THE RELATIONSHIP BETWEEN TWO TYPES OF ARTIFICIAL LIGHTING AND
RESTLESSNESS AS MANIFESTED BY LEVEL OF ACTIVATION
AND MOTOR ACTIVITY IN THE ELDERLY

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 CHAPTER I

THE PROBLEM

Introduction

Restlessness is a universal phenomenon requiring the attention of those caring for the elderly (Cohen-Mansfield, 1986). Norris (1975) defines restlessness as "...a discontinuous animal behavior evidenced by non-specific, repetitive, unorganized, diffuse, apparently non-purposeful motor activity that is subject to limited control" (p. 107). She writes that although this behavior is generally thought of as negative, its real purpose is to prepare the organism to cope with change, challenge, or threat (Norris, 1986). In this sense, restlessness is related to a person's perception of the environment as arousing.

It has been theorized that individuals and the environment are mutually capable of eliciting responses from one another (Scheidt & Windley, 1985). One environmental stimulus that impinges upon humans is light. Although radiation from the sun or from artificial sources has an obvious influence in facilitating visibility, and consequently performance, light also contributes to the visual quality of the environment and to the sense of well-being felt by those in the environment (Flynn, 1977).

The behavioral response to the light in the environment depends on three variables of the illuminant: the spectral power distribution, the intensity, and the temporal pattern of light exposure (Thorington, 1973). All three of these factors have been modified as humans take advantage of artificial light sources (Wurtman, 1975).

Because fluorescent lights are the chief means of illumination in public buildings, the
effects of such lights need to be explored. This is particularly true for the elderly, who spend a greater amount of time in-doors. It has been suggested that characteristics of the environment have a great impact on the behavior of the frail elderly. (Lawton, 1980).

The researcher focused on the spectral power distribution of two different fluorescent lights: warm white fluorescent lighting, which has energy concentrated toward the red region of the spectrum, and broad spectrum fluorescent lighting, which has energy more evenly distributed across the spectrum, including the blue region of the spectrum. Research has demonstrated that the color red induces greater arousal, whereas blue has a more calming effect (Ali, 1972). Increased arousal, in turn, has been associated with greater motor activity (Barry, 1974).

The researcher’s purpose in this quasi-experimental study was to gain a greater understanding of restlessness as measured by level of activation and motor activity and its relationship to the spectral power distribution of artificial light sources.

**Problem**

Is there a relationship between the spectral power distribution of two different fluorescent lighting sources and two measures of restlessness in the elderly?

**Subproblems**

1. Is warm white fluorescent lighting related to a greater degree of motor activity in the elderly as compared to broad spectrum fluorescent lighting?
2. Is warm white fluorescent lighting related to a higher level of activation in the elderly as compared to broad spectrum fluorescent lighting?
Definitions

**Broad Spectrum Lighting** is a fluorescent lighting source having a spectral power distribution (SPD) of nearly equal energy at all points including the shorter wave-lengths of the spectrum (violet) (Thorington, 1985). The General Electric Chroma 50 fluorescent lamp provides broad spectrum fluorescent light and was used as an experimental treatment in this study (see Appendix L).

**Light** is that portion of the electromagnetic spectrum which is capable of producing visual sensation. The SPD of natural sunlight ranges from a wave-length of approximately 380 nanometers to 760 nanometers (Thorington, 1985). Fluorescent light is electromagnetic energy generated by a non-thermal, ultraviolet photon excitation of phosphors. The relative SPD of fluorescent lights differs from natural daylight and varies depending upon the phosphors used.

**Restlessness** is a feeling of increased activation, that is, a phenomenological awareness of general bodily energy state, accompanied by an increase in motor activity. Restlessness was measured by the use of the Motor Activity Rating Scale (Fitzpatrick & Donovan, 1979) and the Activation-Deactivation Check List (Hoskins, 1978).

**Spectral Power Distribution (SPD)** is the characteristic color of a particular light source. It is the radiant power emitted by the source at each wavelength or band of wavelengths over the visible portion of the electromagnetic spectrum (General Electric, 1987).

**Warm White Fluorescent Lighting** is a fluorescent lighting source which has a SPD concentrated toward the longer wavelengths of the spectrum (red). The General Electric SPX30 fluorescent lamp provides a warm white fluorescent light and was used as an experimental treatment in this study (see Appendix L).
The sample was limited to participants who were physically and mentally able to engage in self-measurement of level of activation and free of any acute or chronic condition which interferes with mobility (Strauss, Corbin, Fargehaugh & Glaser, 1984).

