

1979

The behavioral correlates of alternative lighting designs.

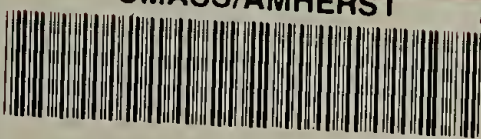
Lauren A. Birenbaum
University of Massachusetts Amherst

Follow this and additional works at: <https://scholarworks.umass.edu/theses>

Birenbaum, Lauren A., "The behavioral correlates of alternative lighting designs." (1979). *Masters Theses 1911 - February 2014*. 1333.
<https://doi.org/10.7275/6870860>

This thesis is brought to you for free and open access by ScholarWorks@UMass Amherst. It has been accepted for inclusion in Masters Theses 1911 - February 2014 by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact scholarworks@library.umass.edu.

UMASS/AMHERST



312066013566223

THE BEHAVIORAL CORRELATES
OF ALTERNATIVE LIGHTING DESIGNS

A Thesis Presented

by

Lauren A. Birenbaum

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE

September, 1979

Department of Psychology

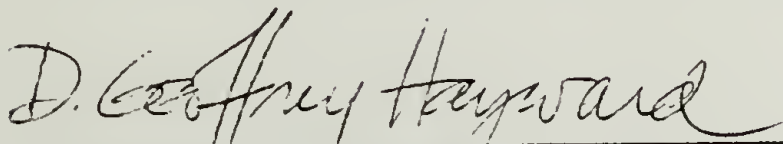
THE BEHAVIORAL CORRELATES
OF ALTERNATIVE LIGHTING DESIGNS

A Thesis Presented by:

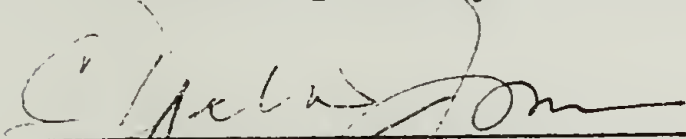
by

Lauren A. Birenbaum

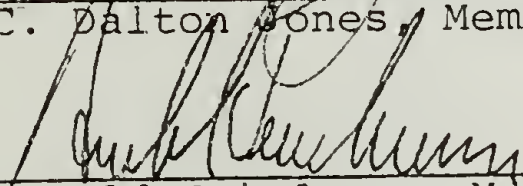
Approved as to style and content by:



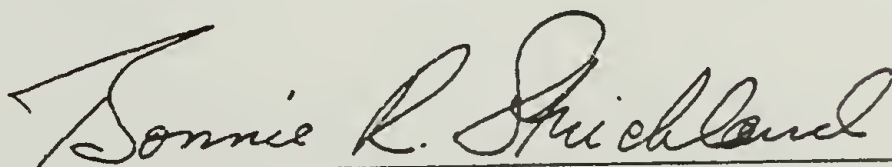
D. Geoffrey Hayward, Chairperson of Committee



C. Dalton Jones, Member



Arnold Friedmann, Member



Bonnie R. Strickland, Department Head
Psychology Department

Acknowledgements

I would like to thank the members of my committee, C. Dalton Jones and Arnold Friedmann for their support and advice. I would also like to give special thanks to Billy Weitzer and Mary Leanoir Brydon-Miller, fellow environmental psychology graduate students, for their invaluable help, encouragement and friendship. Most of all I would like to thank the chairperson of my committee, D. Geoffrey Hayward for his strength, support, advice and inspiration throughout this investigation. Finally, my gratitude to the American Red Cross for their cooperation and assistance during the design and data collection phases of this research.

Abstract

This investigation studied the relationship between human behavior (social, spatial, attitudinal and physiological responses) and two different lighting systems. The study was conducted at a Red Cross bloodmobile site located in the Campus Center at the University of Massachusetts/Amherst. Data was collected under overhead illumination and table lamp illumination (independent variable). Measures included interviews of general impressions, observation of patterns of seat selection and social interactions, pulse rate and blood pressure. Multivariate analysis of variance was initially used (to simultaneously analyze all the variables) followed by further MANOVA tests or appropriate univariate analyses (ANOVA and chi square). It was found that under table lamp illumination donors spent the greater portion of their time in conversation, tended to sit next to one another and felt more socially outgoing and interested in their surroundings than individuals who donated under overhead illumination.

TABLE OF CONTENTS

ACKNOWLEDGEMENT.....	ii
ABSTRACT.....	iii
Chapter	
I. INTRODUCTION.....	1
Task vs. Ambient Lighting.....	3
Spatial Responses to Alternative Lighting Designs.....	5
Social Responses to Alternative Lighting Designs.....	10
Physiological Responses to Alternative Lighting Designs.....	19
Optimal Levels of Stimulation and Adaptation.....	23
Crowding and Stress.....	25
The Overload Concept.....	27
Lighting and its Relationship to Theories of Psychological Stress.....	28
Summary.....	30
II. RESEARCH OBJECTIVES AND PROCEDURES.....	32
Site Selection.....	34
Advantages.....	36
Disadvantages.....	37
Site Description.....	37
Independent Variable.....	42
Dependent Variables and Methods of Data Collection.....	46
Subjects.....	49
Equipment.....	49
Procedures.....	52
Predictions.....	53
III. RESULTS.....	56
Attitudinal Profile- The Interview.....	58
Spatial Behaviors.....	67
Social Behaviors.....	75
Social behaviors in the waiting area..	75
Social behaviors in the canteen area..	83
Physiological Responses.....	87

IV. DISCUSSION.....	89
Attitudinal Responses.....	89
Spatial Responses.....	90
Social Responses.....	93
Theoretical Implications.....	97
Methodological Implications.....	99
Design Implications.....	100
BIBLIOGRAPHY.....	102
APPENDIX A.....	108
APPENDIX B.....	110
APPENDIX C.....	113

LIST OF TABLES

1.	Summary Table of Subject's Previous Donating Histories and Reactions to the Donating Process.....	50
2.	Summary Table for Analysis of Variance: Mean Ratings for Interview Questions Eight and Nine.....	64
3.	Variables Which Significantly Contributed to Differences Between the Behavior of Subjects in the Waiting Area.....	76
4.	Summary of Analysis of Variance: Duration of Reading by Lighting Condition in the Waiting Area.....	78
5.	Summary of Analysis of Variance: Duration of Active Talking by Lighting Condition in the Waiting Area.....	79
6.	Summary of Analysis of Variance: Duration of Active Talking by the Number of Other People Present and Condition in the Waiting Area.....	80
7.	Variables Which Significantly contributed to Differences Between the Behavior of Subjects in the Canteen Area.....	84
8.	Summary of Analysis of Variance: Duration of Active Talking by Lighting Condition in the Canteen Area.....	85
9.	Summary of Analysis of Variance: Duration of Reading by Lighting Condition in the Canteen Area.....	86

LIST OF FIGURES

1.	Floor Plan of Bloodmobile Site.....	40
2.	Waiting Area.....	41
3.	Canteen Area - Overhead Lighting Condition...	43
4.	Canteen Area- Table Lamp Lighting Condition..	44
5.	Overhead Lighting Plan.....	45
6.	Table Lamp Lighting Plan.....	47
7.	Summary of the Distribution of Responses to Interview Questions Five, Six, Seven, Eight and Nine.....	65-66
8.	Distribution of Where Donors Chose to Sit in the Waiting Area.....	68
9.	Distribution of Where Donors Chose to Sit in the Canteen Area.....	70
10.	Distribution of the Number of Other People Present in the Waiting Area.....	71
11.	Distribution of the Number of Other People Present in the Canteen Area.....	72
12.	Where Other Donors Sat Relative to the Subject in the Waiting Area.....	73
13.	Where Other Donors Sat Relative to the Subject in the Canteen Area.....	74
14.	Percent of Time Subjects Spent Reading or Actively Talking in the Waiting and Canteen Areas.....	81
15.	Percent of Total Number of Interactions Initiated by Staff or Donors in the Waiting and Canteen Areas.....	82

C H A P T E R I

INTRODUCTION

For most 20th century Americans, lighting is taken for granted. It is the rare case where a home does not have electricity and is either forced or chooses to use alternative lighting devices. In the public domain it is virtually unheard of not to have electric lights. In addition, increasingly sophisticated technology has made lighting extremely accessible and versatile. Compare, for instance, the lighting in your home and the following description of earlier illumination.

...lighting devices, up to the early 19th century, were all more or less the same for the light they could give; were inclined to deteriorate at varying rates upon which to considerable degree their price depended; were conversely in need of more or less frequent attention, and were usually messy and dirt producing. The cheaper light fuels were, in addition, smelly. A great multiplicity of lights generated a great deal of heat and consumed vast quantities of air (an important point in a theatre, for instance)...¹

Lighting also has had a considerable impact upon working conditions in industrial settings:

The sweated laborer working long hours in poor conditions in the 19th century has been the theme of innumerable treatises on social history. We have been told of the insanitary conditions,

¹O'Dea, William T., The Social History of Lighting, Macmillian, New York, p. 7.

the ignoring of safety measures, the provisions of crude bunks for the young workers forced to sleep at the mills. The machines have been described and the food, clothing, wages, sins and virtues of the workers discussed. The one thing that has rarely been mentioned is the gloom in which they necessarily worked after sundown. Things were better from the 1860's onwards, but compared to modern standards were appalling even then. It was the same in offices. It could hardly be otherwise because the only alternative was to burn a number of candles too great to be contemplated as a economic possibility.²

Examples can be cited to illustrate how almost every facet of 19th and 20th century social, economic and architectural development have, to some degree, been influenced by the technological development of lighting.

Most investigations pertaining to the psychological impact of lighting have been concerned with how lighting is perceived. The area of visual perception, for example, focusing on phenomena such as color perception, size constancy and depth perception provided one starting point for lighting research. Recently, the perception of light has been considered in another context; that of environmental perception. Ittelson (1973) has discussed the distinction between visual perception and environmental perception. Whereas an individual can observe an object, an individual is a participant in the environment. This

²Ibid., pp. 116-117.

implies several important characteristics about the way a person interacts with the environment; 1) a person does not have control over the amount and type of incoming information, 2) there are meanings and messages communicated to an individual which influence one's actions and responses to a particular environment and 3) this information enables the individual to develop a judgement about the general ambiance. This transactional approach defines a complex set of interdependencies between the perception of the environment and the behavioral responses to that environment. Past research, however, has emphasized perception with little attention given to behavior. The investigation of the interaction between lighting and behavior, therefore, is fundamental to the development of an understanding of how an individual formulates expectations, motivations and judgements about his/her environment. A critical need in the investigation of lighting and behavior is how to devise methods which best address the lighting-behavior issues and to unify existing approaches within some theoretical framework. This research was designed to address that need.

Task vs. Ambient Lighting

Currently, the investigation of the relationship between lighting and behavior falls into two main categories;

task performance and the role of ambient lighting on "non-task" behavior.³ The largest area of research is concerned with behaviors associated with lighting for visual tasks. For example, industrialization has promoted investigation of the relationship between lighting and task performance (Hawthorne experiments, by J.F. Roethlisberger, Harvard University Press, 1942). These investigations include task performance studies of perceptual responses to certain lighting conditions. However, this literature does not go far enough in understanding lighting-behavior relationships; it is also important to investigate how lighting influences non-task behaviors.

Research concerned with behaviors associated with lighting for room ambiance (contrasting with visual tasks) has studied individual, non-interactive behaviors such as orientation and circulation patterns, emotional, anxiety or arousal responses to lighting, and illumination as it interacts with attitude and well-being. Social behaviors have also been studied including, for example, interpersonal distancing, noise levels under different lighting conditions, lighting as it affects counseling interactions, and

³Birenbaum, Lauren A., D. Geoffrey Hayward, Lighting and Human Behavior, Amherst, Ma.: University of Massachusetts, The Environmental Institute, unpublished annotated bibliography, 1978.

cues for appropriate social behaviors. This area of research provides a framework from which it is possible to understand the psychological impact of artificial illumination on human behavior (see Birenbaum and Hayward, 1978).

A review of the research concerning lighting-behavior interactions for behaviors other than task performance can be organized into three categories; 1) spatial responses to alternative lighting designs, 2) social responses to alternative lighting designs and 3) physiological responses to alternative lighting designs. These will be discussed in turn.

Spatial Responses to Alternative Lighting Designs

One area of environment behavior research that has used lighting as an experimental variable concerns studies of personal space and interpersonal distancing. Perceptions of distance can be influenced by the intensity, color and type of illumination resulting in changes of observed behaviors.

Nesbitt and Steven (1974) were interested in investigating the role of stimulus intensity and its influence upon personal space. Specifically they hypothesized that subjects would regulate the amount of stimulation received from others by "positioning themselves relative to particular others according to the intensity of stimulation those

individuals provide".⁴ The theoretical foundation was partly taken from Hall (1966) who observed that the closer together people were, the more intense was their experience. In a high intensity environment, therefore, it was expected that people stand farther apart to moderate the total stimulation. Further, Nesbitt and Steven hypothesized that extreme levels of stimulation in the context of personal space are experienced as stressful or adverse, and past data were cited which suggested that stress was a function of environmental setting as well as absolute physical distance.

The study was conducted at a Southern California amusement park. A "stimulus person" positioned him/herself behind a subject waiting in line for one of the attractions. In the low stimulus condition the stimulus person wore conservative clothing and in the high stimulus condition the attire was characterized as "loud" and "brightly colored". In a second study smell was also manipulated. Two lighting conditions were used; high (daylight) and low (nighttime). Measurements were taken of the distance the subject placed between him/herself and the stimulus person. The results

⁴Nesbitt, Paul D., Gerard Steven, "Personal Space and Stimulus Intensity at a Southern California Amusement Park", Sociometry, 1974, Vol. 37, No. 1, p. 105.

indicated that both brighter clothing and the presence of perfume increased the personal distances. There was, however, no significant effect attributable to lighting but it should be pointed out that the poor lighting conditions were sufficiently dim to eliminate the perception of color. Nesbitt and Steven maintained that it was the lack of control over lighting that resulted in no effect and not that lighting would not influence personal distancing. They concluded that personal distancing is a mechanism which can regulate the amount of stimulation received from others and

Finally, without any (or sufficient) outlets, the individual should show some signs of stress. It has already been found that both the presence of others (Cottrell, 1972) and the closer presence of another (Barefoot and Kleck, 1971) lead to behavioral arousal. Increases in illumination level, sound, or temperature might be expected to do the same.⁵

Giesen and Hendrick (1974) also investigated interpersonal distancing by studying the relationship between seating distance and room illumination. Their study differed from the previous experiment in that instead of intimacy as the focus, the primary interest was the affective outcomes of small group interaction. Specifically, the purpose of their investigation was to determine the effect of

⁵Nesbitt, Paul D., Gerard Steven, "Personal Space and Stimulus Intensity at a Southern California Amusement Park", Sociometry, 1974, Vol. 37, No. 1, pp. 113-114.

seating distance on group interaction and to investigate the interactive effects of room illumination and seating distance in determining group evaluations.

Seating distance was varied between two distances. Three levels of illumination were employed; "normal" lighting, dim, and dark as well as one condition where hue was varied. Subjects sat in a circle on cushions and discussed current social issues. Dependent measures included, 1) ratings of moods during the group discussion, 2) ratings of subjects' attitudes toward the discussion topic, 3) questions which served as manipulation checks for perceived seating distance and perceived illumination level and 4) rating of each individual subject by each of the other subjects present.

There were no significant outcomes to the experimental conditions investigated. This suggests that either small group interaction is not influenced by proximity of others and levels of illumination or that the experimental setting and/or the measures were not appropriate. No further investigation has been done, however, which clarifies these issues.

Orientation to the source of illumination is another example of spatial behaviors influenced by lighting. John Flynn (1973) observed that individuals tended to choose seats in a cafeteria so that they were facing an illuminated

wall. Thus, the seats orienting the individual towards the wall were filled first at each table.

In an investigation measuring which path an individual will choose at a left-right decision point, Tayler and Sucov (1974) obtained the following results: 1) when the paths are equally lit, people will most often take the path to the right, 2) people will tend to choose a path if it is brighter, and 3) there is an illumination ratio threshold, below which the brighter path has little effect.

Posture is another kind of behavior which can be affected by lighting. For example, Willard Allphin (1954) investigated school lighting and posture. He photographed children while writing at their desks, and noted the angle which the children tilted their heads, the direction they tilted their heads (right vs. left), and the distance the children placed between themselves and their writing surface. The classrooms were lit by artificial lights enclosed in globes and by windows. Based solely upon his photographs, Allphin concluded that there was no connection between posture and illumination and that school children do not adjust their posture to avoid or reduce daylight glare.

In response to Allphin, Harmon (1954) pointed out that the conclusions Allphin drew were not supported by past research. Further he felt that the methodological weaknesses

of Allphin's investigation did not justify the conclusions presented. Following an extensive literature review of the influence of lighting upon posture, Harmon summarized his position on the field as follows:

It offers promise of revealing quantitative answers to many of the illumination problems of "performance efficiency"; "visual fatigue", "comfort-discomfort", brightness characteristics, and many of the other stresses or strains of visually-centered work which correlates with lighting design .⁶

Social Responses to Alternative Lighting Designs

The studies discussed above involving interpersonal distancing under various lighting conditions also provide evidence for the types of social behaviors which may be influenced by different illumination levels. For example, the investigation of Giesen and Hendrick (1974) explored implications for small group interactions under various lighting conditions. Other social behaviors which have been observed to be influenced by ambient illumination include noise levels, social aggression and affective responses in various social settings.

⁶Harmon, Darrell Boyd, "School Lighting and Posture", Illuminating Engineering, July, 1954, Vol. 49, p. 366.

Sanders, Gustanski and Lawton (1974) conducted their investigation of the effect of ambient illumination on the noise level of groups in a classroom building corridor. They found that noise under low levels of illumination was significantly reduced. This has been one of the few studies conducted outside of a laboratory setting and provides valuable insights into problems which arise with this approach. Primarily, the problem was control. Duration of exposure to the altered environment and the presence of heterogeneous illumination in the low illumination condition characterize two of the problems which were encountered in the investigation.

Carr and Dabbs (1974) investigated the effects of lighting, distance and intimacy of topic on verbal and visual behaviors. They hypothesized that subjects would make one of two types of responses: accommodation or compensation. An accommodating response in an intimate situation would be to respond to increased intimacy with behaviors which would further increase that intimacy (Jourard and Friedman, 1970). If, however, individuals compensate then as the situation became more intimate, the resulting behaviors would attempt to decrease the level of intimacy (Argyle and Dean, 1965, Goldberg, et. al., 1969, and Exline, 1965). A compensatory mechanism is another way to

describe a behavioral mechanism which would aid the individual in maintaining the desired level of stimulation when the intensity of the stimulation deviates from optimal levels.

Lighting was a central variable because it was hypothesized to affect verbalization and eye-contact and was also viewed as an indicator of how the subjects perceived intimacy. If, for example, subjects perceived the dimly lit setting as more intimate than the brighter condition it could be hypothesized that past experience was influencing the subjects' judgement of intimacy since in our society dim lighting is associated with intimate settings. If, however, subjects perceived the brighter setting as more intimate it would be possible to conclude that factors other than past experience were important to the subjects when judging the level of intimacy.

Female subjects were initially interviewed in a room where the experimenter (E) was sitting behind a desk and the subject (S) was sitting in front. Lighting was provided by overhead, fluorescent lamps. E asked S about marriage plans, anger-provoking situations and hobbies, recording eye contact and verbal output. The responses to these questions served as baseline data. Next, subjects were asked if they would answer more personal questions

involving the subject's sexual feelings and behaviors. If the subject agreed they were then taken into a second room which was set up in one of the four experimental conditions combining bright or dim lighting and near or far distancing between E and S. The measures included 1) latency (time between last word of E and first word of S), 2) talking time, 3) total response time, (latency + talking time), 4) percent of talking time, 5) number of words, 6) percent of eyecontact, 7) number of eye contacts and 8) average length of eye contact. A questionnaire was also administered at the conclusion of the experimental session which obtained subjects' perceptions of lighting, seating distances and the interviewer.

