administered to such children to reduce hyperactive behavior. See: T. Shetty, "Photic Responses in Hyperkinesis of Childhood," Science, Dec. 24, 1971.) Shetly's study was not concerned with fluorescent lights.

--Deficient color spectrum. John Ott is the most prominent champion of this theory. He claims that the adverse effects of conventional fluorescent lighting can be traced to the fact that they are deficient in the ultra-violet (UV) end of the visible (color) spectrum. (See: J. Ott, "Responses of Psychological and Physiological Functions to Environmental Light, Parts I and II," Journal of Learning Disabilities, May and June, 1968.)

--Emission of other non-visible electromagnetic radiation. This theory holds that the possibly deleterious effects of fluorescent lamps may be due not to a deficiency of UV waves, but to shorter and/or longer wavelengths of the electromagnetic spectrum--such as "soft" X-rays and radio frequency waves--incidently emitted by such lamps. Dr. Lewis Mayron of the Nuclear Medicine Research Laboratory at Hines, Illinois, presents a rather impressive list of references supporting this theory. (See: Mayron, et al, "Light, Radiation and Academic Achievment: Second Year Data," Academic Therapy, in press.) Note: it is speculated that the causal mechanism behind both the foregoing theories is neuro-endocrine mediation--i.e., light or energy, visible or non-visible, may trigger chemical reactions in the brain or body, thus causing a change in the individual's behavior. (See: R. Wurtman, "The Effects of Light on the Human Body," Scientific American, July 1975.)

--The "flat glare" effect. This theory holds that there is nothing inherently wrong with fluourescent lights, except for their placement: they are often placed within the student's line of vision, thus producing eyestrain. Also, some say that the flat, shadowless light that illuminates all details in a room equally may make it more difficult for easily distracted children to concentrate. One study, made in several schools for the deaf, showed that a variable lighting system, with which the teacher might highlight visual learning tasks at will, influenced the pupils to transfer their attention to the appropriate visual at the appropriate time. A study at the Cleveland Teaching Center found that by using supplementary lighting to highlight specific visual aids, attention was increased by a mean of 80 per cent and attention duration by a mean of 52 per cent. (See "A Basic Course on School Lighting," Modern Schools, May 1975.)

--The psychological effect. This is the least dramatic of the theories, but also the least arguable. In the opinion of a surprising majority of people, fluorescent lights simply are not as psychologically pleasing and restful as the warmer incandescent lights we normally have in our homes. This theory holds simply that teachers and children working in a more pleasant environment will work better.

All researchers mentioned above have stated the need for further research in this field.

--prepared by Marylyn Painter
Jan. 1976

American Printing House for the Blind

BOARD OF TRUSTEES

Charles W. Allen, Jr.
John W. Barr, III
Watson B. Dabney
Lyman C. Martin, Jr.
Marion S. Webb, Jr.
James S. Welch

CONSULTANT TO BOARD OF TRUSTEES
Finis E. Davis

MEMBERS EX OFFICIO
Superintendents of Public Institutions for Education of Blind and Chief Officers of State Departments of Education

Incorporated
CARSON S. NOLAND, LL.D.
Vice President and General Manager

1839 FRANKFORT AVENUE
MAILING ADDRESS: P.O. 6085
LOUISVILLE, KY. 40206

Tel. 502-895-2405
TWX 810-535-3449

OFFICERS
WATSON B. DABNEY
President
CHARLES W. ALLEN, JR.
Vice President
JOHN W. BARR, III
Treasurer

January 13, 1978

Miss Jane H. Norris
1707 Dove Loop Road, #2305
Grapevine, Texas 76051

Dear Miss Norris:

This letter is in response to yours of January 6, 1978, requesting information on hyperactivity in blind children. I have no direct information on this but am enclosing a copy of our Bibliography of Research on the Visually Handicapped, 1953-1971. Most references included in it will predate those included in your computer search of ERIC and Psychological Abstracts. Offhand, I don't recall any dealing directly with hyperactivity in the blind; however, you may be able to pick up information on this topic in articles concerned with blindisms (it was considered a blindism at one time), and in articles on retrolental fibroplasia and retinoblastoma, as it has been thought by some to be related to those conditions.

Another person you might contact is Dr. Joan B. Chase of Rutgers' Medical School. At one time she was doing research in which she may have obtained either information about hyperactivity in the blind or references to such.

I am sorry that I cannot be of more direct help to you on this matter.

Sincerely yours,

June E. Morris
Acting Director
Department of Educational Research

JEM/da

Enclosure

Westinghouse Electric Corporation Lamp Divisions

The Westinghouse Plaza
Bloomfield, New Jersey 07003

April 5, 1978

Ms. Jane H. Norris
1707 Dove Loop Road, Apt. 2305
Grapevine, Texas 76051

Dear Ms. Norris:

It was a pleasure talking with you last week concerning information required for your dissertation on School Lighting.