The long-standing nature of chronic conditions makes it difficult to assess health in the elderly using medical diagnoses. The elderly tend to have different states of functioning and symptoms at different points throughout an illness. Consequently, Shanas and Maddox (1976) suggest that health in the aged be assessed using a functional model. To control for the effects poor health and functional difficulties have on motor activity, participants in this study were limited to those who reported good or excellent health, were able to ambulate without assistance, and reported an adequate range of motion for self-care (dressing, bathing, and grooming).

Certain drugs are known to alter mood and mobility by their action on the central nervous system (Pagliaro & Pagliaro, 1986). Akathisia, a syndrome of motor restlessness, often accompanies the use of neuroleptic drugs and phenothiazine-derivatives (Friedman & Wagner, 1987). The use of these drugs, including sedative-hypnotics, muscle relaxants, major tranquilizers, and anti-Parkinson's drugs, may introduce extraneous variance. Consequently, participants who reported use of these drugs were excluded from the study.

To control for extraneous variables that may influence perception, individuals who reported legal blindness or who tested positive for color blindness, using a pseudo-isochromatic plate, were excluded from the study. The pseudo-isochromatic plates of the American Optical Company are the most widely used of all color blindness tests. This test is easily administered and detects the two primary types of color blindness (Burnham, Hanes, & Bartleson, 1963).

Because a periodicity in level of activation or arousal has been observed in humans,
only individuals who woke after 5:00 A.M. and before 9:00 A.M. were included in the study (Colquhoun, 1971; Kleitman, 1963). This provided for a relatively homogeneous sample, with most participants’ overall level of arousal rising at the point of data collection.

**Need for the Study**

Today there is a great interest focused on the study of the interaction between humans and their environment. Human life is to a large degree a product of the environment. Electromagnetic radiation from the sun is part of the basic environment in which humans have evolved, and this radiation has both direct and indirect effects on life (Wurtman, 1975).

Fluorescent lamps, in contrast to natural sunlight, have only been in use since the early part of this century. They were developed to maximize visibility by concentrating as much of the lamp’s energy output as possible at certain bands of the spectrum. One of their shortcomings is that they render color poorly in contrast to natural daylight (Hughes & Neer, 1981). These alterations in color can affect mood, muscular activity, and level of arousal (Jacobs & Hustmyer, 1974; Nourse & Welch, 1971; Wilson, 1966). Research on this subject has shown that the autonomic nervous system is significantly less aroused during blue than during red illumination (Ali, 1972; Jacobs & Hustmyer, 1974). Blue elicits feelings of increased relaxation and lessened anxiety and hostility, but red is associated with increased tension and anxiety. These results suggest a need to investigate the use of cooler white light sources such as broad spectrum as a means of minimizing chronic tension (Hughes & Neer, 1981). The results imply that the arousal potential of warm white light sources may contribute to restlessness in the elderly. With increasing age, the visual system becomes less sensitive to the shorter wavelengths (Abranov, 1985). This is due to the yellowing of the lens and cornea causing them to absorb more
of the shorter wavelengths, thereby reducing their intensity at the retina. The use of broad spectrum lighting provides a more natural spectrum, including more light from the blue-violet region of the spectrum. This consideration would be important in institutional settings where inexpensive fluorescent lamps may be the only source of illumination to which patients are exposed on a daily basis.

Despite the reported prevalence of restlessness among the elderly (Thomas, 1988), little progress has been made toward understanding its etiology or management (Cohen-Mansfield & Billig, 1986). The use of restraints and medications continues to be the mainstay of care (Zimmer, Watson & Treat, 1984). Hiatt (1982) suggests that as knowledge of the effects of the environment on behavior develops, such notions as "ecologically based diagnoses" (p. 3) can be made where assessments of the individual are made in conjunction with the environment. Environmental interventions can then be prescribed which maximize well-being. A fuller understanding of the effects of fluorescent lighting and its relationship to restlessness in the elderly might offer an effective, non-invasive method of care. The use of cooler fluorescent lighting may reduce or eliminate the use of restraints and medications when caring for the restless aged. This intervention should prove to be desirable over existing modalities, when one considers the many side effects that prove problematic with current treatments.