Carr and Dabbs predicted the subjects would rate the dimly lit, close distance condition as more intimate than the brightly lit, far distance condition and the overall behavioral response would be one of compensation. In this experiment a compensatory response would be indicated by reduced eye contact and verbal disclosure and increased latency, (pause before beginning to speak) in response to intimacy. Increased eye contact and verbal output and reduced latency in response to the intimate setting would be expected if subjects were accommodating.

The results indicated that subjects were in fact

compensating to the intimate setting. Subjects paused more, used less words and reduced eye contact; in the dim lighting condition subjects compensated even further. The questionnaire revealed that subjects perceived the dimly lit condition as very intimate but also very inappropriate for the interview situation. No effect was obtained for seating distances.

This experiment suggests that lighting interacts with not only visual behaviors but also verbal behaviors and social perceptions. Further, the investigation indicates that lighting can serve as an important source of environmental stimulation which can activate coping mechanisms when it deviates in intensity from an expected or appropriate level.

Richard Page and Martin Moss (1976) investigated the effects of darkness and proximity of a victim. Subjects were found to deliver higher intensity shocks to a "victim" (an experimental confederate), in a dimly lit setting than in a brightly lit setting. The effect was greater when the victim was in close proximity to the subject, rather than isolated in another room. The conclusion drawn by these experimenters was that darkness tends to act as a disinhibitor. The release of social inhibitions in some settings under dim illumination is perfectly acceptable (e.g., in bars), but the implications for dimly lit city streets,

where the disinhibition is expressed as violence, is obvious.

Intensity is not the only aspect of illumination which can influence behavior. Color is also an important characteristic of lighting. Charlan Graff (1978) studied the influence of color on the perceptions of social behaviors. Positive social experiences were associated with high frequency (blue light) illumination whereas negative experiences were associated with low frequency (orange) illumination. Low frequency lighting was also found to be associated with passive accommodation to a particular setting, while active tension release was evidenced to be a characteristic of higher frequency (green) illumination.

Mehrabian and Russel (1974) also reported emotional correlates to color and light intensity. For example, bright illumination was often judged more pleasant by subjects than dim conditions but distinctions were made between brightness and glare. Glare was given a very negative evaluation.

The work of John Flynn and his associates contributed greatly to the understanding of subjective responses to various lighting systems. The concept of user well-being has been systematically explored through his investigations of lighting. Further, he has developed a framework from which to conceptualize how lighting influences perception of the environment.

Patterns of light, according to Flynn, serve as sources of environmental information to which people react in consistent ways. Groups of individuals share "patterns of impressions" about a particular lighting arrangement (Flynn, et al., 1973). That is, the cues or signals from the lighting are interpreted in the same way by the individuals in that particular setting. Many such impressions have social meaning and may influence social behavior. The categories of shared impressions may be summarized as follows:

Perceptual Categories

- impressions of Visual Clarity
- impressions of Spaciousness
- impressions of Spatial Complexity
- impressions of Color Tone
- impressions of Glare

Behavior Setting

- impressions of Public vs. Private space
- impressions of Relaxing vs. Tense space

Overall Preference

- impressions of Preference (like/dislike)
- impressions of Pleasantness⁷

Flynn's framework does not describe specific behaviors which are influenced by illumination nor does it separate task from ambient lighting conditions, but it does begin to organize human responses to lighting in a useful way.

A second contribution Flynn has made to the study of

⁷Flynn, John E., Terry Spencer, "The Effects of Light Source Color on User Impression and Satisfaction", Journal of IES, April, 1977, p. 167.

lighting and behavior has been to investigate appropriate testing procedures. He has explained how differential rating scales for factor analysis, multidimensional scaling and various observation and mapping methods might be used as techniques for lighting research. For example, in one investigation subjects made comparative ratings of six lighting arrangements (Flynn, Spencer, Martyniuk, and Hendrick, 1973). The comparison was made to an initial rating of an arrangement which was in effect when the subject first entered the room. A factor analysis of the rating revealed five factors or "categories of impression" where three of these categories showed a significant difference in impression between two or more of the six lighting arrangements. These categories included: 1) general Evaluative Impression (preference), 2) Perceptual Clarity, corresponding to levels of physical brightness, 3) Spatial Complexity or visual noise or clutter, 4) Spaciousness, referring to the room size and the physical plan of the space, and 5) Formality, or impressions of style or fashion. In a related study using a multidimensional scaling method, judgments of subjects were analyzed for perceived change from one lighting arrangement to another, and a three dimensional solution was obtained which best described those judgments. These dimensions were 1)

peripheral/overhead, 2) uniform/non-uniform and 3) bright/dim. Comparison of the multi-dimensional scaling results and the factor analysis data revealed high correlations between them. For instance, a .99 correlation between the bright/dim dimension and the Perceptual Clarity category indicated that they were measuring the same phenomenon.

Finally, a third contribution of Flynn's research has been to actually supply data and applications of his findings to the area of illumination. Experimental findings support the appropriateness of his methods and indicate that individuals do have shared impressions of the information being communicated via lighting. He has shown that change of the information content of the visual field has an effect on behavior and sensations of well-being (Flynn, Spencer, Martyniuk and Hendrick, 1973; Flynn and Spencer, 1977; Flynn, 1977). An example of the type of application suggested by Flynn's research is the following:

When impressions of general Clarity and Utility are the most prominent purposes of the lighting system, overhead lighting shows measurable subjective reinforcement in this direction. Furthermore, non-uniform overhead systems that light the central portions of the room appear to be more effective in this regard than overhead systems that permit noticeably lower light levels in the central areas. This finding seems to hold up even when the subjects record perceptions of reduced clarity when luminance in the central area is reduced.

(As a separate but related finding, supplementary wall-lighting appears to reinforce general impressions of Clarity.)⁸

It is clear that this approach provides valuable information for those who actually design lighting systems.

Physiological Responses to Alternative Lighting Designs

There have been several approaches to the investigation of the physiological responses to lighting. One approach has been to study the impact on the visual system itself. Maas, Jayson and Kleiber (1974) researched the effects of spectral differences in illumination on visual fatigue. Their work documented physiological responses which occur in the eye in the presence of different spectra of illumination. Their measures included tests of changes in visual acuity, flicker fusion and performance on Photo-electric Rotary Pursuit tests. The results evidenced less perceptual fatigue and better acuity under lighting approximating natural sunlight as opposed to cool white fluorescent illumination.

In an article in the Architectural Ophthalmology (1968) the question was raised pertaining to the point where physiological changes in the rods and cones of the eye become pathological

⁸Flynn, John E., "A study of subjective responses to low energy and nonuniform lighting systems", Lighting and Design Application, February, 1977, p. 14.

(irreversible). It was reported that irreversible blindness occurred in rats after one week of exposure to 700-1000 footcandles produced by fluorescent lighting.

A second area of lighting and its physiological impact is conducted predominantly by photobiologists, and concentrates on how light influences other systems in the body apart from the ones associated with vision. The influence may be direct or indirect. A direct effect of light is a photochemical response through the skin or subcutaneous tissue, one result of which is a sunburn. An indirect response to lighting is through the photoreceptors in the eye. Dr. Richard Wurtman (see Houck, 1979), has described one possible neural pathway which traces an indirect influence. Light entering the eye interacts with the photoreceptors on the retina producing a neural impulse which travels down the optic nerve. This nerve passes through the hypothalamus, a neural area strongly associated with emotions. Finally, through neurochemical channels stimulation reaches the pituitary and pineal glands, the glands which regulate the release of hormones. There have not been studies of the human endocrine system to verify this hypothesized pathway from the eye to the pituitary but Dr. Wurtman has shown that rats raised under cool-

white fluorescent lamps had larger spleens, smaller hearts and smaller gonads than rats raised under full-spectrum illumination (i.e., daylight).

There are many researchers of the physiological influence of lighting who regard light as a necessary nutrient and source of vitamins. Artificial light is considered to be inferior to natural, full-spectrum illumination in providing these nutrients. For example, Dr. Robert Neer of Massachusetts General Hospital and Harvard Medical School associates osteoporosis in the elderly with deficient lighting. He based his work on the findings that rickets in children, (the disease which results in bones becoming brittle) could be virtually abated by exposure to ultraviolet light. Ultraviolet light acts as a natural source of vitamin D, the vitamin which permits the absorption of calcium by the body. Neer hypothesized that osteoporosis is a vitamin D deficiency related disease which was the result of lack of vitamin D in the diet and in the lighting.

The work of Lewis M. Maycon (see Houck 1979), also indicated a relationship between lighting and calcium production. His investigation showed that children who spent their days under cool-white fluorescent illumination had significantly more cavities than children who were

under full-spectrum light.

John Ott, founder of the Center for Light Research, also worked with children. In one of his studies he showed how children exposed to ultraviolet light added to regular school light were less hyperactive, received higher grades and grew faster than children working under fluorescent lighting alone.

In summary, the physiological influence of lighting is wide ranging. Although more studies need to be conducted with human subjects, evidence suggests that artificial illumination can have detrimental effects upon the individual. These effects include visual fatigue, neural activity, heart rate and blood pressure, calcium production, hyperactivity and even cell mutation leading to cancer. Ultra-violet light seems to be the component of full-spectrum illumination which appears to play a major role. Currently, more research is needed to determine the extent of its influence.

Many of the key concepts introduced in the lighting and behavior research tie back into a larger theoretical framework. Three examples from the environment-behavior literature are useful in helping to provide an understanding of how these concepts have been applied; 1) Wohlwill has described adaptation as a balance between psychological

stressors and environmental cues, 2) Stokols has applied psychological stress theory to interpret responses to crowding, resulting in the development of terminology useful for environmental psychologists, and 3) Milgram presents the concept of overload in environment-behavior terms. These three examples are followed by an integration of psychological stress theory with environment-behavior applications.

Optimal Levels of Stimulation and Adaptation

Wohlwill (1974) presents the concept of an optimal level of stimulation in terms of human adaptation to levels of environmental stimulation. He describes levels of adaptation as a function of the individual's expectations. This concept is illustrated by looking at the correlation between environmental stressors and psychological stressors. For example, there is an optimal level of room temperature which maximizes comfort. If the optimal temperature deviates in either direction, the room is perceived as too cold or too hot. In a similar way, there is an optimal level of psychological stimulation which if exceeded in one direction is experienced as understimulation (e.g., sensory deprivation), and when exceeded in the

other direction is experienced as overstimulation, (e.g., overload). Further, as a result of past experience (Milgram, 1970, and Stokols, 1976, add other factors including personal characteristics and attitude) an individual develops expectations about the physical setting which suggest behaviors which are appropriate for that setting. The dimensions of the stimulation which compose the expectations are the intensity, the diversity and the patterning of the stimuli. Deviations in expectation require the individual to activate coping mechanisms which enable readaptation to occur. Wohlwill writes,

What is the significance of such adaptation-level processes for the optimal level of stimulation hypothesis and, more generally, for the manner in which the individual response to particular levels of environmental stimulation? Their relevance resides in the strong possibility that such optimal levels, rather than representing an intrinsically determined characteristic of the effects of stimulus dimensions on the individual, are a function of his history of experience with such dimensions, resulting in the establishment of relatively stable adaptation levels to which expressions of preference or other affective responses become related.⁹

This approach suggests that lighting may influence an individual's behavior if the levels and patterning of illumination do not coincide with an individual's optimal

⁹Wohlwill, Joachim F., "Human adaptation to levels of environmental stimulation", Human Ecology, 1974, Vol. 2, No. 2, p. 134.

level of stimulation as determined by previous experience in similar settings. Further, it suggests that the individual will adapt his/her behaviors to cope with the change in optimal stimulation.

Crowding and Stress

When an individual is placed in a situation where adaptation is necessary, 1) how does an individual determine when a change in behaviors or adaptation is necessary, 2) what mechanisms mediate the adaptive processes and 3) what are the resulting responses of changes in behavior? Stokols (1976) addresses these questions from the perspective of crowding. In his analysis, crowding is experienced as excessive stimulation. Stokols gave the following definition: "The state of crowding exists and is perceived as such by an individual when the individual's demand for space exceeds available supply of such space."¹⁰ An individual is signaled of the deviation from their optimal level of stimulation by the experience of stress. In Stokols' discussion stress is only given negative qualities but it may also have positive qualities; increased awareness is one example. The stress may have

¹⁰Stokols, Daniel, "A social-psychological model of human crowding phenomena", AIP Journal, March, 1975, p. 75.

either psychological qualities such as cognitive inconsistency or emotional imbalance (e.g., infringement or alienation), or physiological qualities as, for example, disequilibrium of internal states (e.g., rise in blood pressure, temperature, etc.). Further evidence which supports this interpretation is provided by the work of Glass and Singer (1969) which showed how some levels of noise were experienced as stressful and even resulted in lowered tolerance for frustration.

An individual's response to a crowded situation is to adapt his/her behaviors such that stress is alleviated. Ideally the individual seeks to make the smallest behavioral change possible in returning to an optimal level of stimulation - that is to determine the smallest cost for the greatest benefits. "No response", therefore, would indicate that the deviation from the expected level of stimulation was not great enough to either be perceived by the individual or to warrant the energy required to adapt.

The nature of the responses to stress may be behavioral, perceptual or cognitive. For example, an individual in response to a crowded classroom may either leave the room, concentrate only on the professor, thereby filtering out the sensation of crowdedness, or may

rationalize to him/herself that is it only for fifty minutes so it is bearable. The individual may choose the second alternative because it not only permits ignoring the discomfort due to crowding but also allows the individual to benefit from the lecture. The implications for lighting are that an individual, when placed in a situation where lighting is not optimal, will be alerted to the deviation from optimal stimulation by the experience of stress, and that the resulting adaptive behaviors will be in response to that stress.

The Overload Concept

The generalization from the work of Stokols to lighting is supported by the approach presented by Milgram (1970). Milgram applies the "overload" concept to an individual's experience of the urban environment. Overload occurs when an individual is bombarded by too many inputs to be processed simultaneously or the inputs are occurring too rapidly to be absorbed. When a person finds him/herself in an overload situation, adaptation occurs so priorities can be set and choices can be made. The adaptive responses which result may be 1) the individual spends less time with each input, 2) the individual disregards low priority inputs, 3) redefinition of social interactions occur, 4)

undesirable input is completely blocked out, 5) filtering devices are activated which decrease the intensity of the input, and 6) specialized institutions are created to absorb input that would otherwise be overwhelming to the individual. Milgram's organizing theory would include lighting as a possible source of overload and therefore, the responses and mechanisms which he discusses become applicable to situations where levels or types of illumination deviate from optimal levels.

Lighting and its Relationship to Theories of Psychological Stress

Up to this point lighting has been discussed from a variety of environment-behavior perspectives. It is helpful to note, however, that these approaches can be set within an even larger theoretical framework. The concepts of optimal level of stimulation and overload, for example, are of major theoretical value to theories of psychological stress and coping.

R.S. Lazarus (1966) has described stress as a psychological condition of an individual involving the anticipation of the inability to effectively cope with some future event. Further, the event carries highly negative consequences if the process for coping is inappropriate; therefore, it is critical to evaluate the coping strategies

available and activate the one which is maximally adaptive. One implication for lighting is that light may serve as a source of information from the environment about the potential threat of a situation, and the appropriateness of the available coping strategies. An understanding of the processes involved in threat appraisal and evaluation may provide insight into how behaviors are influenced by lighting.

A model of a generalized adaptation to stress in which the dynamic, transactional nature of stress is emphasized was developed by B.S. Wild and C. Hanes (1975). According to this model the perceptual domain refers to responses to the stressor situation which are perceived and evaluated. First order responses involve the initial perception of the stressor event. A second order response is an evaluative phase where adjustments are made to the stressor event relative to internal and external mediating factors. Finally, third order responses are the perception and evaluation of inconsistencies between external pressures and internal strain (Kahn 1970). The response mediated through the perceptual domain is subject to redefinition. Feedback, amplification, overload and cost-benefit analysis are factors which are influential in this redefinition. Light carries information to the individual

about the stressor event and could influence the response by providing information contributing to perceptions of these factors.

Summary

In the past lighting research has been dominated by the investigation of the perception of light. Current environment-behaviors perspectives, however, have emphasized the importance of behavior in understanding the processes involved in environmental perception. When behavior has been studied task performance has been of major interest. In this review, however, research has been presented which shows that non-task behaviors can be influenced by ambient lighting conditions. These behaviors include spatial responses, social responses and physiological responses to various types of illumination.

Optimal stimulation levels and overload are two concepts which aid in the formulation of a theoretical framework for understanding the lighting-behavior relationship. These concepts have been developed in theories of psychological stress and coping. Environmental psychologists have applied the transactional approach in the attempt to describe environmental determinants of behavior. Wohlwill (1974) has described in detail how the optimal level of stimulation concept is critical to understanding how an individual adapts to different levels of environmental

stimulation. The transactional approach to the stress phenomenon has also been applied to environment-behavior research by Stokols and Milgram further providing a link between psychological stress theory and environment and behavior issues. Their research has translated psychological stress models into environment and behavior terms and has provided applications.

The implications of this theoretical framework for lighting-behavior research is that an understanding of the processes involved in appraisal and evaluation of a stressful situation may help in the prediction and explanation of behaviors which are influenced by various lighting designs.

C H A P T E R I I

RESEARCH OBJECTIVES AND PROCEDURES

Lighting-behavior research provides one example of how people extract information from the environment that either reinforces response patterns already acquired or brings about a change in response. A theoretical framework for the investigation of the lighting-behavior relationship can be culled out of existing environment-behavior research but how the process works-- that is how lighting interacts with social, spatial and physiological responses-- has little experimental support. The need exists for research to develop methods which measure the behaviors of interest and provide further insight into the processes which are involved. The purpose of this investigation is to pilot some possible research strategies and to begin to test the hypothesized theoretical framework.

With this purpose in mind the research objectives can be summarized as follows:

1) As stated earlier the work of John Flynn and his associates has made a significant contribution to discovering the perceptual influences of lighting. How to measure behavioral changes has not yet been systematically studied. One objective, therefore, is to focus on behaviors

influenced by lighting, not perceptions.

2) To develop methods useful in investigating the relationship between lighting and behavior. Initially, it is imperative to determine behaviors which actually occur in the real setting. For this reason a field study is the most appropriate experimental design for a pilot investigation. Further, a multimethod approach would provide valuable cross-validation of the findings.

3) To begin to define design criteria in terms of behavioral needs as well as physical needs which ultimately will provide useful information to architects and designers. One point of developing a theoretical construct for lighting-behavior investigations was to provide a foundation from which prediction was possible. This research should be communicable to those who need to actually plan lighting systems. The results of these studies should work toward providing design suggestions.

4) To optimize an individual's sense of well-being by obtaining an understanding of the environmental elements which influence behaviors contributing to or hindering feelings of well-being. Especially in public spaces and institutions (e.g., schools, hospitals and prisons) environmental conditions should approximate optimal levels of stimulation because it is in these settings

that the lack of opportunities for physical control represent a direct limitation on individuals' abilities to adapt. Restricted opportunities for adaptation are likely to produce stress.

Site Selection

Some understanding is required of how people respond to various types of lighting in the actual settings where the lighting will occur. The first step, therefore, is selection of an appropriate site for investigation.

A basic criterion is that there is an apparent need for lighting research. Residential lighting is often under the control of the individual and presumably satisfies the tastes and needs of that person. Institutional lighting, however, does not afford the individual that same control. The need to determine aspects of institutional lighting which most influence an individual's response to that setting become of primary interest.