The published literature enclosed relates to our discussion about the color composition of each of the fluorescent lamp colors, as well as the basic lamp data provided in the specification guide. The spectral power distribution for incandescent Illuminant 'A' is included for reference. I did not find the article written by Bellchambers, but did locate a portion of a relevant article by Hopkinson & Collins.

Also included is a typical lighting design problem. The result represents the average lighting level for the room. Light distribution can be determined by point by point calculations described in the lighting design booklet.

The bulletins describing Ultralume show curves describing human visual response correlated to color; it is not the color distribution of the lamp. The humans response to brightness (alone) is represented by the luminosity curve shown on page 1-3 of the photo copied Westinghouse Lighting Handbook text.

We had only briefly discussed the influence of lighting upon human behavior. Light level, the color temperature (^{o}K), color distribution (as CRI) of the light source are particularly important. If you are designing an experiment, either a straight Analysis of Variance, or a Two Level Factorial version, you may wish to include these three factors as variables.

Westinghouse Electric Corporation
Lamp Divisions
One Westinghouse Plaza
Bloomfield, New Jersey 07003

March 17, 1978

Ms. Jane H. Morris
1707 Dove Loop Road, Apt, 2305
Grapevine, Texas 76051

Dear Ms. Norris:

Please accept my apology for this late reply to your inquiry for additional information concerning school lighting. But the enclosed information had just crossed my desk.

I hope that the article will assist you with your paper. The Lighting Design and Applications (LD&A) magazine is a publication of the Illuminating Engineering Society, located in New York City.

The first fifteen pages relate to school lighting applications. The design aspects are then considered. Only the mathematical appendices have been ommitted.

If I can be of any further assistance in providing additional information related to your dissertation, please do not hesitate to write or call.

Very truly yours,

William J. Lally
Fluorescent Lamp Product Planning

WJL:mw

Enclosure

If I can be of further assistance, please do not hesitate to write or call. I would be interested in how your dissertation progresses.

Very truly yours,

William J. Lally
Fluorescent Lamp Product Planning

WJL/mw

Enclosures;

A-8550	A Practical Guide to Fluorescent Lamps
A-9035	Ultralume Fluorescent Lamps
A-9066	Ultralume Fluorescent Lamps
A-8206	Footcandle Levels & Interior Lighting Design
S-400	Westinghouse Large Lamp Specification Guide
SPD	Illuminant 'A'
Chapter (1)	Westinghouse Lighting Handbook
Example Problem:	Kindergarten Classroom
	The Ergonomics of Lighting (Hopkinson & Collins)

UNIVERSITY OF FLORIDA
COLLEGE OF ARCHITECTURE

DEPARTMENT OF ARCHITECTURE

201 Flint Hall

June 27, 1978

Jane Hartwell Norris
1707 Dove Loop Road
Apt. 2305
Grapevine, Texas 76051

RE: Effects of fluorescent lighting on hyperactivity in children.

Dear Ms. Norris:

Sorry, but I have done no work in this area.

Sincerely,

Lee Shaw

Leland G. Shaw (oc)
Professor of Architecture

LGS/bac

Westinghouse Electric Corporation Lamp Divisions

One Westinghouse Plaza
Bloomfield New Jersey 07003

August 18, 1978

Ms. Jane H. Norris
1707 Dove Loop Road, Apt. 2305
Grapevine, Texas 76051

Dear Ms. Norris:

Thank you for your letter concerning the spectral distribution of the light output from fluorescent lamps. You had asked for a breakdown of F30T8 spectral output data that could be easily understood by the committee members concerned with your dissertation.

The data included in the chart you refer to is for F40 lamps and provides the total energy output between wavelength bands. On page 17 of the enclosed bulletin you will note that the intensity of energy at 60 centimeters from the lamp surface is provided in graphic form. Though the form of the Sylvania and Westinghouse data is different you can assume that the watts output in the chart coincides with the intensity shown in the graphs. Unfortunately, I do not have similar data for the Natural fluorescent lamps.

To correlate the difference between the energy output for F40 and F30T8, simply take the ratio of lumen output of the two lamp sizes to determine the spectral energy levels for the F30T8.

I hope the enclosures answer your question adequately. Should you require additional material, please do not hesitate to write or call. My telephone is (201) 465-3461. Please accept my best wishes for success with your dissertation.

Very truly yours,

William J. Lally
Fluorescent Lamp Product Planning

WJL/mw

Enclosures