Theoretical Rationale

Norris (1975), in her theoretical elaboration of the concept of restlessness, explains that this behavior can be evoked when one perceives the environment as arousing. Light is an aspect of the physical environment which has been shown to elicit feelings of relaxation as well as tension (Flynn, 1977). The term "activation" has been used to refer to this phenomenological awareness of general bodily energy state (Thayer, 1967). Activation is
both a general state and specific to the situation (Duffy, 1972). There is an enduring pattern of arousal (tonic), which is characterized by a circadian fluctuation and a briefer state of arousal which results from immediate stimuli (phasic), such as light (Kroeber-Riel, 1979).

One determinant of the arousal potential of a stimulus such as light is its color or spectral power distribution (Berlyne, 1971). Natural sunlight is the illuminant in which the human eye has developed through the ages, and it is a composite of all colors of the spectrum. It is just within this century that humans have used fluorescent lamps as a source of illumination. These sources have differed greatly from natural sunlight in their spectral power distribution.

Warm white fluorescent lamps differ from natural sunlight in their spectral power distribution. Unlike natural light, warm white fluorescent lamps have a spectral power distribution which is shifted toward the longer wavelengths (red) (Thorington, 1985).

Broad spectrum fluorescent lighting, on the other hand, has nearly equal energy at all points from 400 to 700 nm (Abramov, 1985). Although these lamps tend to be more expensive and less efficient than spectrally attenuated lamps, they simulate the spectrum of natural light and include the blue-violet region of the spectrum (Thorington, 1985).

Studies of the arousal potential of different colors have repeatedly demonstrated that red is significantly more arousing than other colors and that blue tends to have a subduing effect upon the observer (Ali, 1972; Jacobs & Hustmyer, 1974; Nourse & Welch, 1971; Wilson, 1966). Similar effects have been observed in studies of warm white and broad spectrum fluorescent lighting sources (Chance, 1982; Maas, Jayson & Kleiber, 1974). Results suggest that autonomic nervous system arousal, as measured by heart rate and blood pressure, is less under broad spectrum lamps as opposed to warm white fluorescent lamps.

If fluorescent lights are capable of increasing feelings of activation, vis-a-vis their particular spectral power distribution, then these same illuminants may be a source of
restlessness. Elaboration of activation theory by Malmo (1959) forms a basis for this approach.

Malmo (1959) states that one's level of activation varies from sleep to excitation and is a function of cortical stimulation of the reticular activating system. This system can be stimulated by external factors, such as light or sound, as well as internal factors, such as thought processes. The system then stimulates other areas of the cortex to energize the body, leading to increased arousal, motor activity, and thought processes (Kroeber-Riel, 1979).

There is empirical evidence which suggests an association between the arousal potential or activating properties of stimuli and greater amounts of motor activity. Research by Barry (1974) and Falco (1976) lend support to the proposition in that both investigators found an increase in motor activity under conditions of complex auditory input and tension-maximizing visual input, respectively.

Restlessness has been conceptualized along a continuum of motor activity with each increment in motor activity expressing greater tension (Norris, 1986). This tension can be operationalized as level of activation. From this perspective, restlessness may be measured using amount of motor activity and level of activation as two criterion variables for the concept.

Hypotheses

1. Elderly persons exposed to broad spectrum fluorescent lighting will exhibit less motor activity than those exposed to warm white fluorescent lighting.

2. Elderly persons exposed to broad spectrum fluorescent lighting will report a lower level of activation than those exposed to warm white fluorescent lighting.
CHAPTER II

REVIEW OF RELATED LITERATURE

The Concept of Restlessness

Although restlessness is a universal phenomenon, very little has been written about it in the geriatric literature. Norris (1975) describes this behavior as a disturbance in rhythmicity, triggered in lower animals by changes in light, food supply, air turbulence, and other environmental influences. In a similar fashion, Norris relates human restlessness to the arousal potential of the environment. From a theoretical point, she explains that restlessness may be related to a person's perception of the environment as strange, incomprehensible, threatening, exciting, or challenging (Norris, 1975).

Restlessness is generally thought of as a negative concept, a behavior that needs to be controlled. Norris (1978), in her theoretical elaboration of the concept, believes its real purpose is to prepare the organism to cope with change, challenge, or threat. It may be the initial phase of a coping process, a transitional state between change and problem solving, or a primitive defense response to a primitive perception of danger. In systematizing restlessness, she points out that this behavior occurs along a continuum: first as small muscle activity, proceeding to gross muscle activity, and then to total body involvement. Each stage expresses greater discomfort or tension.