The next step is to determine which type of institutional setting to study. A large part of this decision is based upon feasibility. The site itself should be flexible in order to accommodate several experimental procedures or tests of methods. It should be a site where the design implications are of interest to designers,

architects and engineers. Individuals in the particular setting should benefit from the outcome of the study. Finally, ethical restrictions are imposed upon the experimenter determining the extent to which manipulations of a specific environment are possible. In most field studies, major disruptions of procedures and functioning are not tolerated.

Based upon the above considerations, health services settings were selected as the particular sites for investigation. There have been previous investigations which clearly indicated that even minor design alterations can produce observable changes in attitudinal and behavioral responses to a hospital setting (Becker, 1977). The bulk of investigations, however, have indicated that there is a lack of standards and little basis for determining the optimal lighting in hospital patient rooms, operating rooms and hospital or clinic waiting areas. The IES Handbook (Beck, 1976) recommends for hospital waiting areas a general illumination level of 200 footcandles and for local reading 330 footcandles. Comparatively the U.S. Public Health Service suggests general lighting to be 10 footcandles and reading illumination between 20-30 footcandles (Architectural Record 1963). One study has indicated that a "safe" reading level for humans is about 20 footcandles (Archives of Opthamology 1968) although the

study noted how some designers urge bringing sunlit, out-of-doors illumination levels inside; that is they suggest bringing approximately 10,000 footcandles indoors! There has been virtually no behavioral research upon which the existing standards have been based. Clearly health services settings would benefit from the investigation of the lighting-behavior interaction.

Weighing the advantages and disadvantages of various health service environments, blood donor sites were selected. These advantages and disadvantages may be summarized as follows:

Advantages. In the blood donor setting the naturally-occurring behaviors are among those which are hypothesized to be influenced by lighting: that is, the opportunity for social interaction, visual exploration and physical orientation to take place.

Measures can be collected unobtrusively. For example, the physiological measures in the study are the same as the measures which the nurses collect from all individuals before they are permitted to give blood.

There is the ability to control the amount of time the individual will spend in the setting. For example, there is a set amount of time the individual must remain in the recuperative area after giving blood. This solves

the problem which exists in clinic settings where people leave the setting directly after their appointment making follow-up measures impossible. The treatment of the subjects is held constant. In most health services settings people are there for different reasons, therefore, in the doctor's office the individuals receive different treatments. At the blood donor sites all individuals receive the same treatment.

Depending upon the location of a particular site, different groups are available for giving blood. For example, the University of Massachusetts sites recruit mainly students.

The individuals are healthy when they enter the setting. This eliminates the confound of illness interfering with the experimental manipulations.

Disadvantages. The anxiety produced by giving blood may interfere with the experimental manipulation.

No two sites have the same physical design. This influenced the ease of adapting the lighting to a particular experimental condition. It also challenges experimental validity and reliability of measures across settings.

Site Description

One of the bloodmobile sites operated by the American

Red Cross is located in a conference room on the ground floor of the Campus Center building on the University of Massachusetts/Amherst campus. It is operated weekly during each semester.

All blood donor sites consist of three areas. The first is the waiting/reception area. People entering the site are met by a nurse or volunteer in charge of registering each individual, and collecting medical histories. Included in this area is the reception table, a table where medical histories are taken and, a seating area for people to wait if necessary. The second area is where the blood is actually drawn. The number of donating beds varies depending upon the size of the site. The third area is the "canteen". Donors are encouraged to wait approximately fifteen minutes before leaving the site. During this time nurses watch donors to insure there are no ill-effects from giving blood. Typically this area has table and chairs arranged in a dining style, and cookies and beverages are served.

At the particular site in the Campus Center, the waiting and reception areas were located in the corridor outside the room where the donating took place. The registration table was placed directly in front of the door to the donating room and seven chairs were arranged in a U-shaped

configuration to one side of the registration table. The corridor was lit by overhead incandescent spotlights. Four spots were located over the waiting area and two over the registration table. The site was located at one end of the corridor making it possible to separate the waiting area from the rest of the corridor by use of an 8' x 6' screen. The corridor itself was carpeted. The walls were concrete and the ceiling was acoustic tiles (see figures 1 and 2).

Under the existing lighting conditions, the average light level was 44 footcandles in the waiting area, and 21 footcandles at the registration table.

In the donating room itself there were four separate stations: 1) a table where medical histories were collected, 2) the table for the technician who processed the blood, 3) the donating beds and 4) the canteen area. These four stations are illustrated on the floor plan. All the tables and chairs were provided by the Campus Center. The Red Cross brought with them the donating beds, supplies for the canteen area, medical supplies and equipment for processing the blood. There were six overhead fluorescent fixtures with two lamps in each fixture providing 35 footcandles at the level of the tables. The room was carpeted. Two walls were panelled with cork, and

BLOODMOBILE SITE

1. WAITING AREA
2. REGISTRATION
3. MEDICAL HISTORIES
4. TECHNICIAN
5. DONATING BEDS
6. CANTEEN AREA

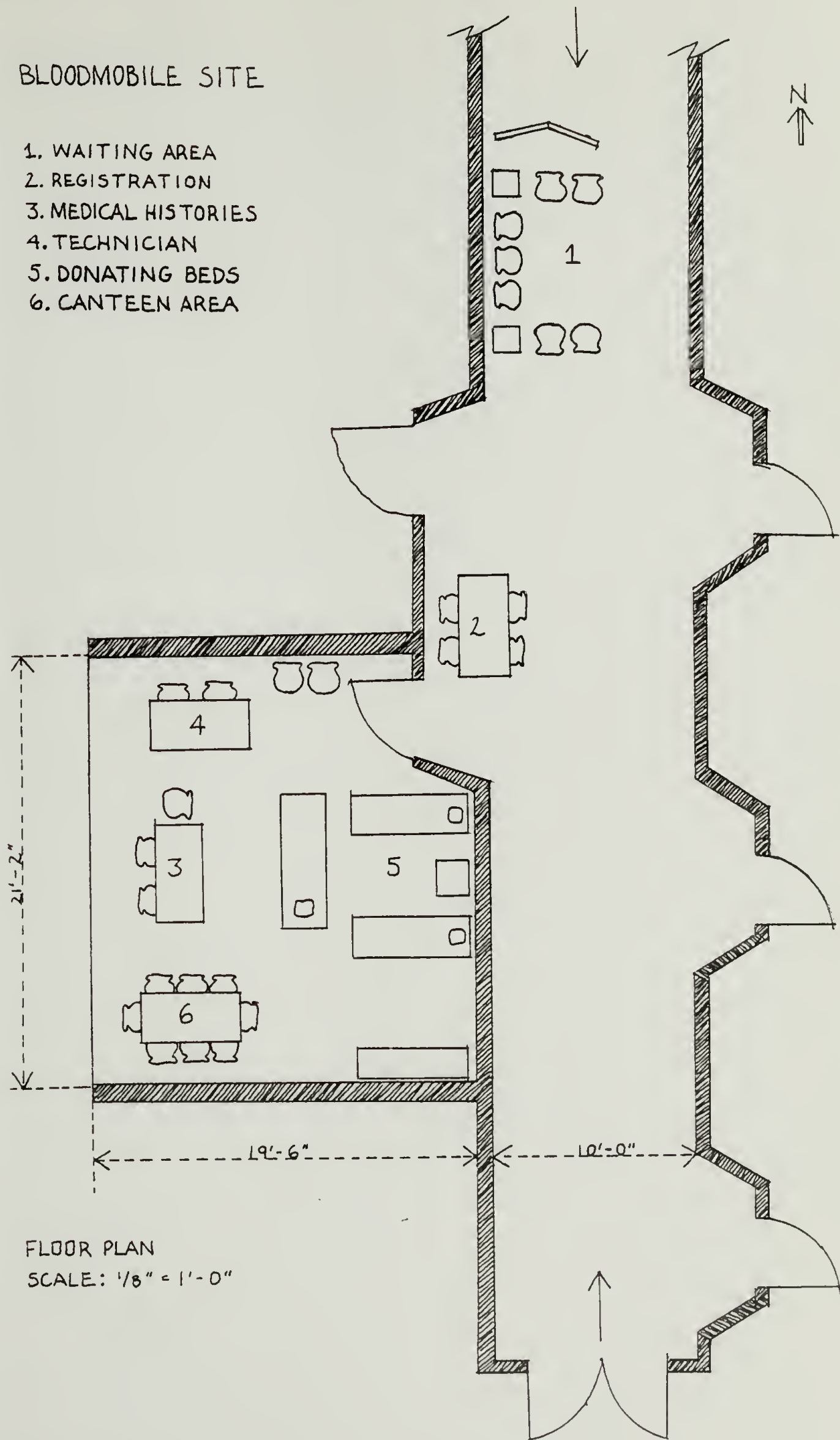


FIGURE 1



OVERHEAD CONDITION

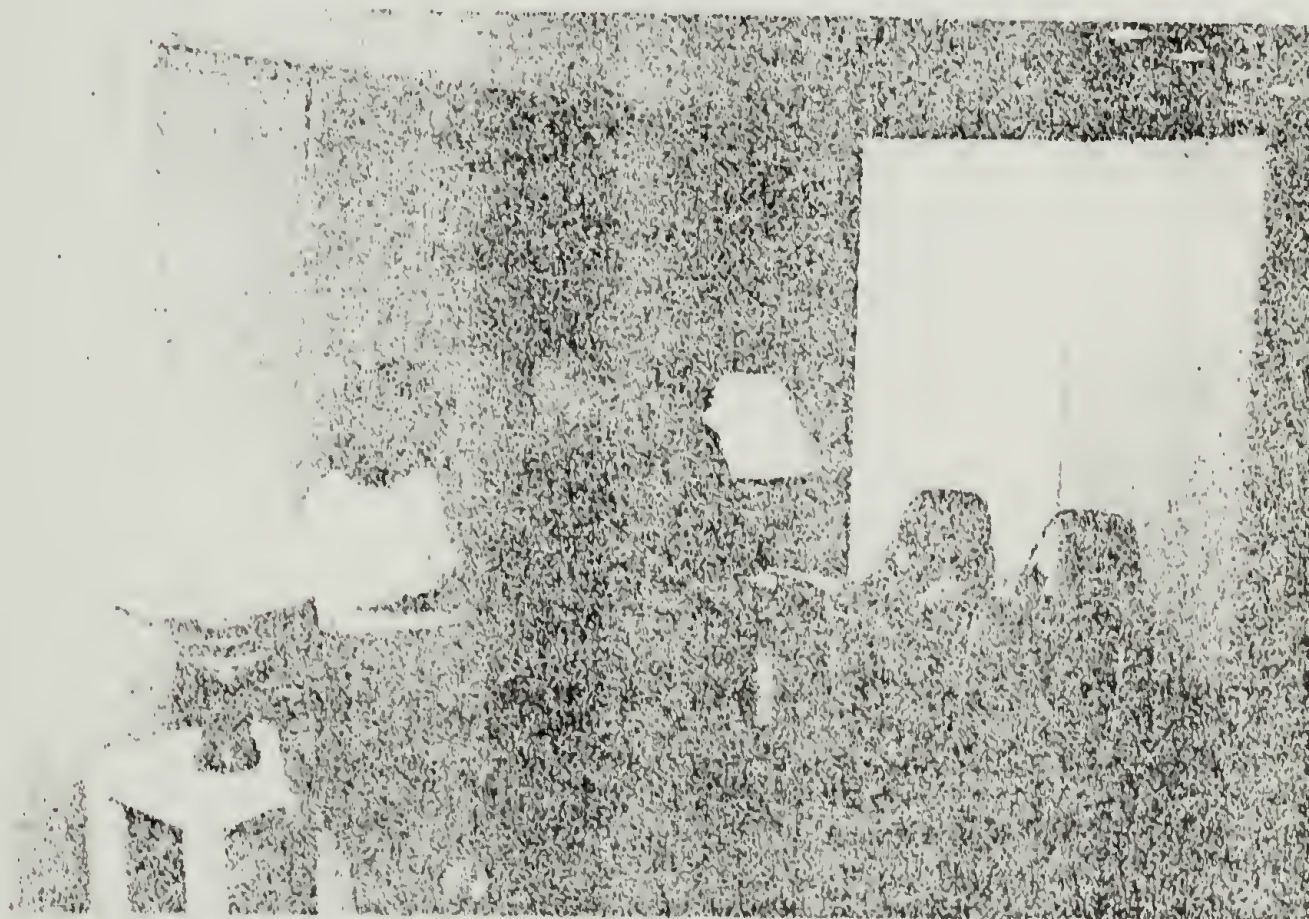


TABLE LAMP CONDITION

FIGURE 2
THE WAITING AREA

two walls were white. Photographs of the donating room (see figures 3 and 4) give some indication of the cramped feelings in the space. Actual dimensions are specified on the floor plan (figure 1).

The blood donor staff included three nurses, a technician, and a volunteer. The nurses rotated tasks: a nurse was always by the donating beds, one nurse took medical histories and the third floated, filling in where needed. The technician was at his station or going out for more supplies. Usually the volunteer spent only a portion of the time at the site. Her job was primarily organizational, making sure signs were posted and appointments were made. In this study the experimenter was located at the registration desk to greet people and insure that consent forms were signed.

Independent Variable

The principle independent variable for this study was the lighting system (and resulting ambient lighting conditions from each system). Two examples of this variable were studied: an overhead lighting system, and an arrangement of table lamps. The existing lighting condition was characterized by overhead incandescent spots in the waiting area and overhead fluorescent lamps in the donating and canteen areas (figure 5). In the experiment-



FIGURE 3
THE CANTEEN AREA
OVERHEAD LIGHTING CONDITION

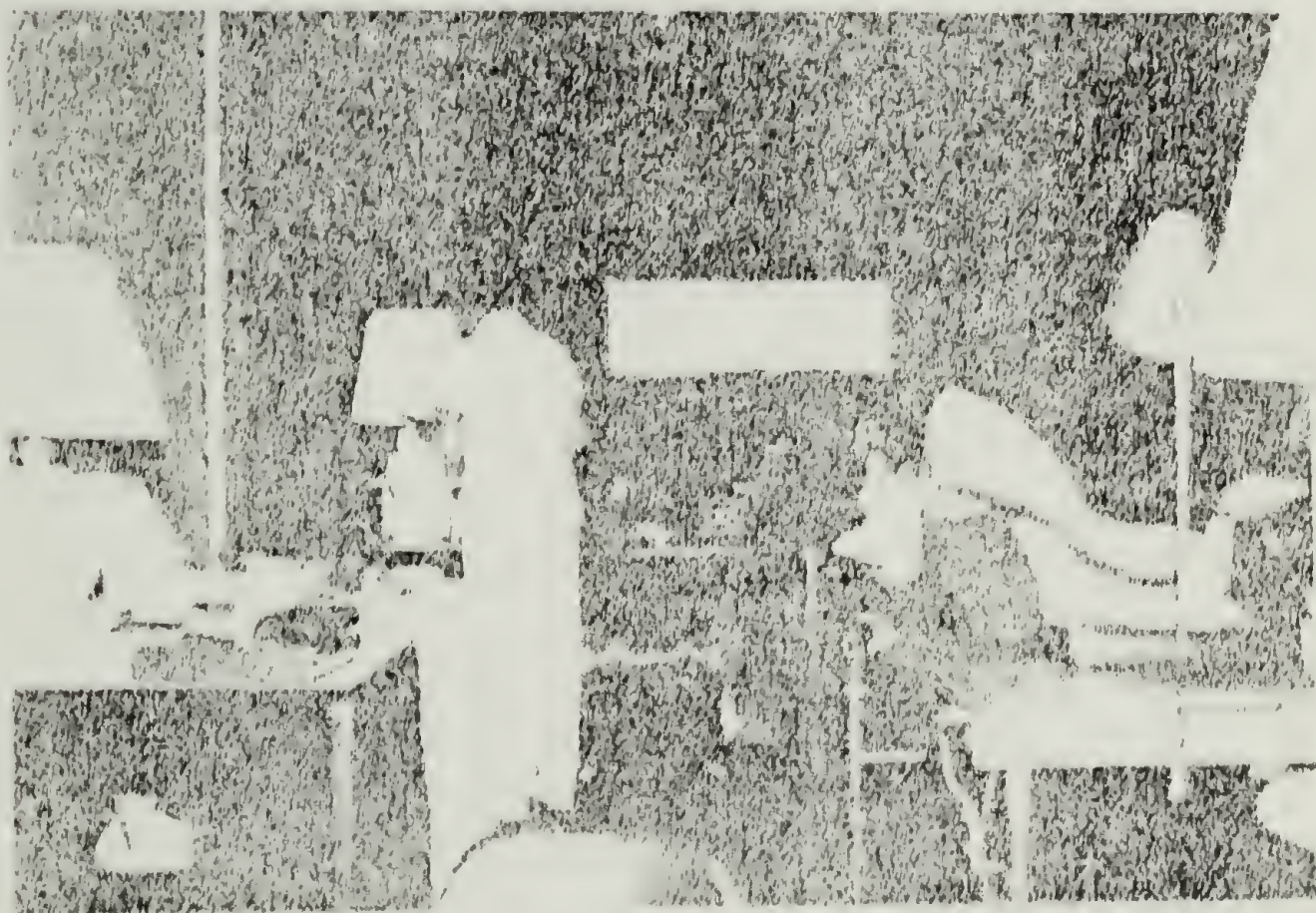
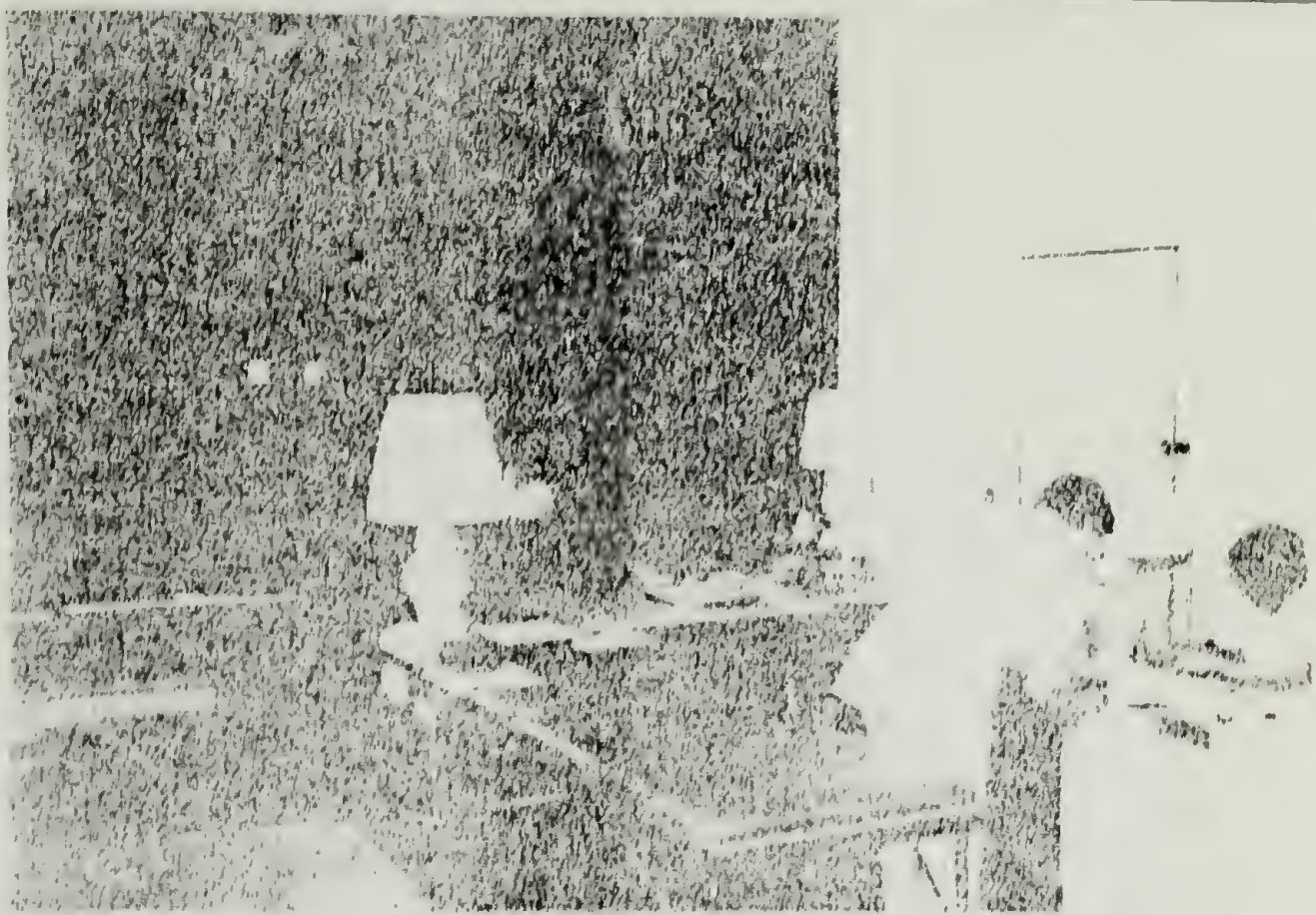


FIGURE 4
TABLE LAMP LIGHTING CONDITION
THE CANTEEN AREA

BLOODMOBILE SITE

⊗ INCANDESCENT
⊠ FLUORESCENT

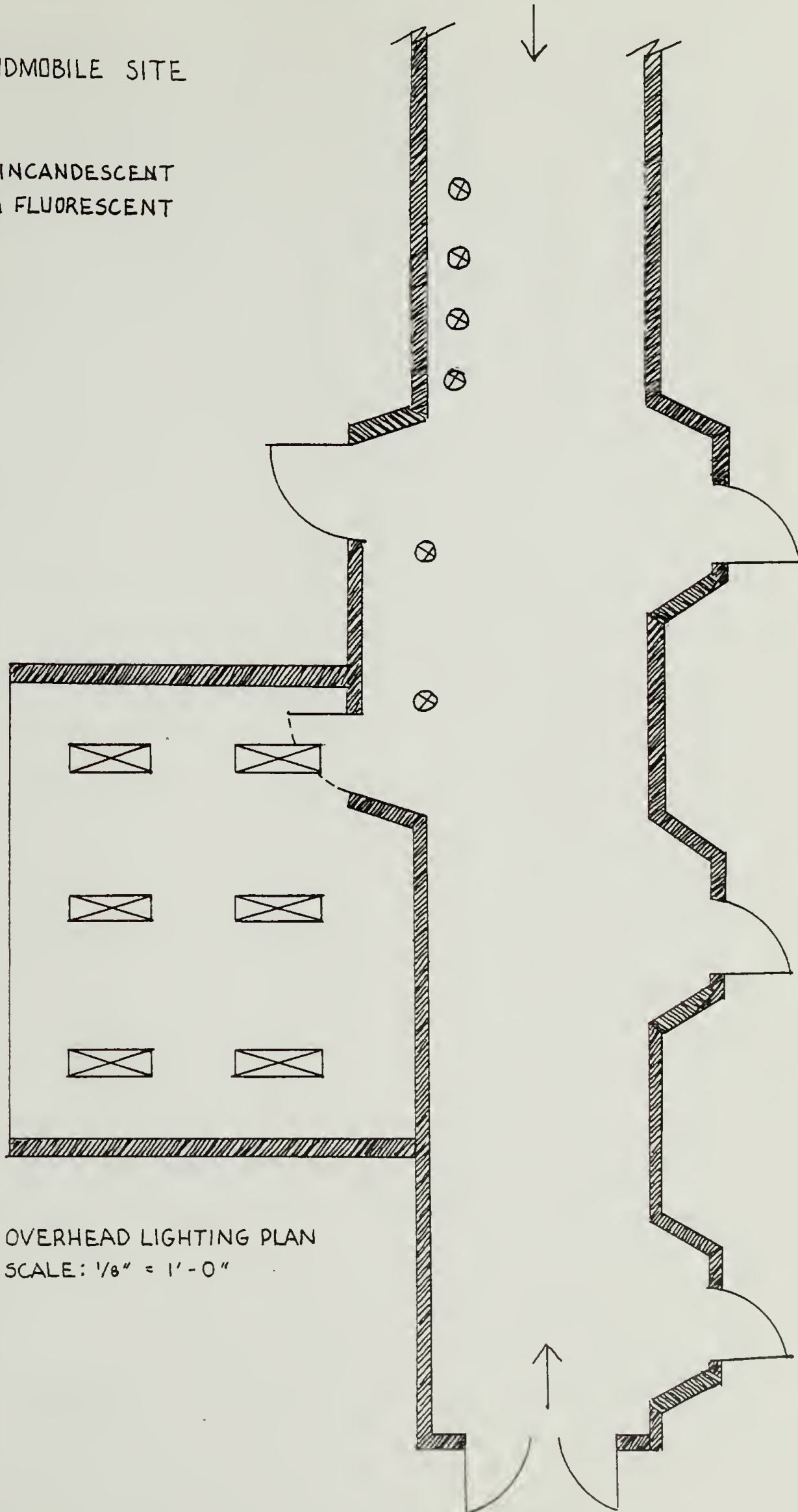


FIGURE 5

al lighting condition all overhead fixtures were turned off and were replaced by table lamps. In the waiting area two table lamps were placed on end tables (figure 6). Inside the donating room there were a total of six table lamps; one at the head of each donating bed, one on the medical history table, one at the technicians station and one at the canteen area (the placement of lamps was such that one of the other table lamps was also adjacent to the canteen area, making a total of two; see figure 6). Further, a clamp-on lamp was attached to each donating bed to insure that the nurses had enough light to see the veins in the donor's arm.

Dependent Variables and Methods of Data Collection

Four different types of measures were obtained for each individual: physiological, spatial, social and attitudinal.

The physiological measures included pulse rate and blood pressure. Pulse rate was obtained at two separate times: first when the individual entered the setting (at the registration desk) and a second time while the person was giving their medical history to the nurse. Blood pressure was also taken by the nurses during the medical history interview.

BLOODMOBILE SITE

⊗ TABLE LAMP

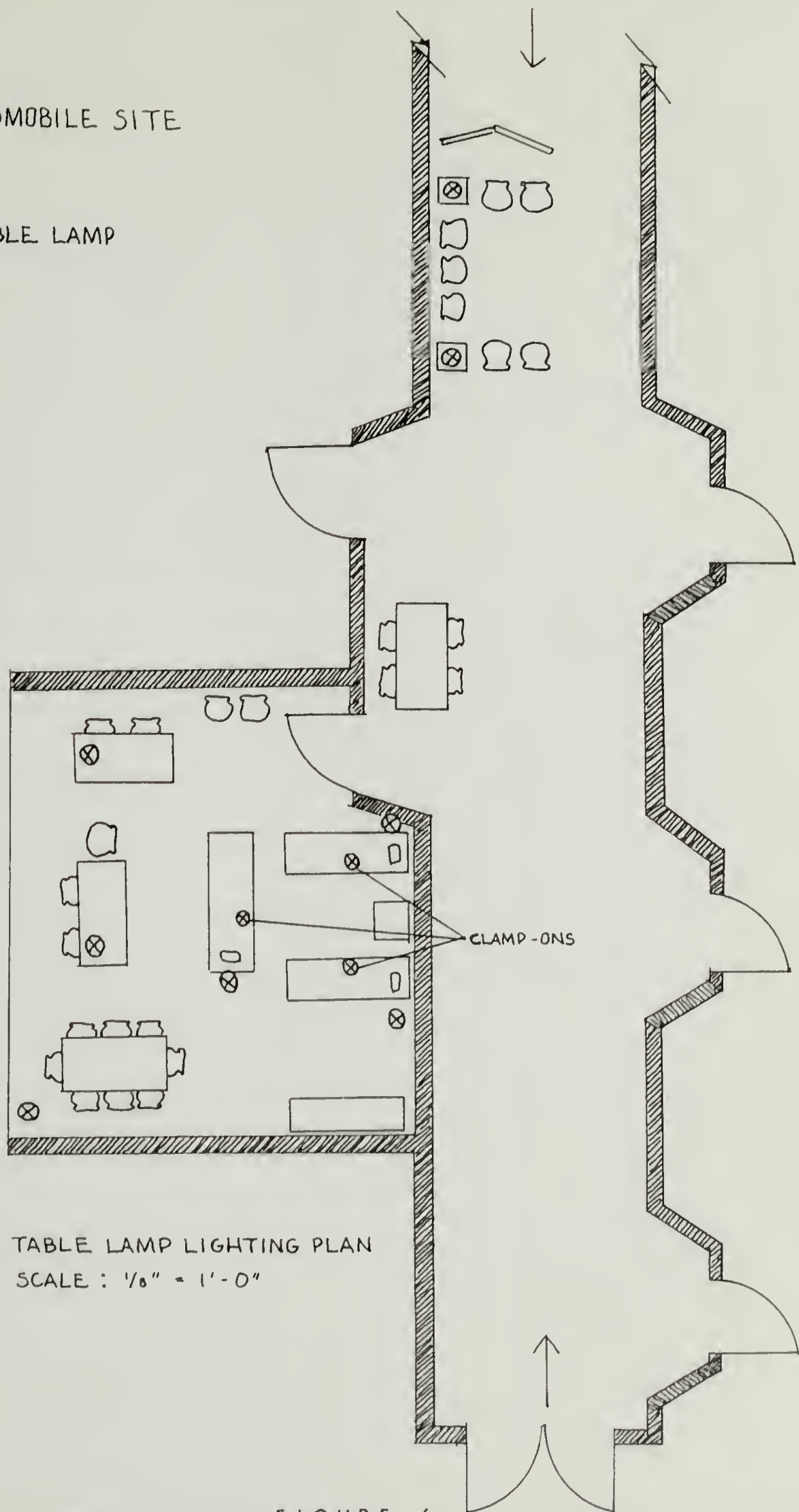


TABLE LAMP LIGHTING PLAN
SCALE : $\frac{1}{8}" = 1'-0"$

FIGURE 6

Spatial information included the length of stay in the canteen and waiting areas, the seat selected by the subject in each area, the number of other people present in the waiting or canteen area, and the location of the others present.

Measures of social interactions included the number of instances and the duration of talking with others, the initiator of such social interactions (staff or donor), an assessment of the content of the interaction (related or unrelated to donating blood), and whether the subject was actively or passively involved in the interaction. These measures were collected by recording a behavioral profile of each subject (by observation) in both the waiting and the canteen areas. Thus, passive and non-interactive, solitary behaviors were also recorded. In this study passive participation was defined as paying attention to and following a conversation between other individuals but not contributing verbally to that interaction. Solitary behaviors included, for example, reading, writing and looking around.

An interview provided a sense of the moods and attitudes of the donors. Questions investigated whether or not the lighting was noticed, if the site met with expectations, if the site was appropriate for a bloodmobile, how responsive and interested the individual was to the surroundings,

how socially outgoing the individual felt and, in general, how the person reacted to the donating process.

Subjects

Subjects were predominantly students from the University of Massachusetts/Amherst between the ages of 18 and 22. A total of 135 people were observed; 66 in the existing lighting condition and 69 in the experimental lighting condition. Subjects were both male and female (68 female, 67 male). Most people came to donate blood by themselves (80.9%). Only 19.1% were accompanied by a friend and of that group 13.7% came with one other person, and 5.4% came with two or more other individuals. Ninety-two percent of the subjects had donated previously. Looking at the number of previous donations (table 1) it was clear that 50% of the subjects had donated more than five times before. Less than 10% of the donors had any sort of reaction to the donating process. Of those who did, the reaction was characterized as mild. The individual usually felt a little dizzy. The distribution of these variables did not significantly differ between groups.

Equipment

Existing lighting conditions: Lighting in the wait-

Table 1

Summary Table of Subjects' Previous Donating Histories
and Reactions to the Donating Process

Number of Previous Donations	Percent
1	18.7
2	6.7
3	5.3
4	10.7
5	5.3
<u>> 5</u>	<u>45.3</u>
Total	92.0
First Time Donors	8.0
	<u>100.0</u>
Reaction to Donating Process	7.9
No Reaction	<u>92.1</u>
	100.0

ing and registration area was provided by overhead, incandescent spotlights, each with 150 watt bulbs. The illumination in the donating room was from six overhead fluorescent fixtures. The fixtures were 1' x 4', with two tubes in each.

Experimental lighting condition: Table lamps used in the waiting area and donating room were "ginger jar" lamps. The base of the lamps were cream colored and the shades were white. One hundred watt bulbs were in all the table lamps. Clamp-on desk lamps located on each donating bed used 25 watt bulbs, providing extra light but minimizing glare and heat. There were a total of eight ginger jar table lamps and three clamp-on lamps used.

Furniture: Black and chrome stack chairs were used in all areas. The registration, medical history, technician and canteen tables were 5'-0" x 2'-6", with black, metal legs and white plastic tops. The two end tables in the waiting area were 1'-6" square, made from white plastic.

Red Cross furniture: The three portable donating beds were 6'-2" x 2'-2" x 2'-3". The beds had metal frames and green plastic cushioned surfaces.

Procedures

Donors were greeted by the experimenter (E) at the registration table. E instructed the donor how to complete the registration form and gave the option to fill out a voluntary consent form. If the person consented to participate in the study his/her pulse was taken. After completing the forms at the registration table, donors were asked to have a seat in the waiting area until a nurse was available to collect their medical histories. While in the waiting area, E collected observational data. Donors were called into the donating room by the nurses. First, the individual went to the medical history table, then to the donating beds. Medical histories usually lasted about five to ten minutes, and the average time donating a pint of blood was seven minutes. Following donation, the subject was led to the canteen area and given soda and cookies. The instructions to the donor were to remain at least fifteen minutes to insure that the individual did not have a reaction. While in the canteen area, observational data was again collected. As the donor was leaving the site he/she was stopped by the interviewer and asked if he/she had time to answer a few questions about the donating process. If the donor refused, the interviewer thanked them anyway, and if the

donor agreed, the interview was administered.

Predictions

When an individual is in a mildly stressful situation the lighting design, or general ambience created by the lighting, can reduce, maintain or heighten feelings of stress. It was predicted that the table lamp lighting condition would tend to reduce stress whereas the overhead lighting condition would maintain the feelings of stress associated with donating blood.

The expected response when the lighting is from incandescent table lamp sources is that the donors will initiate and participate in more interactions for longer periods of time than donors in the overhead lighting condition. Behaviors in the overhead condition are predicted to be predominantly solitary (e.g., reading and writing). Individuals in the table lamp condition will tend to stay longer than those in the overhead condition. Finally, it is predicted that the difference between the two pulse measures will be less in the overhead condition than in the table lamp condition. This prediction is based on the assumption that when the individual first enters the setting he/she is slightly stressed. In the overhead condition the individual remains stressed therefore the

difference between the first pulse reading and the second will be small. Under the table lamp illumination the pulse will return to normal resting level resulting in a larger difference between the pulse measures.

In summary, when the lighting is from incandescent, table lamp sources, donors will initiate and participate in more interactions, report less anxiety and be willing to stay longer, than when the illumination levels are characterized as bright, overhead fluorescent.

C H A P T E R I I I

RESULTS

The purpose of this investigation was tri-fold: 1) to examine the way in which social, spatial, physiological and attitudinal responses were influenced by two different lighting systems, 2) to pilot research methods appropriate for the investigation of the lighting-behavior relationship and 3) to work towards providing suggestions for the design of lighting systems in health services settings. The obtained results have provided a significant contribution to each of these goals.

The findings give the following overview of how people are influenced by lighting. In the table lamp condition individuals spent more time talking to one another than in the overhead lighting condition; in the overhead condition people spent more time reading (reading and talking are inversely correlated, as the length of stay remained relatively constant). Seating patterns further explained the difference between lighting conditions. People in the table lamp condition tended to sit next to one another, and subjects preferred to sit facing into the donating room. Under overhead fluorescent illumination

people most often sat one or two seats apart and tended to sit with their backs to the donating room. Finally, in the table lamp condition donors characterized their moods as more socially outgoing and more responsive to their surroundings than people in the overhead condition. In this chapter, these results will be presented in detail.

The principal hypothesis of interest was whether or not people differed on social, spatial, physiological and attitudinal responses under two lighting conditions. The general approach to this analysis was to isolate the variable which most contributed to the difference between the two types of lighting. A picture of how an individual was responding to the environment was then pieced together from this reduced set of variables. Thus, multivariate analyses of variance were performed on all the variables. This type of analysis simultaneously considered the effect of all the variables, as opposed to the univariate analysis which looks at the influence of each variable in isolation. The advantage to this approach was that it took into account the way in which data from different measures were correlated in some arbitrary and unknown way. To have simply run univariate tests without the MANOVA would have been capitalizing on chance. The factors

which were determined to contribute significantly to the variance between the groups were then further analyzed by appropriate univariate or multivariate procedures (for all MANOVA's Roy's largest root criterion was used to determine the critical F value). Finally, for some variables only descriptive statistics were possible.

Data were analyzed by lighting conditions and by days. There were three data collection days for each lighting condition. For all tests no significant differences were found between days (MANOVA's were calculated for differences between days within the same lighting condition as well as across lighting conditions). Significance was obtained for differences between the overhead lighting condition and the table lamp condition, therefore the results are presented in terms of the difference between conditions.

First, the results of the interview will be reported providing a sense of the general impressions, moods and attitudes of the donors as they went through the process, and a context for understanding differences between the observed behaviors. Then, the results of the spatial measures will be discussed followed by the results of social measures. Finally, the physiological findings will be reported.

Attitudinal Profile - The Interview

The interview measured attitudes and moods by asking two types of questions: 1) open-ended questions pertaining to general impressions of the donating process and the physical design and 2) scaled questions specifically directed at impressions of the canteen area, and general moods of the subjects.

Responses to the four open-ended questions revealed the following trend of the general impressions of the donating process. Individuals in both conditions found the staff to be pleasant, sociable, and efficient and the atmosphere relaxed and comfortable. People in the table lamp condition voiced less complaints, and suggested fewer changes in the physical set-up indicating a slightly higher degree of satisfaction than those donating under overhead fluorescent illumination. The general impressions of lighting supported this trend in that a large percent of the responses of those in the overhead lighting condition described the lighting negatively (too bright, cold, blue, hospital-like, etc.) whereas in the table lamp condition many more positive descriptors were used to characterize the lighting as well as its influence on the general ambience. A more detailed account of responses to the open-ended questions is presented below.

- 1) "What parts of the process of giving blood do you think are handled especially well? For example, did it take too much time, or did you feel rushed? Were you made to feel as comfortable as possible?"

Individuals who donated under the overhead lighting characterized the nurses as friendly, efficient, sociable and quick. In general donors felt they were handled professionally, and described the atmosphere as comfortable and relaxed. Special note was given to the back rub at the end, the painless needles, and the preference for the ear blood test (i.e., a drop of blood taken from the ear to determine blood iron content; a drop from the finger is the more common procedure). Several commented on the problem of waiting. The most often received comment was that the donors felt "everything was fine".

Similar to those in the overhead condition, people who donated under the table lamp illumination also commented most often that "everything was fine". Again, nurses were described as talkative, friendly, efficient, and sociable. Attention was given to the fact that the nurses provided a good explanation of the procedures. Donors appreciated the positive attitude of the staff. Of concern to some was the food and the temperature of the room. There were also comments upon the painless needles and the relaxed, comfortable atmosphere.

- 2) "Are there any things that you think could be handled better for your comfort and satisfaction? For example, is there any way you would change the procedures or the way you were treated?"

Donors in the overhead lighting condition, for the most part, felt there were no changes they would make (62.5%). Some suggestions were that the bloodmobile schedule appointments to reduce waiting and slowing down of the process. Some requested better food (natural vs. junk), more comfortable donating beds, and music. One individual voiced the need for more space.