The concept of restlessness has not been widely researched, but similar behavior in the elderly, such as agitation and wandering, has been described (Cohen-Mansfield, 1986; Cornbleth, 1977; Dawson & Reid, 1987; Monsour & Robb, 1982; Snyder, 1978;
Struble & Sivertsen, 1987). These studies, while suggestive of factors associated with restlessness, tend to be weak; several are ex-post facto in design or have small numbers of subjects. In addition, the findings of these studies do little to clarify, explain, or predict the occurrence of restlessness. They do suggest a relationship between restlessness and cognitive decline in the elderly. There is also the suggestion that the environment and one's perception of the environment have an impact on the behavior, and that restlessness in old age may be a manifestation of life-long patterns of coping.

**Restlessness: The Behavior and Relation to Activation Theory**

Restlessness was viewed as a feeling of increased activation accompanied by an increase in motor activity. The basis for this perspective is derived from activation theory and research which document a relationship between an increase in motor activity and level of arousal.

Activation has been used to refer to the sleep-waking-excitement continuum, a state of arousal or level of drive (Malmo, 1959). More recently, the concept has been defined as a phenomenological awareness of general bodily energy state (Thayer, 1967). Several different theoretical approaches have been suggested as a basis for understanding this behavior.

Using a neurophysiological approach, Lindsley (1951) developed an "activation theory of emotion." He demonstrated that changes in alertness are associated with EEG changes and suggested that a brain mechanism was responsible for this state of arousal.

Hebb (1955) and Malmo (1959) built on this work and held that one's level of activation is a function of cortical stimulation of the reticular activating system. This system can be externally stimulated by sights and sounds or internally stimulated by such things as thought processes. The system, in turn, stimulates other areas of the brain and leads to
increased arousal, psychological and motor activity, and information processing (Kroeber-Riel, 1979).

Berlyne (1960) expanded on this notion by suggesting that when stimulation deviates in either an upward or downward direction from an optimum influx, it becomes drive-inducing or aversive. He defines the arousal potential of a stimulus as the degree to which the stimulus can disturb or alert the organism and dominate behavior over the claims of competing stimuli (Berlyne, 1971). The specific determinants of arousal potential include intensity, size, color, sensory modality, novelty, complexity, degree of change, suddenness of change, incongruity, and uncertainty.

Fiske and Maddi (1961) describe the activating properties of stimuli much as Berlyne described their arousal potential. Specific activating properties of stimuli include intensity, meaningfulness, and variation. According to their theory, when central nervous system activation is low, the organism may increase internal stimulation by becoming restless, by moving about to increase proprioceptive inflow, or by actively seeking external sources of stimulation. Research has supported this theory (Hocking & Robertson, 1969).

Hocking and Robertson (1969), using a quasi-experimental design, compared fifteen male undergraduates, who scored high on the Zuckerman Sensation Seeking Scale (SSS), to fifteen male undergraduates who scored low, during a three-hour sensory restriction experiment. They found that subjects who scored high on the SSS demonstrated a significantly ($x = 177.38, p < .001$) greater need to move about than those subjects who scored low. Work by Zuckerman, Persky, Hopkins, Murtaugh, Basu and Shilling (1966) and Lambert and Levy (1972) substantiate these findings in that both studies documented significantly more restlessness in high-sensation seekers in situations of sensory deprivation.

There is also evidence for a relationship between an increase in cortical arousal and an increase in motor activity. Barry's (1974) findings lend support to this proposition. The investigator found that both introverts and extroverts demonstrated high levels of motor
activity under conditions of coded auditory input. This suggests that as sensory overload or arousal increases, motor activity increases in a similar fashion.

In a related investigation, Falco (1976) studied fifty-six female subjects between 18 and 30 years of age, who were confined to bed rest for one hour, and found a significant relationship between higher degrees of field dependence, as measured by the Portable rod-and-frame test (Oltman, 1965), and the embedded figures test (Witkin, 1971), and gross motor activity of the non-dominant limb. In addition, gross motor activity was found to be triggered by the visual environment; that is, those individuals who did not receive visual input and those who were exposed to a tension-producing five-minute silent movie demonstrated greater motor activity.

No studies were found which addressed restlessness in the aged and environmental stimulation, but it has been shown that the elderly have lower sensation-seeking scores (Zuckerman, Eysenck & Eysenck, 1978; Zuckerman & Neeb, 1980), and they tend to be more field dependent (Schwartz & Karp, 1967) than younger age groups. On the basis of these findings, one might hypothesize that the elderly would be more aroused and restless under conditions of increased stimulation as opposed to decreased stimulation.