Eighty-two percent of the individuals in the table lamp condition felt there were no changes they would make.

- 3) "Could you please describe the kind of lighting around the canteen area?"

When the canteen area was lit by overhead, fluorescent lights 37.5% named the lighting correctly as fluorescent, 57.5% noticed the lights but could not name them, 16% said they did not notice the lights, and one individual named the lighting incorrectly as neon. The illumination was described as too bright, too blue, white, cold, adequate, appropriate, hospital-like, institutional, good for reading and O.K. Some suggested that the site could use less lighting or could use softer, yellow lighting.

Of the forty-six respondents to this question in the

table lamp condition, no one named the type of lighting as incandescent, although some commented that it was not fluorescent. Curiously, an individual in this group also referred to the lighting as neon. It was described as good for reading, appropriate, adequate, well-lit, not too bright, soft, warm, good/nice, fine, regular/normal, and dim. The light fixtures were called "little lamps" by several donors. Comments pertaining to the general ambience because of the lighting were offered. The atmosphere was characterized as mellow, different, comfortable/relaxing, sedate and subdued. Five individuals (10.9%) did not notice the lighting.

- 4) "Overall, what suggestions would you have for making improvements in the physical set-up and design of blood donor clinics?"

In the overhead lamp condition 23.5% responded that they had no suggestions for improvements, and that the set-up in the Campus Center was fine and efficient. Many suggestions for improvements pertained to space needs. Comments included more space in general, more space for the canteen area, and complete separation of the different areas. One donor suggested changing the bed arrangement. There were requests for more color, plants, music, and posters. Lack of windows was also one complaint.

Of the individuals who donated under the table lamp condition, 30.4% felt there were no changes they could suggest. Twenty-three percent however, felt that more space was needed. Better food was of concern to 11% of the individuals. Making the atmosphere more homey by introduction of more color, plants, music and posters was suggested. Two individuals felt the beds should be rearranged.

The second half of the interview was specifically concerned with the donor's impression of the canteen area and the moods of the donor while in this area. These questions were on a seven point scale. The advantage of scaled questions was that they permitted a more systematic, testable approach to the attitudes of the donors.

The general outcome was that donors in both lighting conditions found the area appropriate and meeting their expectations. The people in the table lamp condition tended to rate the canteen area as more pleasant than those in the overhead condition. Finally, the moods of the donors differed significantly between conditions. Individuals in the table lamp condition tended to feel more responsive and interested in their surroundings and more socially outgoing than donors in the overhead condition.

The multivariate analysis of variance revealed a significant difference between the groups on the five scaled

questions ($F = 2.758$, $p < .05$, $\lambda_{\max} = .19982$, $t = 69$, $r = 5$, $s = 1$). Confidence intervals on the contrasts of interest were not significant, although estimates for question eight ("In the canteen area how interested and responsive did you feel to what was going on around you?") and question nine ("In the canteen area how socially outgoing or withdrawn did you feel?") clearly approached significance (eight: $-.66 \pm .85$; nine: $.81 \pm .90$).

The univariate analysis indicated questions eight and nine to be highly significant ($p < .009$, and $p < .007$ respectively). Looking at the distribution of responses to these two questions (figure 7) it can be seen that individuals in the table lamp condition felt more interested and responsive to what was going on around them, and more outgoing and sociable than individuals in the overhead lighting condition.

Question five asked whether or not the canteen area met the expectations of the donor. Question six asked if the donor felt the way the canteen area looked was appropriate. The ANOVA showed that these two questions did not significantly vary across condition. This indicated that both groups felt the setting to be appropriate and fulfilling their expectations of what a bloodmobile should be.

Question seven provided an indication of how pleasant the donors found the canteen area. There was a trend

Table 2

Summary Table for Analysis of Variance:
Mean Ratings for Interview Questions 8 and 9

Variable Name	<u>Lighting Condition</u>	
	Overhead	Table
Eight***	4.27 min.	4.93 min.

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Lighting Condition	7.59	1	7.59	7.24*
Residual	<u>77.52</u>	<u>74</u>	<u>1.05</u>	
Total	85.12	75	1.14	

Nine****	3.50 min.	2.69 min
----------	-----------	----------

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Lighting Condition	9.92	1	9.92	7.66**
Residual	<u>95.87</u>	<u>74</u>	<u>1.30</u>	
Total	105.79	75	1.411	

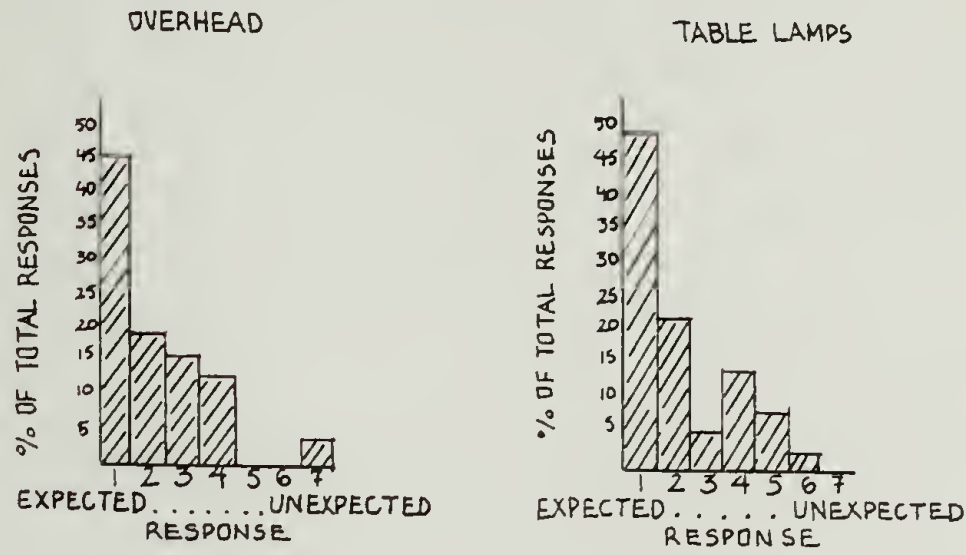
*p = .009

**p = .007

***Eight: In the canteen area how interested and responsive did you feel to what was going on around you?

****Nine: In the canteen area how socially outgoing or withdrawn did you feel?

5. Would you say the general atmosphere in the canteen area was:



6. Would you say the way the canteen area looked was:

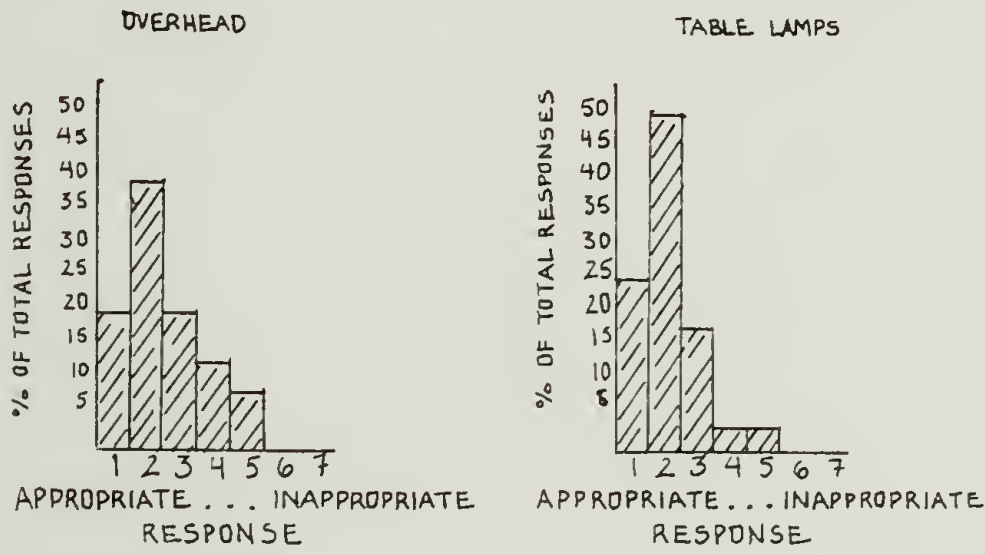
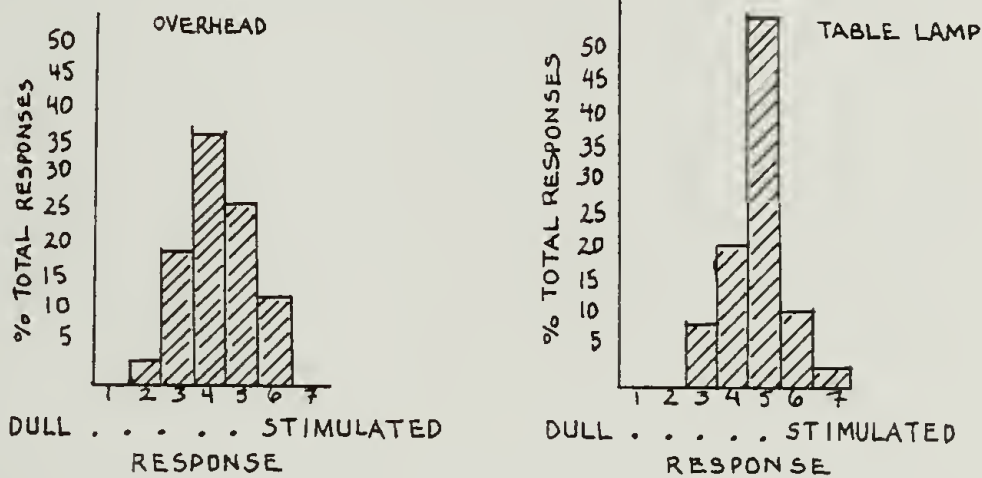


FIGURE 7
SUMMARY OF THE DISTRIBUTION
OF RESPONSES TO INTERVIEW QUESTIONS
FIVE AND SIX

7. Would you say the canteen area was:



8. In the canteen area how interested and responsive did you feel to what was going on around you?



9. In the canteen area how socially outgoing or withdrawn did you feel?

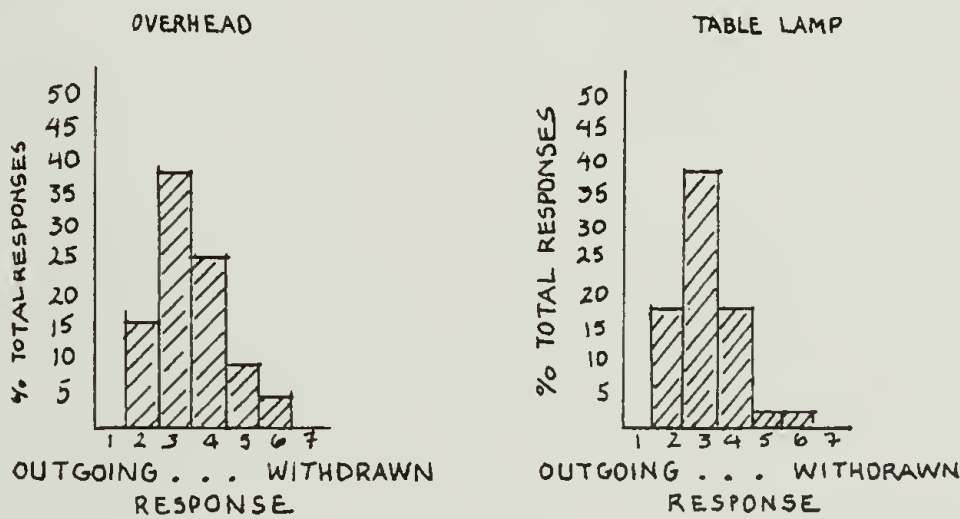


FIGURE 7-CONT.

SUMMARY OF THE DISTRIBUTION
OF RESPONSES TO INTERVIEW QUESTIONS
SEVEN, EIGHT AND NINE

($p < .2$) for people in the table lamp condition to rate the canteen area as more pleasant than people in the overhead condition.

Spatial Behaviors

Measures of spatial behaviors included 1) length of stay in the waiting or canteen area, 2) seat selected by the subject, 3) number of other individuals present (which admittedly is more of a social measure, but it is included here for its relationship with seating patterns) and, 4) the location of the other people present.

The length of stay in both the waiting area and the canteen area did not vary significantly across condition. The mean length of stay in the waiting area was 12.1 minutes with the mode at 10 minutes. Individuals were in the canteen area for a mean of 15.9 minutes; the mode was 10 minutes.

In the waiting area frequency distributions for seat selection did not reveal a pattern that differed between groups (χ^2 was also insignificant). People in both groups, however, appeared to select seats which maximized the distance between individuals (see figure 8). In the canteen area, however, the general pattern of seat selection did change between the conditions: in the overhead lighting condition, people tended to sit facing the wall (away

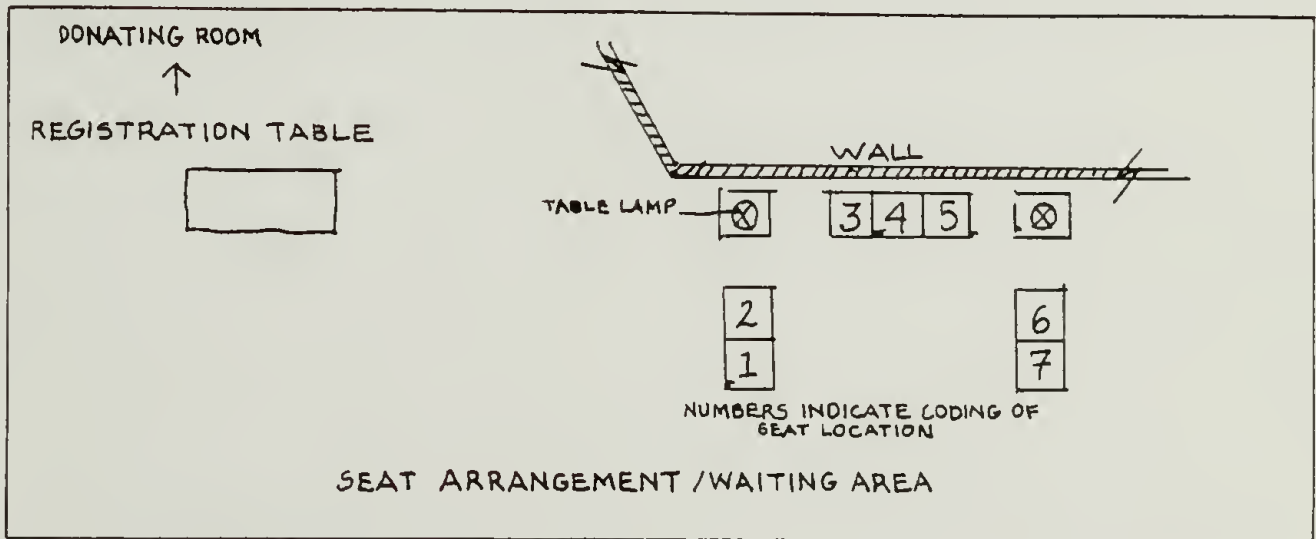
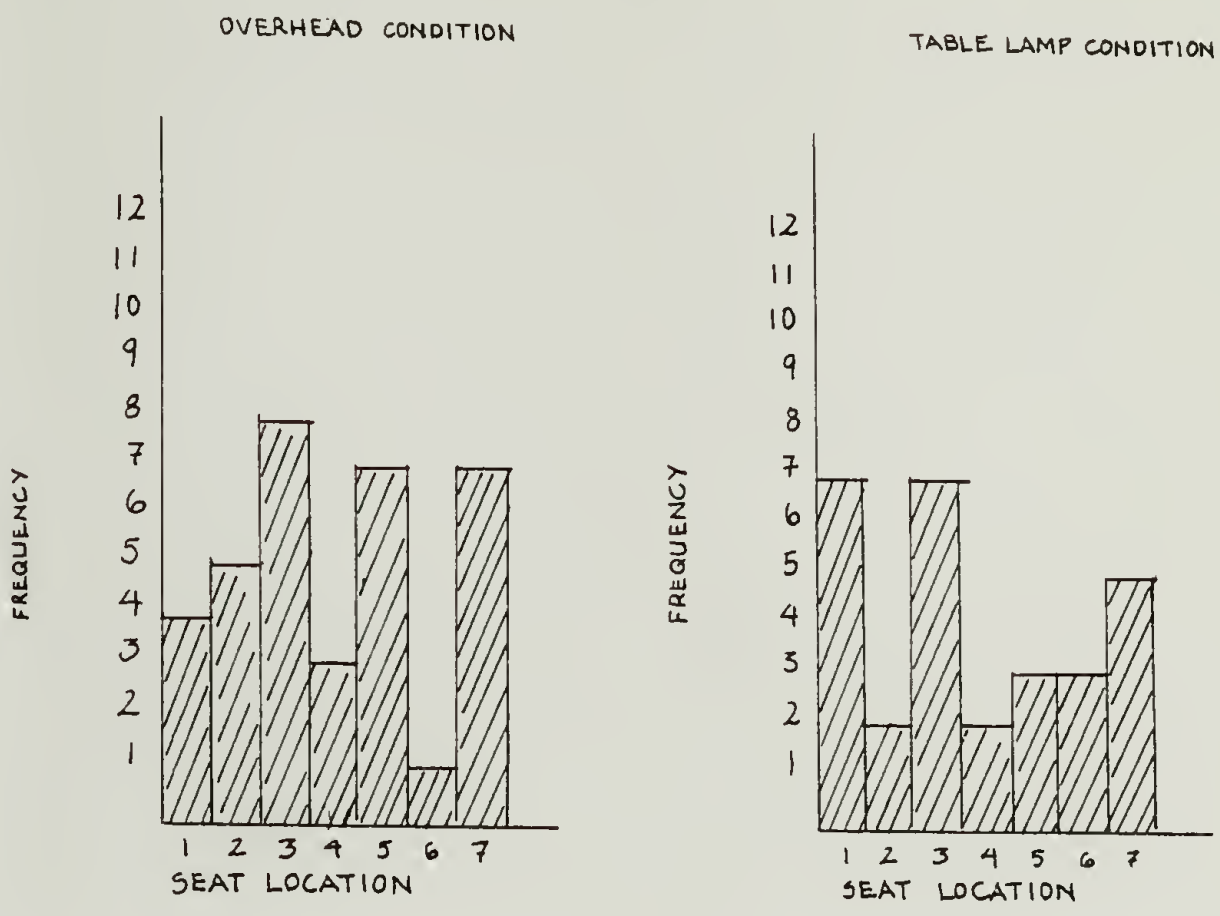


FIGURE 8
DISTRIBUTION OF WHERE
DONORS CHOSE TO SIT IN
THE WAITING AREA

from the donating beds), while in the table lamps condition, people tended to sit with their backs to the wall (facing the donating beds and the rest of the room). A chi-square was significant at the .05 level ($\chi^2 = 14.118$, $p < .05$). Specifically, there was reduced popularity of seats number 8 and 2, in the table lamp condition (figure 9).

The number of others present did not differ between groups in the canteen area but significantly differed in the waiting area ($\chi^2 = 11.01$, $p < .05$, figure 10).

To analyze the location of others present, locations were divided into groups: 1) next to the subject, 2) one seat apart, 3) two seats apart, 4) three seats apart, and for the waiting area only 5) four seats apart and 6) five seats apart. A chi-square revealed that there were no differences between lighting conditions for how other people present positioned themselves relative to the subjects in the waiting area. In the canteen area this was not the case. People in the table lamp condition sat next to each other significantly more often than individuals in the overhead condition ($\chi^2 = 10.46$, $p < .05$). Figure 13 shows a clear pattern in the table lamp condition of where other people sat relative to the donor. This result suggests that in the waiting area the most important factor which determined seat selection was the

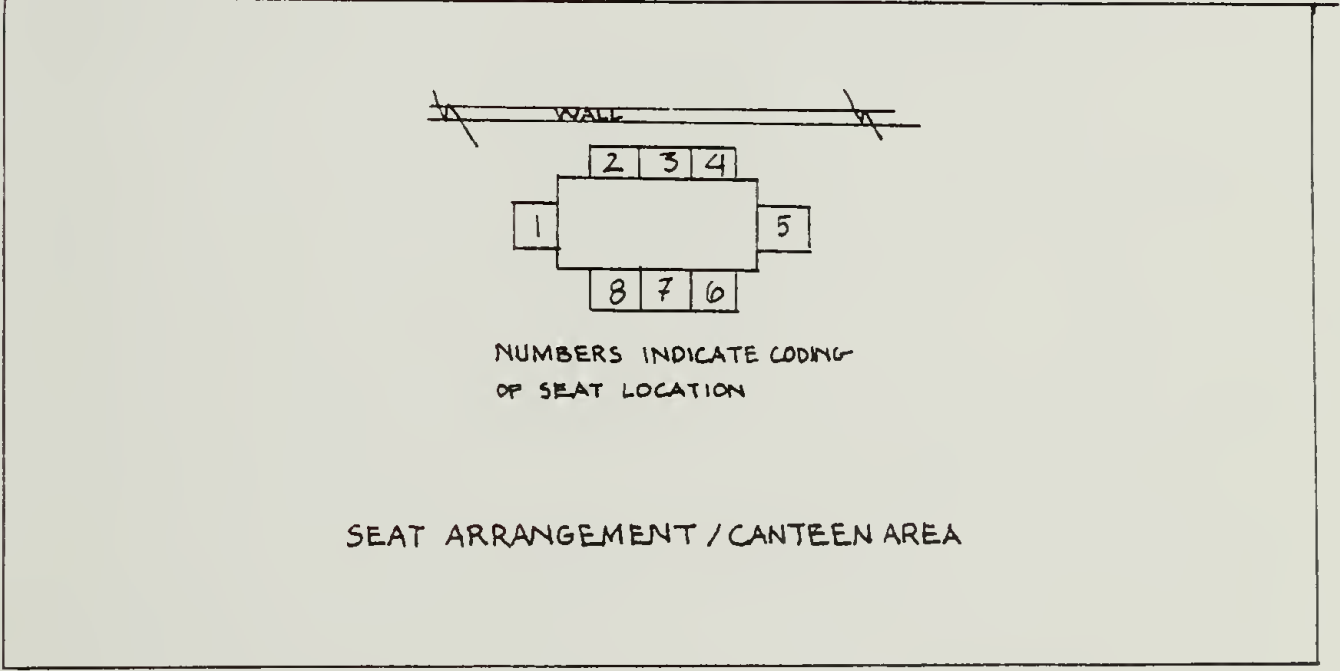
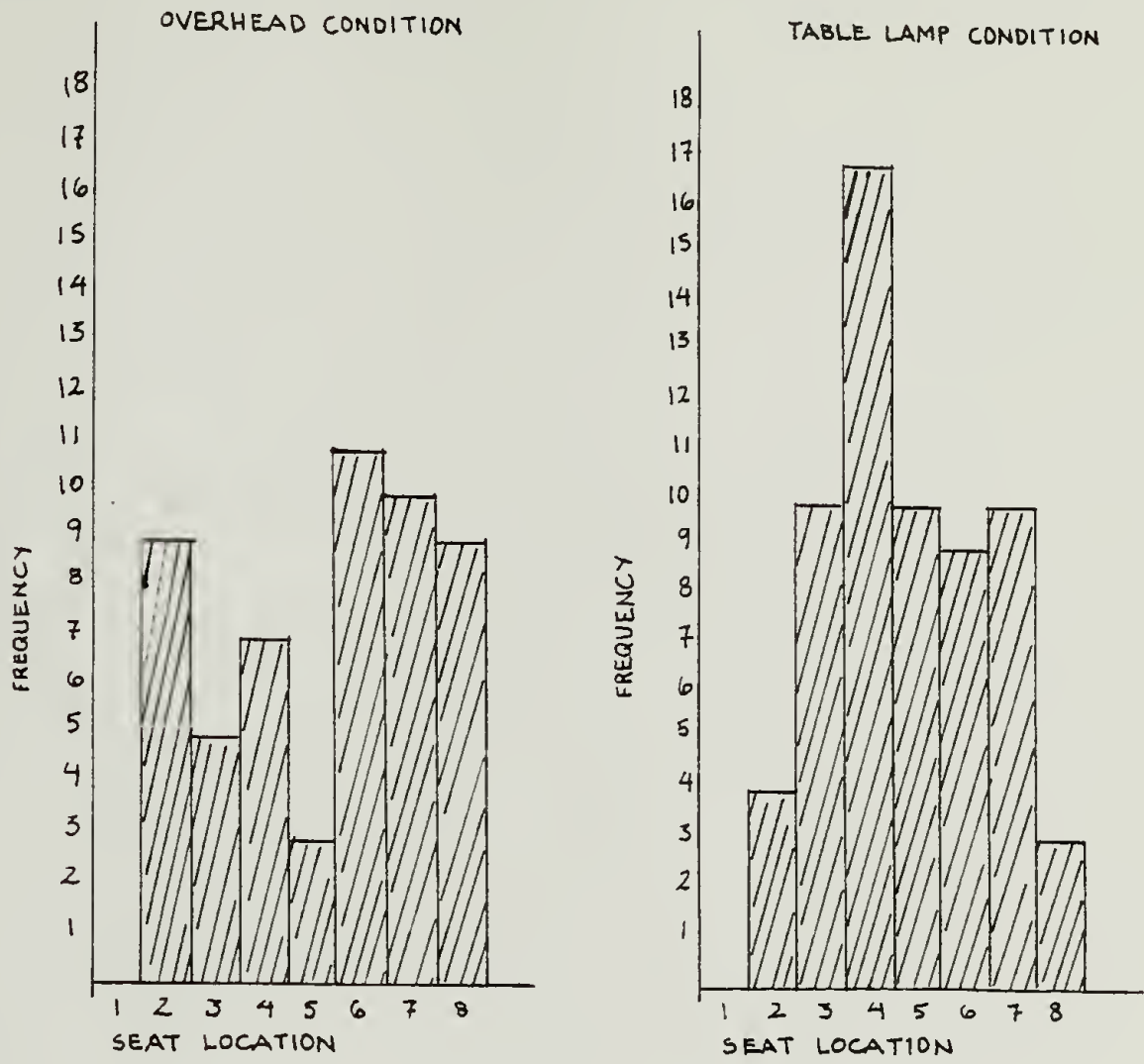


FIGURE 9
DISTRIBUTION OF WHERE
DONORS CHOSE TO SIT IN
THE CANTEEN AREA

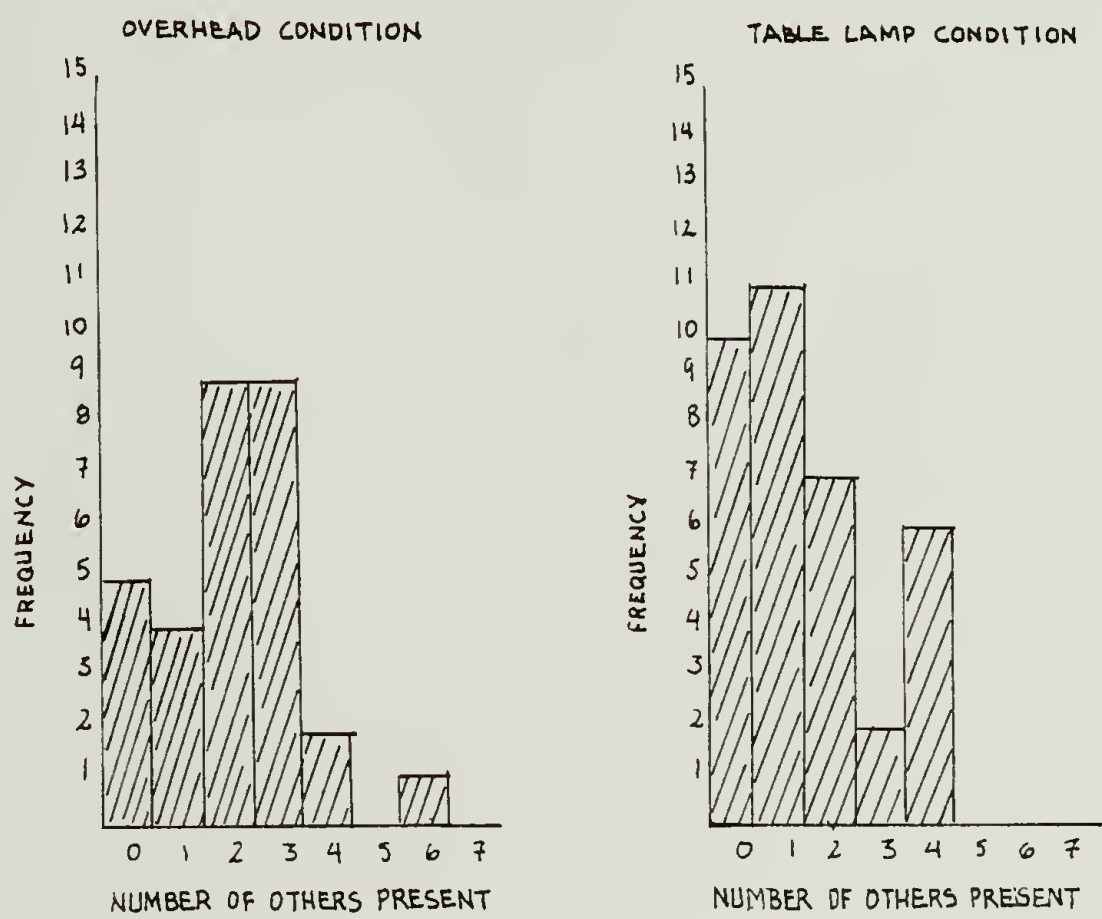


FIGURE 10
DISTRIBUTION OF THE NUMBER
OF OTHER PEOPLE PRESENT IN
THE WAITING AREA

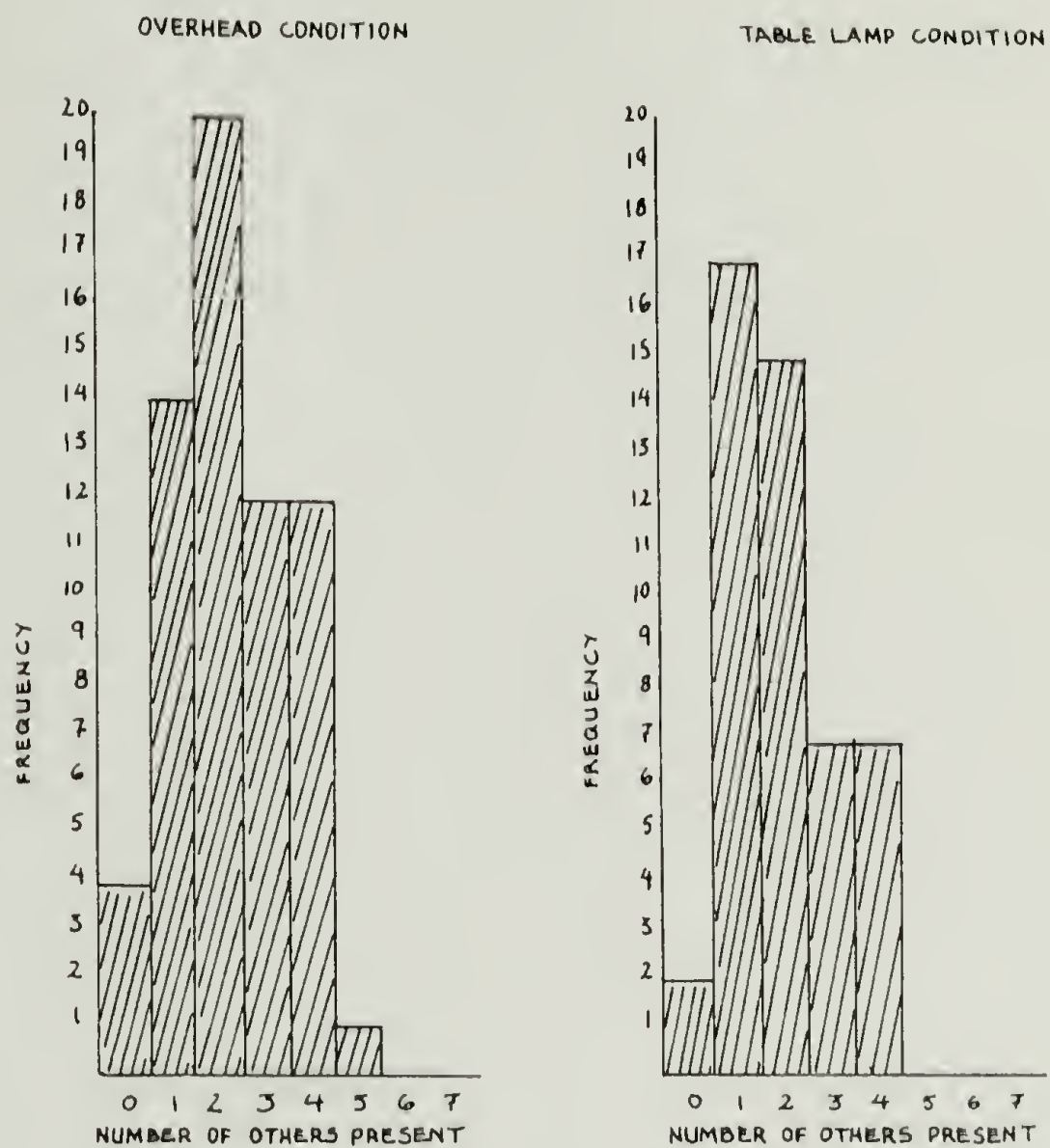


FIGURE 11
DISTRIBUTION OF THE NUMBER
OF OTHER PEOPLE PRESENT IN
THE CANTEEN AREA

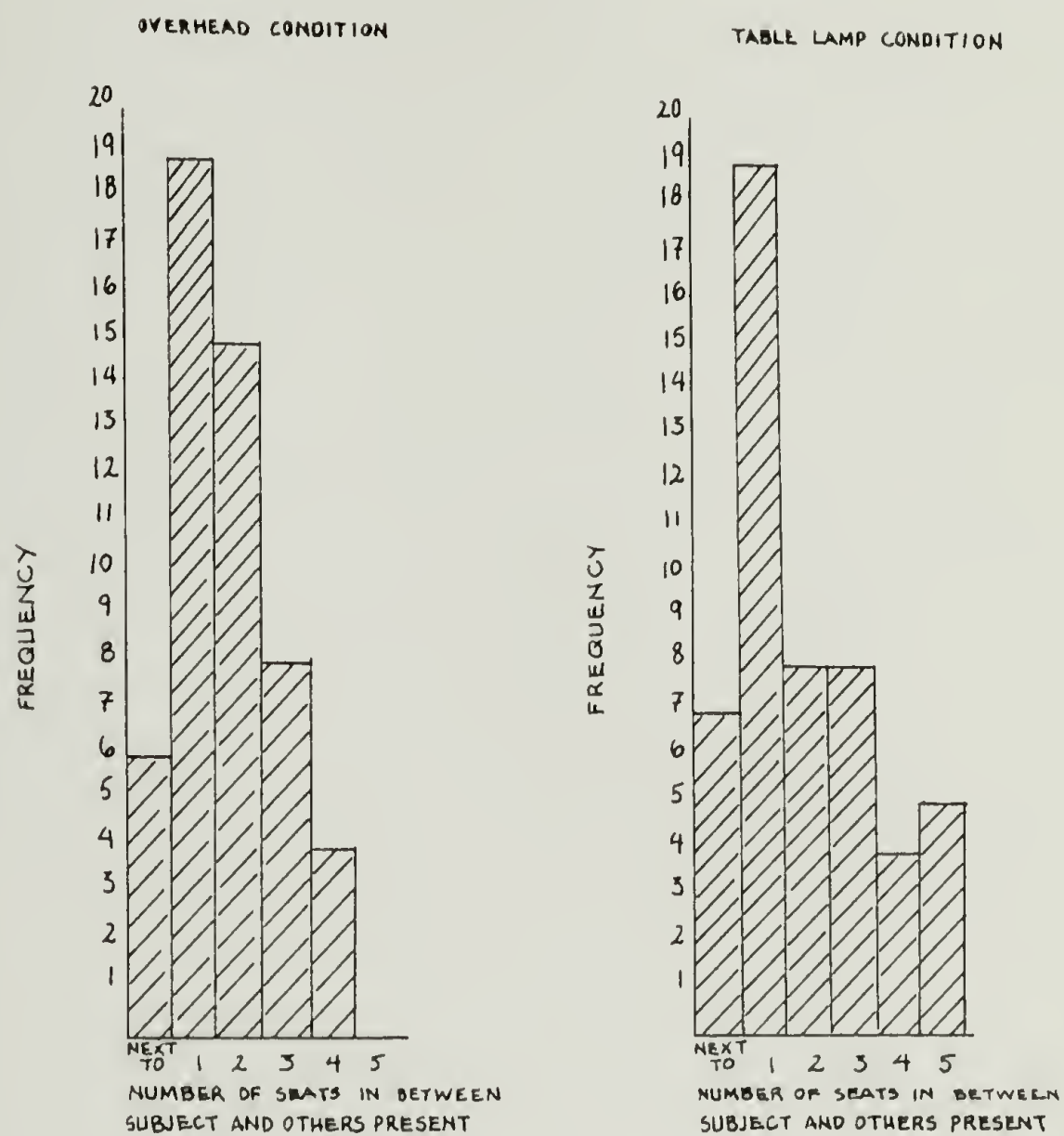


FIGURE 12
WHERE OTHER DONORS SAT
RELATIVE TO THE SUBJECT
IN THE WAITING AREA

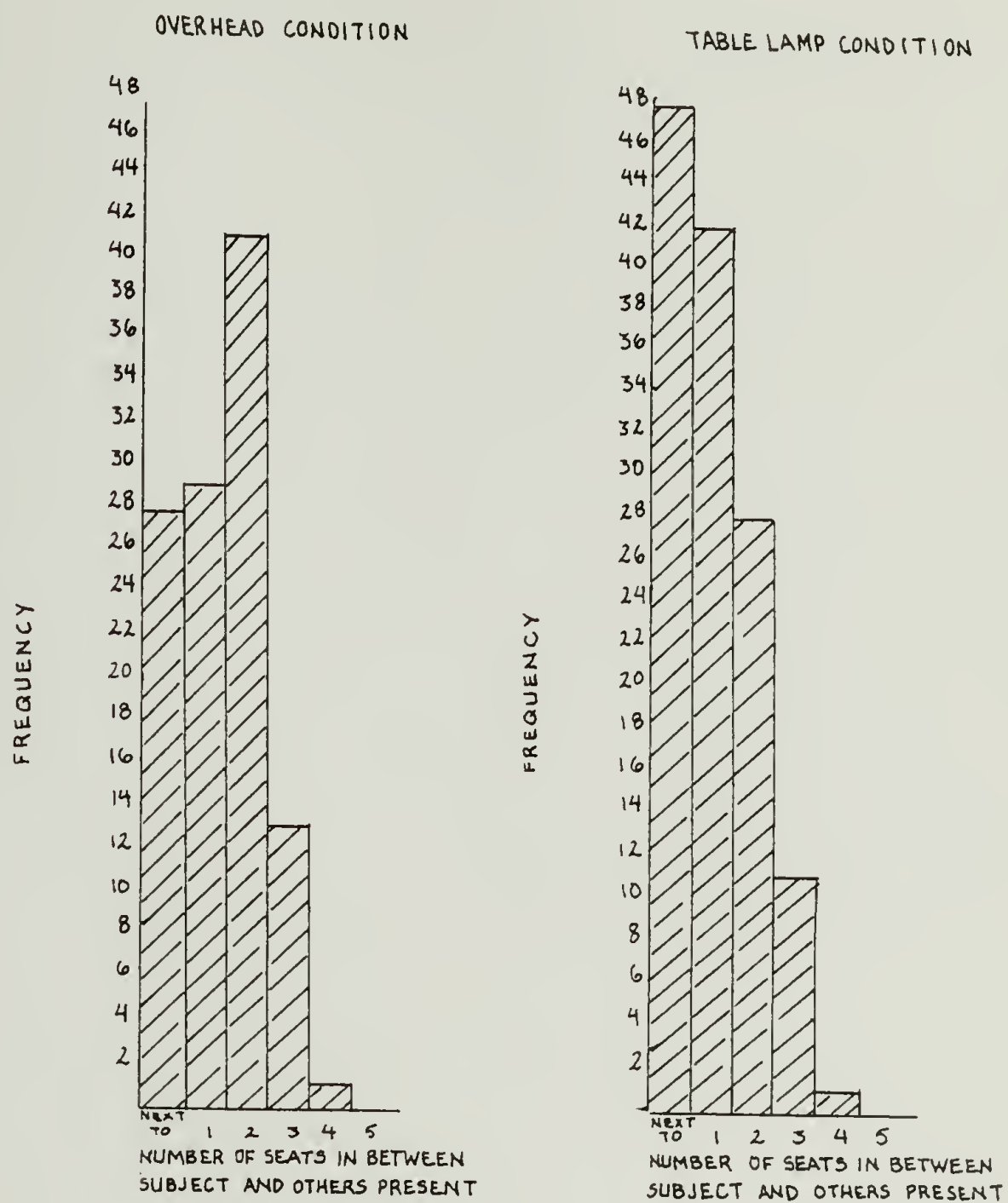


FIGURE 13
WHERE OTHER DONORS SAT
RELATIVE TO THE SUBJECT
IN THE CANTEEN AREA

number of others present. In the canteen area the preferred seats facing the wall in the overhead condition and the differences in people's positioning themselves in relation to others indicates an influence of the illumination on spatial behaviors (figure 13).