The existing evidence on arousal level and age, however, is inconclusive. One problem has been the failure to differentiate between tonic and phasic activation in studies which use physiological measures of arousal (Kroeber-Riel, 1979).

For example, Shmavonian, Miller and Cohen (1970), using a quasi-experimental design, compared the arousal level of twenty-four young subjects aged 17 to 25 to twenty-two subjects aged 61 to 76. Using a variety of physiological measurements (respiration, heart rate, plethysmograph, EEG, and urinary catecholamines), it was determined that the aged exhibited much poorer reactivity than young subjects when subjected to electric shock. Powell, Eisdorfer and Begdonoff (1964), using plasma free fatty acid (FFA) as a measure of neurohumoral activation, found that their twenty-four aged subjects
had significantly higher (p < .01) levels of FFA at all points in a word learning task than the twenty-four younger individuals. The peak mean level in the older participants was 732u Eq liter as compared to 616u Eq liter in young participants. These high levels persisted in the aged subjects for a longer period of time and indicate heightened levels of arousal in comparison to younger subjects.

Welford (1965) suggests that the aged are in a tonic state of underarousal, but when presented with novel or intense stimuli may become phasically over-aroused. This over-activation results in tension, anxiety, and heightened activity or restlessness.

These studies indicate that characteristics of the physical environment can elicit restless behavior. Both high and low levels of stimulation have been associated with increases in arousal and motor activity.

**Color and Behavior**

One determinant of the arousal potential of a stimulus is its color (Berlyne, 1971). Pressey's (1921) early work on the influence of color upon mental and motor efficiency suggested the need to investigate these influences in greater depth.

Studies of the arousal potential of different colors have repeatedly demonstrated that red is significantly more arousing than other colors and that blue tends to have a subdued effect upon the observer.

Wilson (1966) measured conductance level and galvanic skin response (GSR) in twenty undergraduate students after exposing them to red and green slides in alternating order. Using a one-tailed sign test, results indicated that red is more "arousing" than green, particularly in the GSR data (p < .002). Subjective reports were consistent with the GSR data: the red was described as more stimulating, exciting, awakening, overpowering, and lively.
Jacobs and Hustmyer (1974) exposed twenty-four males (median age 20 years) to four different colored slides: red, yellow, green, and blue. Measures were taken of GSR, heart rate, and respiration as indicators of level of arousal. An analysis of variance revealed that neither the heart rate data nor the respiratory rate data supported the hypothesis of a differential color effect. However, the differential effect on GSR was significant with red being the most arousing color, but not significantly more than green, followed by green and yellow with blue being the least arousing. The lack of significance between red and green disagrees with Wilson's (1966) findings. One explanation for this discrepancy is that both of these studies used different specifications for the colors used. Wilson did not equate his red and green stimuli in degree of brightness.

Nourse and Welch (1971), who did equate their stimuli for brightness, exposed fourteen subjects to violet and green light for 60 second periods for a total of six minutes. Results indicated that the GSR was greater to violet than to green ($t = 2.18, p < .05$) for the first exposure. This response was not evident during the second and third 60 second periods. With time, there were no significant differences between responses to violet and green. A possible explanation for the initial difference is the spectral purity of the two colors. It was noted that the green light was relatively "pure," having a range of wavelengths of approximately 450 to 630 nm. The violet light consisted of a band of wavelengths covering the entire spectrum and peaking at 455 nm (blue) and 677 nm (red).

Ali (1972) compared the alpha attenuation response (AAR) in ten normal adult males under red and blue light using EEG recordings. The AAR serves as an index of cortical activation and decreases with an increase in stimulus duration. This recovery of the alpha rhythm is called cortical habituation response (CHR). A $t$-test of related measures indicated that there was greater alpha recovery under blue light than under red light ($p < .02$). After five minutes of exposure to the blue light the mean alpha amplitude was recorded as 53.44%, a gain of 7.84% from resting. In contrast, the mean alpha amplitude after five minutes of exposure to red light was 27.79%, a gain of only 1.29% from resting. These
results indicate that CHR under red is delayed more than under blue and that red induces greater cortical arousal.

It has been observed in several studies that color can effect an individual's level of arousal. Those colors with longer wavelengths (red) seem to be more arousing than those of the shorter wavelengths (violet).

Light and Behavior

The study of human interaction with light is quite varied. This subject of research is relatively new, but the existing evidence suggests that both solar and artificial sources of light have definite psychophysiological effects on human beings (Wurtman, 1975).