Social Behaviors

Social behaviors were observed twice for each individual: in the waiting area and in the canteen area. The results from these two areas will be discussed separately.

Social behaviors in the waiting area. The multivariate analysis of variance for the seventeen original measures of social behaviors revealed that only eleven of these variables significantly contributed to variability between the groups, ($\lambda_{\max} = .58835$, $s = 1$, $r = 16$, $t = 60$, $F = 1.84$, $p < .05$). Table 3 lists measures in the waiting area which contributed to the difference between groups.

To determine which of these variables were contributing to the difference, confidence intervals were calculated. The result was that confidence intervals for the contrasts of interest were not significant. This implies that it was some linear combination of these variables which together produced a difference in behavior between

Table 3

Variables Which Contributed Significantly to Differences
Between the Behavior of Subjects in the Waiting Area

1. Frequency staff-initiated interactions -- active talking, topic related to the donating process.
2. Frequency donor-initiated interactions -- active talking, topic unrelated to the donating process.
3. Frequency active talking (total).
4. Duration active talking (total).
5. Frequency passive talking (total).
6. Duration passive talking (total).
7. Frequency reading (total).
8. Duration reading (total).
9. Frequency writing (total).
10. Duration writing (total).
11. Duration other (total).

the groups. Two of the eleven variables, however, approached significance; duration of active talking and duration of reading. The univariate analysis of variance revealed these two variables to be significant ($p < .05$). A comparison by group of the percent of time spent reading and the percent of time spent actively talking showed an inverse relationship between these two variables (see figure 14). The percentages were calculated as proportions of the total length of stay in the particular area. Under the overhead, incandescent lights 7.2% of the time individuals in the waiting area were actively involved in conversation. In contrast, 67.0% of the time individuals spent reading. When the waiting area was illuminated by table lamps a shift occurred resulting in more time spent talking (32.4%) and less time spent reading (42.9%).

Figure 15 further describes the nature of the interactions. It can be seen for both conditions, interactions were almost entirely initiated by the donors. In the overhead condition 3% of the interactions were staff initiated and 97% were donor initiated. In the table lamp condition 13.6% of the interactions were staff initiated and 86.3% were donor initiated.

Despite the significant difference between conditions obtained for the number of people present in the waiting area, there was no significant contribution of this varia-

Table 4

Summary of Analysis of Variance: Duration of Reading
By Lighting Condition in the Waiting Area

Variable Name	<u>Lighting Condition</u>			
	Overhead	Table		
Duration Reading	8.69 min	4.74 min.		
<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Lighting Condition	260.22	1	260.22	6.61*
Residual	<u>2559.57</u>	<u>65</u>	<u>39.38</u>	
Total	2819.79	66	42.72	

*p = .012

Table 5

Summary of Analysis of Variance: Duration of Talking by
Lighting Condition in the Waiting Area

Variable Name	<u>Lighting Condition</u>			
	Overhead	Table		
Duration Active Talking	0.93 min	3.58 min.		
<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Lighting Condition	116.98	1	116.98	6.59*
Residual	<u>1153.63</u>	<u>65</u>	<u>17.75</u>	
Total	1270.60	66	19.25	

*p = .013

Table 6

Summary of Analysis of Variance: Duration of Active
Talking by the Number of Other People Present
and Condition in the Waiting Area

Variable Name	<u>Lighting Condition</u>	
	Overhead	Table
Duration Active Talking	0.93 min	3.58 min.

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Lighting Condition	91.12	1	91.12	5.65*
Number of Others	98.26	2	49.13	3.04**
Lighting Condition X Number of Others	73.71	2	36.85	2.28***
Residual	<u>968.41</u>	<u>60</u>	<u>16.14</u>	
Total	1265.88	65	19.48	

*p = .021

**p = .055

***p = .111

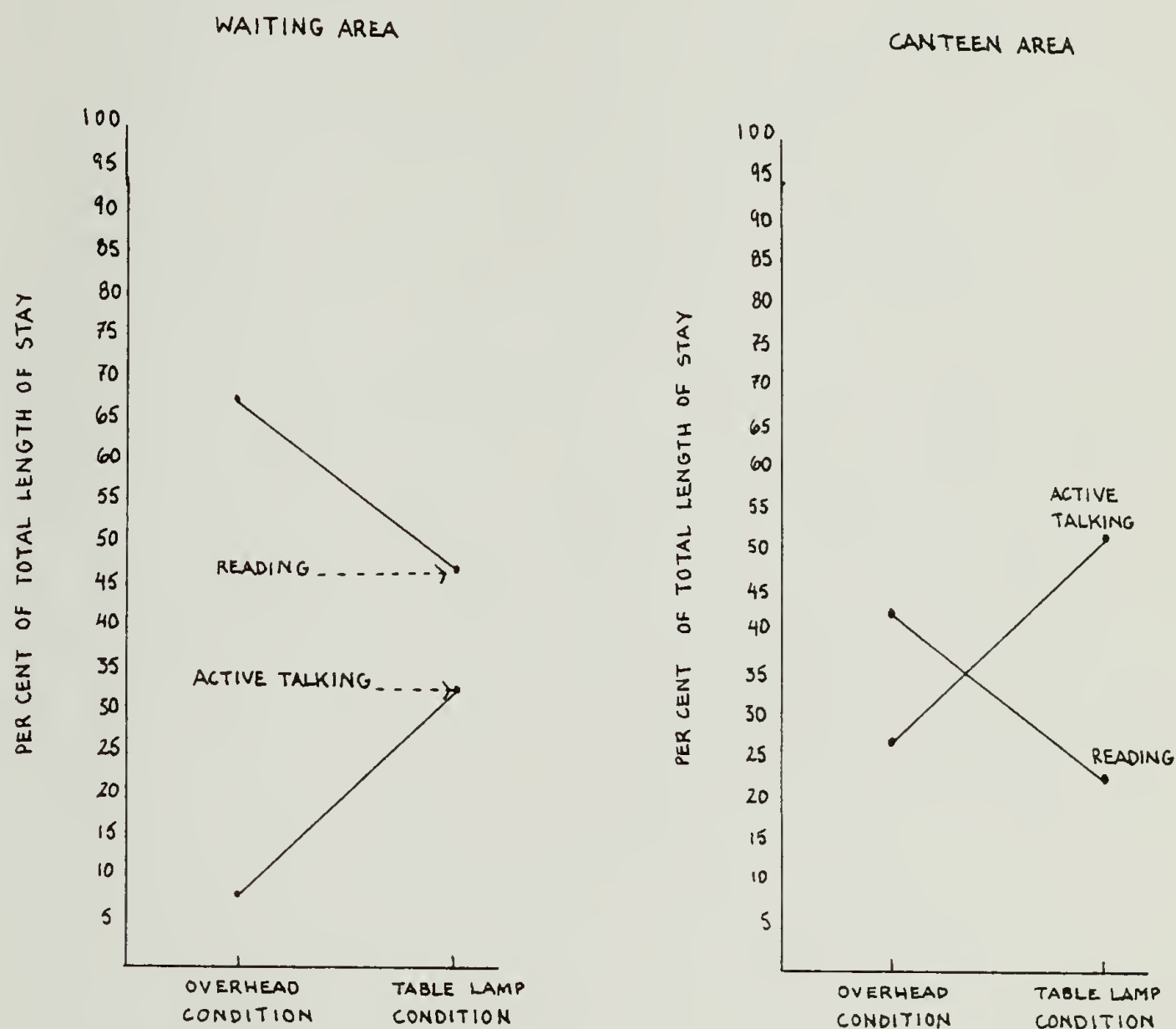


FIGURE 14
PERCENT OF TIME SUBJECTS SPENT
READING OR ACTIVELY TALKING IN
THE WAITING AND CANTEEN AREAS

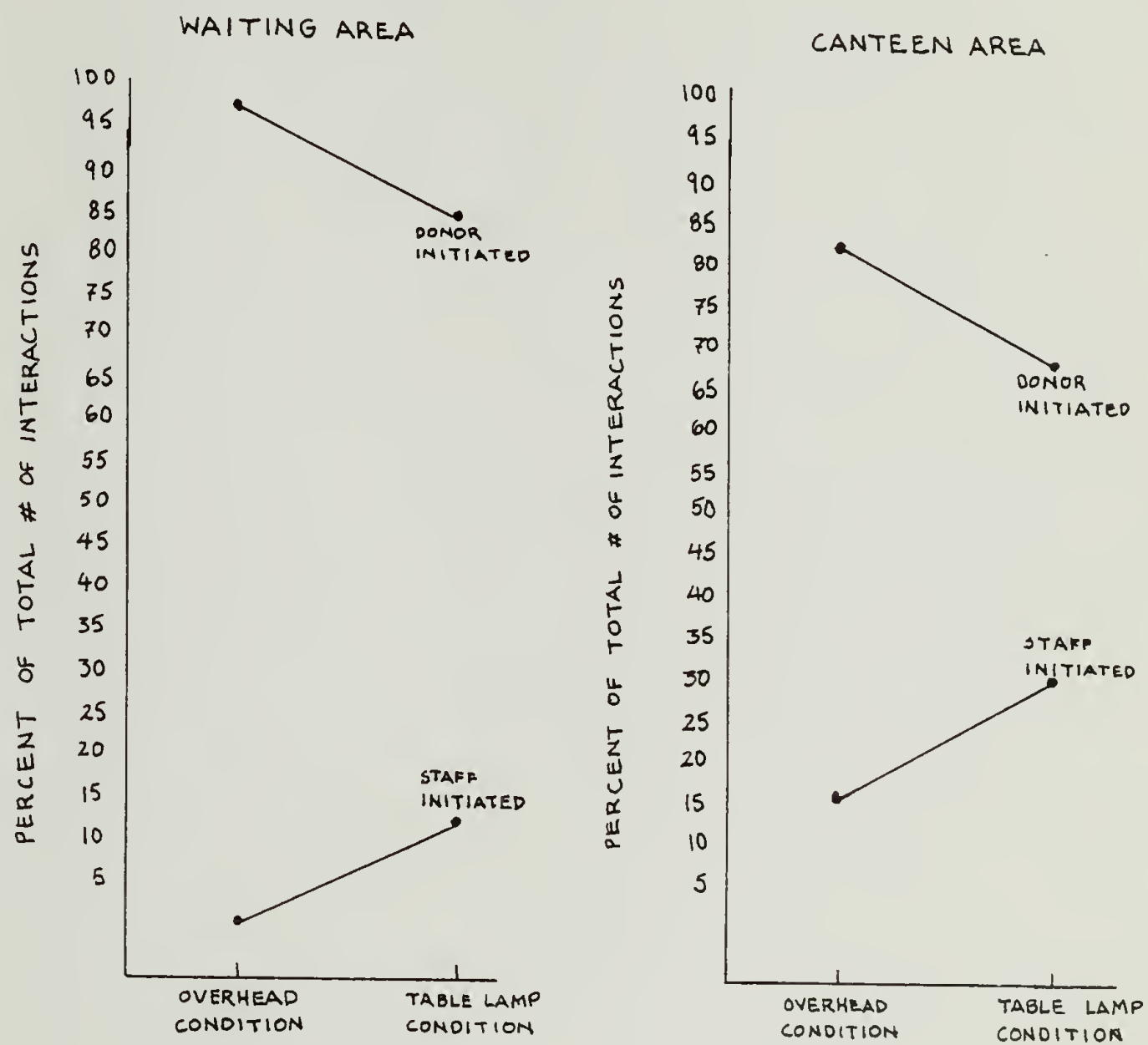


FIGURE 15
PERCENT OF TOTAL NUMBER OF INTERACTIONS
INITIATED BY STAFF OR DONORS IN
THE WAITING AND CANTEEN AREAS

ble to the differences in time spent talking.

Social behaviors in the canteen area. Of the original twenty-one measures, eleven remained of interest. These variables are listed in Table 7. The MANOVA testing the variance of these measures between conditions was determined to be significant ($F = 1.9$, $p < .05$, $\lambda_{\max} = .369$, $s = 1$, $r = 20$, $t = 96$).

Confidence intervals were not significant except for the staff initiated interactions where the donor was passively participating in a conversation unrelated to the donating process ($-.138 \pm .102$). Less than one percent of the total number of interactions were of this type for the overhead condition compared to 4% in the table lamp condition. Similar to the waiting area data, duration of active talking and duration of reading approached significance. Univariate tests for these two variables were highly significant ($p < .006$). A comparison of the percent of total time spent reading versus actively involved in conversation showed that for the overhead condition, individuals spent 28.4% of their time talking and 43.0% of their time reading. For the table lamp condition, however, 52.2% of the time individuals were conversing and only 22.6% of the time was spent reading (figure 14). Further figure 15 shows that for the overhead condition 15.6% of the interactions were

Table 7

Variables Which Significantly Contributed to Differences
Between the Behavior of Subjects in the Canteen Area

Frequency staff-initiated interactions

1. Active talking, topic unrelated to the donating process.
2. Passive talking, topic related to the donating process.
3. Passive talking, topic unrelated to the donating process.

Frequency donor-initiated interactions

4. Active talking, topic related to the donating process.
5. Active talking, topic unrelated to the donating process.
6. Frequency active talking (total).
7. Duration active talking (total).
8. Frequency passive talking (total).
9. Duration passive talking (total).
10. Frequency reading (total).
11. Duration reading (total).

Table 8

Summary of Analysis of Variance: Duration of Active Talking by Lighting Condition in the Canteen Area

Variable Name	<u>Lighting Condition</u>	
	Overhead	Table
Duration Active Talking	4.30 min.	8.87 min.

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Lighting Condition	606.95	1	606.95	8.53*
Residual	<u>8180.36</u>	<u>115</u>	<u>71.13</u>	
Total	8787.31	116	75.75	

*p = .004

Table 9

Summary of Analysis of Variance: Duration of Reading by
Lighting Condition in the Canteen Area

Variable Name	<u>Lighting Condition</u>	
	Overhead	Table
Duration Reading	6.51 min.	3.59 min.

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Lighting Condition	248.25	1	248.25	7.21*
Residual	<u>3697.51</u>	<u>115</u>	<u>32.15</u>	
Total	3945.77	116	34.02	

*p = .006

staff initiated and 84.4% were initiated by a donor. The table lamp condition showed a similar distribution: 30.5% of the total number of interactions were staff initiated and 69.5% were donor initiated.

A two-way ANOVA for duration of active talking by condition and number of other people present showed no significant contribution of the number of others or the interaction between the two independent variables. As expected, there was again a significant main effect for condition (more talking in the table lamp condition).

Physiological Responses

Measures of physiological responses for each individual were pulse rate and blood pressure. Pulses were recorded as the individual first entered the setting and during the medical history interview. Even though the general MANOVA was significant, no significant variance between conditions on the two different pulse measures was obtained; that is the confidence intervals for these contrasts were not significant. The average pulse rates were for pulse 1, 78 beats per minute and for pulse 2, 72.5 beats per minute. Further an ANOVA tested whether the difference between the two measures of pulse rate varied between conditions. Again, no differences were found.

Because only one blood pressure reading was obtained

for each individual it was difficult to interpret the results. To compare between groups it would have been necessary to assume that people were in the same blood pressure range when first entering the setting. This assumption, however, was not possible. Further, a general test for differences between groups was not significant. This result was expected in that the Red Cross required the blood pressure to fall within a specified range. Individuals deviating from this range were not permitted to donate, and therefore, were not included in the subject pool.

C H A P T E R I V

DISCUSSION

The primary objective of this study was to determine if there was an impact of alternative lighting systems upon behavior. The results have shown that attitudes as well as spatial and social behaviors can be influenced by lighting or the ambiance created by different types and levels of illumination. There are several important theoretical, methodological and applied implications of these results for future research. Before these implications can be summarized, however, the results need to be discussed in more detail. In this chapter a discussion of the major findings will be presented followed by a summary of their implications.

Attitudinal Responses

The open-ended interview questions suggested that donors in both conditions viewed the setting as comfortable and the staff as sociable and competent. The fact that on the first three scaled questions (asking about impressions of appropriateness, expectations and pleasantness) both groups did not differ in response was an important outcome. There was the possibility that the

table lamps were incongruent with the physical set-up of the Campus Center where the site was located. This would lead subjects not to view the setting as appropriate or expected even though it might have been very pleasant and relaxing. The groups, however, responded similarly, suggesting both lighting conditions were appropriate, they were not different from expectations and were perceived as pleasant. In contrast, perceived sociability was influenced by lighting. Clearly individuals in the table lamp condition viewed themselves as more socially outgoing and interested and responsive to their surroundings than those in the overhead condition. This result follows the direction of findings obtained by John Flynn (1973). In his studies the overhead, uniformly lit condition was evaluated as the most "tense". In the context of psychological stress, feeling more sociable and outgoing could be an indication of feeling less tense. Individuals were more relaxed and more willing to interact with their surroundings in the table lamp condition than in the overhead condition.

Spatial Responses

The measures of spatial behaviors described the individual to varying degrees. It was predicted that length

of stay in a particular area would be influenced by the lighting. Specifically, if the individual was comfortable and relaxed, he/she would stay longer than an individual who was more stressed by the situation. This measure, however, was not as variable as first anticipated. In the waiting area the length of stay was determined by the number of other people donating blood; if no one was donating it was not necessary to wait. In the canteen area, nurses asked people to wait for fifteen minutes after giving blood. Keeping track of the time by the donor was facilitated by a large wall clock located in the room. Further, many individuals had classes or appointments to keep so they were very conscious of how long they were staying. The result was subjects tended to stay only for the specified time even though there was no pressure to leave.

The number of others present and the seating positions were more influential in predicting behavior differences between the two groups. In the waiting area the pattern of seat selection was for individuals to maximize the distance between each other as suggested by the highest frequencies for alternate seats. The distribution of where other people were positioned relative to the subject further confirmed this pattern of seat selection (the most popular being one or two seats apart from the subject).

In the canteen area the pattern of seat selection varied significantly between conditions in the following ways; 1) the direction the subject preferred to face and 2) where the individual sat relative to the others present.

Under the overhead lighting individuals tended to sit with their backs to the room. This was not an expected result. According to the personal space studies, people prefer to sit with their backs to the wall and facing into the room. One explanation for this might be that people do not like watching others donating blood. Some of the people interviewed, for example, suggested a physical separation between the canteen area and the donating beds for this reason. (It should be remembered that the distance in between the canteen table and the donating beds was only about three feet). Sitting with their backs to the room, therefore, was a way of blocking from view people on the donating beds. A second possibility was that individuals were trying to create a more intimate grouping around the canteen area. It could be viewed as an attempt at stress reduction by blocking the activities of the room from view and creating a smaller space dominated by a darkly colored wall.

Under the table lamp condition this pattern did not

exist: thus, 1) individuals did tend to sit facing into the space, perhaps indicating that the effects of lighting overcame this tendency to face away from the donating area, 2) this may also support the idea that under incandescent lighting donors felt more interested in what was going on around them, and 3) the non-uniform, softer illumination from the table lamps may have made the donating process appear less aversive and more interesting to the people who were watching from the canteen table. Also, the distribution of where others sat relative to the subject clearly showed a significant tendency for people to sit next to one another in the table lamp condition. This result indicated a willingness to interact with the other people present which was not found in the overhead condition. Further this result coincides with the finding that people in the table lamp condition were actively involved in conversation for a large portion of the time spent at the canteen table as opposed to donors in the overhead condition who preferred to read.

Social Responses

The results from observations of social interactions clearly indicated donors spent more time talking in the table lamp condition than the overhead condition whereas the dominant behavior of donors under overhead illumination

was reading. The result was especially striking because the analysis included people who were either in the waiting area or the canteen area by themselves and therefore did not have the opportunity for interaction. Further, for the waiting area data, a greater percentage of the individuals were alone in the waiting area during the table lamp condition than in the overhead condition yet there was a significant difference between amount of time spent in conversation and the time spent reading. Past research has indicated that increased social interactions can coincide with decreased perceptions of stress. The findings obtained in this study therefore, indicate that alternative lighting conditions can be one component of the physical environment which can influence stress reduction.

The types of interactions were almost entirely donor-initiated and unrelated to the donating process (nor were they about the lighting). In the waiting area, there were no staff people except when they came out of the donating room to call an individual for his/her turn. This obviously explains the lack of staff initiated conversations in this area. How busy the nurses were (the number of people present) tended to determine their degree of interaction with people in the canteen area. Several people at the canteen table usually was an indication that the site was busy. In this situation staff would not have the opportunity to

talk with donors in the canteen, however, there was more opportunity for donors to interact with each other. Further research could examine more closely how the behavior of the staff was influenced by the different lighting conditions and how their behavior might interact with donor behavior.

Of all the data collected, the physiological data provided the least amount of information but remains one of the greatest potential measures of environmental influences on behavior. The primary problem for this study was control. In order for pulse rate to be a viable measure the conditions prior to donating blood needed to be specified more accurately. For example, the activities before entering the site could influence pulse. Whether the individuals were exercising, smoking, or eating could make a significant difference. Second, the time spent in the waiting area needed to be controlled more precisely. Individuals could have adapted during a fifteen minute interval such that their pulses would return to a normal, baseline level in either condition. To determine whether the lighting was maintaining a pulse acceleration or deceleration a second measurement of pulse rate was needed one to five minutes after entering the setting. This would provide enough time for the individual to observe their surroundings but not enough time for complete adaptation to occur. Blood pres-

sure also has potential for revealing more about the physiological reaction of an individual to the environment. In this study, however, there were no comparative measures. With only one blood pressure measure, differences between groups were uninterpretable.

The lack of physiological results suggests one area in need of future research. It also suggests the need for a more complete profile of the donor to account for the individual differences when first entering the setting. The assumption throughout this study has been that the entering state of all subjects fell within the same range. The physiological basis of support for this assumption was that there were necessary criteria needed to be met in order to donate blood. Behaviorally, there were no equivalent criteria. For instance, as just mentioned, the activities the individual was participating in prior to donating could have greatly influenced how they reacted to the setting. It could also be imagined that individuals who spent their waiting time reading were people who had a class to go to directly following donating. One approach to control for individual differences would be to do a repeated measures design. This design, however, would not be very practical for this particular setting because of the difficulty getting the same individuals to return to

the site. An alternative approach would be to match pairs of individuals between groups. This would ensure, to some degree, that subjects were relatively equivalent from the onset.

To summarize, people thought that the lighting conditions in this setting were appropriate and pleasant and met with their expectations. Under table lamp illumination the donors felt more interested and responsive to the situation around them and more outgoing and sociable compared to individuals who donated under fluorescent lighting. Social and spatial behaviors were also influenced by the lighting: subjects engaged in conversation for longer periods of time and spent less time reading in the table lamp condition than in the overhead condition. Finally, people often selected a seat in the canteen area which was next to another person and which faced into the donating room when the space was illuminated by table lamps.

Theoretical Implications

Several perspectives provide explanations for the observed results. In the context of psychological stress theory the tendency for donors in the overhead condition to participate in solitary behaviors (i.e., reading) could be viewed as a mechanism which reduced stimulation from the

environment. By reading one could effectively block out interaction. The implication, therefore, was that the setting illuminated by overhead lighting accentuated or maintained the feelings of stress accompanying donating blood and stress reduction was achieved through a process of blocking out the stressful stimulation. In the table lamp condition the significant increase in social interaction suggested that instead of needing to block out the surroundings, individuals found the setting interesting and were willing to interact with the other people present. Further, individuals were more ready to observe the activity in the room (i.e., facing into the room rather than with their backs to the space). The implication in the table lamp condition was that the illumination led to the setting being perceived as less stressful.

Alternatively, table lamps may have evoked a strong association with home-like environments. The lamps may have communicated to the individual that talking was an accepted and appropriate behavior for the setting. Overhead illumination may have communicated a different message - perhaps one of formality which suggested reading as a more appropriate response. This explanation focuses upon the information resulting from the blending of the particular characteristics of the setting and the illumination rather than how the illumination may have interacted

with stress and coping processes. To test this theory the different components of lighting need to be studied individually. For example were differences attributable to the table lamps per se or to incandescent lighting? If there had been floor lamps would there have been the same results?

Methodological Implications

The importance of field studies as a research approach to the relationship between lighting and behavior was emphasized by this investigation. Primarily the field study ensured observation of the behaviors which were exhibited by donors rather than behaviors which may have been experimental artifact or imposed by the experimenter.

Implications for the types of behaviors observed were also suggested. The multimethod approach greatly strengthened the results. Without looking at the social, spatial, attitudinal and physiological responses cross-validation would not have been possible. For example, this study showed how spatial behaviors and attitudinal responses corresponded to levels of social interaction.

Future research needs to further refine the methods--especially the physiological measures. The approach piloted in this study, however, has provided a model from which to design future investigations.

Design Implications

Finally it is important to realize the design implications. Evidence has been presented which suggests that the lighting design can influence people's behaviors. In the health services setting one design objective is to maximize feelings of well-being and minimize feelings of stress. The use of incandescent lamps can aid the designer in obtaining this goal. The specific aspect of lighting which most contributes to the sense of well-being has yet to be determined. It may be the color of the incandescent illumination, or it may be the fact that table lamps create an atmosphere which overhead illumination cannot duplicate. The methods which have been piloted, however, provide a base from which it will be possible to study other characteristics of lighting. Controlled experimental manipulation of the various aspects of lighting are needed to determine these influences. It is clear, however, that overhead fluorescent lighting is not the optimal illumination for minimizing stress and maximizing feelings of well-being.

The relationship between the reported impressions of the donors and their behaviors indicate that designers need to consider behaviors of an individual as well as their

perceptions of a particular setting. For example, the donors in the overhead condition reported feeling relaxed and comfortable yet if the results are interpreted in the context of psychological stress theory, people in this condition exhibited predominantly solitary behaviors indicating higher levels of stress. The pattern of seat selection provides a second example. The same information would probably not have been obtained by merely asking the donor where he/she preferred to sit.

This has been a pilot project for the investigation of the behavioral correlates of alternative lighting design. The results have yielded evidence for the nature of the relationship between lighting and behavior and have suggested directions for future research and implications for applied uses. Lighting may be an aspect of the environment which often goes unnoticed, but not one which is unimportant.

BIBLIOGRAPHY

- Administrative Management, "Task/Ambient Lighting: often the answer but not a panacea", June, 1978, pp. 26-29.
- Allphin, Willard, "School Lighting and Posture", Illuminating Engineering, April, 1954, Vol. 49, pp. 192-196.
- Andrew, R.J., "Arousal and the Causation of Behavior", Behavior, 1974, Vol. 51 (3-4), pp. 135-165.
- Appley, M.H., Adaption-Level Theory, Academic Press, Inc., 1971.
- Architectural Record, "Lighting Hospital Patients' Rooms", November, 1963, Vol. 134, No. 11, pp. 192-193.
- Archives of Opthamology, "Lighting and Health Hazards", January, 1968, Vol. 79, p.2.
- Beck, William C., "Operating Room Lighting" The Journal of Hospital Research, November, 1976, Vol. 2, No. pp. 40.
- Beck, William C.; William H. Van Slyke, "Light, Color and Lamps in the Hospital" The Guthrie Bulletin, Winter, 1976, Vol. 45.
- Beck, Jacob, "Lightness and Orientation", American Journal of Psychology, September, 1969, Vol. 82, pp. 359-366.
- Becker, Franklin D., User Participation, Personalization and Environmental Meaning: Three Field Studies, Program in Urban and Regional Studies, Cornell University, Ithaca, N.Y., 1977, pp. 105-162.

- Birenbaum, Lauren A.; D. Geoffrey Hayward, Lighting and Human Behavior, Amherst, Ma.: University of Massachusetts, The Environmental Institute, unpublished annotated bibliography.
- Carr, Suzanne J.; James M. Dabbs, Jr., "The Effects of Lighting, Distance and Intimacy of Topic on Verbal and Visual Behavior", Sociometry, 1974, Vol. 37, pp. 592-600.
- Flynn, John E., "A study of subjective responses to low energy and nonuniform lighting systems", Lighting and Design Application, February, 1977, pp. 6-15.
- Flynn, John, E.; Terry Spencer, "The effects of light source color on user impression and satisfaction", Journal of IES, April, 1977, pp. 167-169.
- Flynn, John E.; Spencer, Terry; Martyniuk, Osyp; Hendrick, Clyde, "Interim study of procedures for investigating the effect of light on impression and behavior", Journal of IES, October, 1973, pp. 87-94.
- Giesen, Martin; Clyde Hendrick, "Effects of seating distance and room illumination on the affective outcomes of small group interaction", Social Behavior and Personality, 1974, Vol. 2, pp. 87-96.
- Glass, David C.; Jerome E. Singer, Urban Stress, Experiments on Noise and Social Stressors, Academic Press, New York, 1972, pp. 182.

Graff, Charlan, Influence of Color on the Perceptions of Social Behavior, paper presented EDRA 9, April 11, 1978.

Harmon, Darrell Boyd, "Social Lighting and Posture", Illuminating Engineering, July, 1954, Vol. 49, pp. 362-366.

Houck, Catherine, "Caution: Artificial Light May Be Hazardous to your Health", Copyright 1978 by New York Magazine Company, Inc. Reprinted by permission in Review, March, 1979, pp. 27-34.

Ittelson, William H. (Ed.), Environment and Cognition, Seminar Press, New York, 1973, pp. 187.

Lazarus, Richard S., Psychological Stress and the Coping Process, McGraw Hill Book Company, New York, 1966, pp. 466.

Lighting Design and Application, "Grading Impressions and Behavior", January, 1974, pp. 37-40.

Maas, James B.; Jayson, Jill K.; Douglas A. Kleiber, "Effects of Spectral Differences in Illumination on Fatigue", Journal of Applied Psychology, 1974, Vol.59, No. 4, pp. 524-526.

McGrath, Joseph E. (Ed.), Social and Psychological Factors in Stress, Holt, Rinehart and Winston, Inc., New York, 1970, pp. 352.

- Mehrabian, Albert; James Russell, An Approach to Environmental Psychology, MIT Press, Cambridge, Mass., 1974, pp. 56-76.
- Nesbitt, Paul D.; Girard Steven, "Personal Space and Stimulus Intensity at a Southern California Amusement Park", Sociometry, 1974, Vol. 37, No. 1, pp. 105-115.
- O'Dea, William T., The Social History of Lighting, MacMillan, New York, 1958.
- Page, Richard A.; Martin K. Moss, "Environmental Influences on Aggression: The Effects of Darkness and Proximity of Victim", Journal of Applied Social Psychology, 1976, Vol. 6, No. 2, pp. 126-133.
- Proshansky, Harold M.; Ittelson, William H.; Rivlin, Leanne G. (Eds.), Environmental Psychology 2nd Edition, People and Their Physical Settings, Holt, Rinehart and Winston, New York, 1976, pp. 494-508.
- Sanders, Mark; Gustanski, Jerry; Mike Lawton, "Effect of Ambient Illumination on Noise Levels of Groups", Journal of Applied Psychology, 1974, Vol. 59, No. 4, pp. 527-528.
- Stokols, Daniel, "The Experience of Crowding in Primary and Secondary Environments", Environment and Behavior, March, 1976, Vol. 8, No. 1, pp. 49-86.

Taylor, Lyle H; Eugene Sucov, "The Movement of People Towards Lights", Lighting Design and Application, January, 1974, pp. 54-55.

Wild, Bradford; Carolyn Hanes, "A Dynamic Conceptual Framework of Generalized Adaptation to Stressful Stimuli", Psychological Reports, 1976, Vol. 38, pp. 319-334.

Wohlwill, Joachim F., "Human Adaptation to Levels of Environmental Stimulation", Human Ecology, 1974, Vol. 2, No. 2, pp. 127-147.

List of Appendices

- A - Voluntary Consent Form
- B - Interview of Blood Donors' Reactions About the Site
- C - Sample Data Collection Sheet

APPENDIX A

VOLUNTARY CONSENT FORM

Research Project on Environmental factors
which influence feelings of well-being in Blood Donor Sites

conducted by

Environment and Behavior Research Center
The Environmental Institute
University of Massachusetts
Amherst, MA 01003
413/545-0648

DESCRIPTION OF THE PROJECT: The purpose of this project is to determine aspects of the physical environment which contribute to a sense of well-being and minimize feelings of anxiety in a blood donor setting. Some people will be observed and interviewed. The information obtained will be treated confidentially and anonymously. Although approved by the Red Cross, this is an independent study not connected with the Red Cross.

CONSENT: I understand the above description of the project and I consent to participate in this study. I agree that my pulse rate and blood pressure information collected by the staff at this blood mobile site may be used by this research project. If interviewed, I understand that I may refuse to answer any questions which I don't want to answer, and that I am free to withdraw my consent at any time, without prejudice.

Signed, _____
(name of respondent) (street address)

Print Name Here: _____

If you have any questions or concerns please contact:
Dr. D. Geoffrey Hayward, Director
Environment and Behavior Research Center

Blaisdell House
University of Massachusetts
413-545-0648

Whether you decide to participate in this study or not, we urge you to continue to be a blood donor. Your cooperation is greatly appreciated.

APPENDIX B

INTERVIEW OF BLOOD DONORS' REACTIONS ABOUT THE SITE

Hi, could I ask you a few questions about this blood donor site, and about your reaction to it? (If donor says 'yes' right away, start asking questions: otherwise continue with explanation). We're doing a study of people's experience -- in cooperation with the Red Cross -- to find out whether improvements can be made in the physical set-up of these blood donor sites. It'll only take a couple of minutes... do you mind? (If donor refuses, say thanks anyway)

- 1) Have you donated before? yes _____ no _____
If yes: How many times? _____
- 2) Did you have any physical reaction to giving blood?
yes _____ no _____
- 3) What parts of the process of giving blood do you think are handled especially well? (Pause, if no response ask probes). For example, did it take too much time, or did you feel rushed? Were you made to feel as comfortable as possible?
- 4) Are there any things that you think could be handled better, for your comfort and satisfaction? (Pause, if no response, ask probes). For example, is there any way you would change the procedures or the way you were treated?

Well, one of the things we're especially interested in is the canteen area -- where you sit and have some refreshments to make sure you don't get dizzy and faint.

- 5) Would you say the general atmosphere in the canteen area was:
 - (1) _____ completely as you expected it would be
 - (2) _____ almost exactly as you expected it would be
 - (3) _____ sort of like you expected it would be
 - (4) _____ you had no expectations
 - (5) _____ was a little different from what you expected
 - (6) _____ varied quite a lot from your expectations
 - (7) _____ completely different from the way you expected it.Why? _____

2.

- 6) And, would you say that the way the canteen area looked, (that is, the type of furnishings, lighting, color, etc.), was
- (1) ☐ extremely appropriate
 - (2) ☐ very appropriate
 - (3) ☐ kind of appropriate
 - (4) ☐ fairly appropriate
 - (5) ☐ kind of inappropriate
 - (6) ☐ very inappropriate
 - (7) ☐ extremely inappropriate
- 7) Would you say the canteen area was
- (1) ☐ extremely unpleasant
 - (2) ☐ very unpleasant
 - (3) ☐ fairly unpleasant
 - (4) ☐ moderately pleasant
 - (5) ☐ fairly pleasant
 - (6) ☐ very pleasant
 - (7) ☐ extremely pleasant
- 8) In the canteen area how interested and responsive did you feel to what was going on around you?
- (1) ☐ Dull and apathetic. Almost no interest or desire for anything.
 - (2) ☐ Bored. Life pretty monotonous and uninteresting.
 - (3) ☐ Slightly disinterested and unresponsive.
 - (4) ☐ Moderately interested and fairly responsive.
 - (5) ☐ Open and responsive to the world and its happenings.
 - (6) ☐ Senses lively. Great interest and delight in everything around me.
 - (7) ☐ Tremendously stimulated. Enormously receptive.
- 9) In the canteen area how socially outgoing or withdrawn did you feel?
- (1) ☐ Highly outgoing, sociable and friendly.
 - (2) ☐ Very sociable and involved in things.
 - (3) ☐ Companionable. Ready to mix with others.
 - (4) ☐ Fairly sociable. More or less accessible.
 - (5) ☐ Not particularly outgoing. Felt a little bit unsociable.
 - (6) ☐ Retiring, would like to avoid people.
 - (7) ☐ Feel detached and withdrawn. A great distance between myself and others.

3.

- 10) Could you please describe the kind of lighting around the canteen area? What did you think of it?
- 11) Overall, what suggestions would you have for making improvements in the physical set-up and design of blood donor clinics?

Thanks a lot for your help. We really appreciate it.

APPENDIX C

SUBJECT #		EXP	
DATE		M F AGE	
START		WITH OTHERS?	
FINISH		#	
LOCATION		1 st TIME #	
CONDITION		TEMP.	
WEATHER		COMMENT	

	STAFF INITIATED		OTHER INITIATED	
	DONOR RELATED	DONOR UNRELATED	DONOR RELATED	OTHER UNRELATED
ACTIVE				
PASSIVE				
Talking active				
Talking passive				
Reading				
Walking around				
Investig. table				
Blank staring				

SUBJECT #		EXP	
DATE		M F AGE	
START		WITH OTHERS?	
FINISH		#	
LOCATION		1 st TIME #	
CONDITION		TEMP.	
LOCATION		COMMENT	

	STAFF INITIATED		OTHER INITIATED	
	DONOR RELATED	DONOR UNRELATED	DONOR RELATED	OTHER UNRELATED
ACTIVE				
PASSIVE				
Talking active				
Talking passive				
Reading				
Walking around				
Investig. table				
Blank staring				