Light is a composite of all colors of the spectrum. Sunlight is the illuminant in which the human eye has developed through the ages. It is just in this century that humans have used electrical sources of illumination. These artificial sources, particularly fluorescent lamps, have differed greatly from natural sunlight in their spectral power distribution. The spectral power distribution of warm white fluorescent lamps differs from natural sunlight. Unlike natural light, warm white fluorescent light has a spectral power distribution which is shifted toward the longer red wavelengths (Thorington, 1985). Broad spectrum fluorescent lighting more closely approximates natural light in its spectral power distribution. However, it is less efficient than the warm white lamp (Thorington, 1985). Fluorescent lights, including these two light sources, have been shown to affect human behavior.

Fenton and Penney (1985) compared the frequency of repetitive motor behaviors of five autistic and five intellectually handicapped children under fluorescent and incandescent lighting conditions. The type of fluorescent lamp used was not specified. A two-way ANOVA with repeated measures on the lighting factor indicated a significant subject
type by lighting interaction ($I = 6.53, p < .05$). Autistic children had significantly higher frequencies of repetitive motor behaviors under the fluorescent light as compared to the incandescent light. The authors suggest that the function of repetitive behaviors in autistic children under conditions of increased environmental stimulation, such as provided by fluorescent lighting, would be to reduce arousal to an optimal level.

Maas, Jayson, and Kleiber (1974) studied twelve male and twenty-nine female undergraduates under cool white fluorescent light, a lamp with a spectral power distribution shifted toward the yellow-green region of the spectrum, and broad spectrum fluorescent lighting. Subjects were naive to the experimental conditions. Measures of fatigue were taken after four hours of study under each of the lamps: Critical Flicker Fusion test, visual acuity, hand-eye coordination, and self-reports of fatigue. While participants' self-reports of fatigue showed no significant differences, results indicated that decreases in flicker fusion and visual acuity were significantly less under broad spectrum than under cool white fluorescent lighting ($p < .05$). In fact, visual acuity was enhanced under the broad spectrum light.

Chance (1982) studied the effect of warm white fluorescent vs. broad spectrum fluorescent lighting on twenty-nine variables of human physical performance. Thirty-four college-aged women comprised the sample for the quasi-experimental design in which subjects served as their own controls. Subjects were asked to exercise on a bike under each of the different lighting conditions. Hourly measurements of heart rate, blood pressure, visual acuity, and reaction time were taken over a four-hour period. Measures of heart rate and blood pressure reflect the functioning of the autonomic nervous system and are an index of arousal and response to environmental stimulation. Results were analyzed using a repeated measures analysis of variance. With the exception of visual acuity and reaction time, all variables showed a significant decrease over the four-hour exposure under broad spectrum. Additional measurements were taken of heart rate after six minutes of exercise, final exercise pulse pressure, maximal oxygen uptake, and time spent
on the bike. The six-minute heart rate was significantly lower under broad spectrum
\( t = 2.41, p < .05 \), as was final pulse pressure \( t = 3.52, p < .01 \), oxygen uptake was sig-
nificantly higher under broad spectrum \( t = 2.25, p < .02 \), and the total time spent on the
bike was greater under broad spectrum lighting \( t = 2.36, p < .05 \). The results suggest
that environmental stress and arousal are less under broad spectrum as opposed to warm
white fluorescent lighting. Furthermore, fatigue sets in faster under the warm white fluo-
rescent lighting.

A series of studies have investigated the influence of fluorescent light on hyperac-
tivity in children. Mayron, Nations, Mayron, and Ott (1974) report a study of the effects of
broad spectrum fluorescent lighting on school-age children. One hundred and nine chil-
dren and four teachers participated in the project. Two existing classes were used as
experimental groups \( N = 54 \) and two as controls \( N = 55 \). The control rooms were illumi-
nated with cool white fluorescent light fixtures while vita-lite (broad spectrum) fluorescent
bulbs were installed in experimental rooms. Students were filmed with hidden cameras
for the duration of a thirty-minute class throughout the semester. The exact method for
measuring hyperactive behavior was not reported, but the researchers explained that
they obtained a change score between the first and the final class period. Using chi-
square, it was determined that the use of broad spectrum fluorescent lighting significantly
reduced hyperactivity \( p = < .0005 \). The results are interesting, but the study has obvi-
ous limitations with method of measurement and failure to control for the effect different
teachers had on student behavior.

In a better designed study of first grade children, O'Leary, Rosenbaum and Hughes
(1978) failed to demonstrate any effect of cool fluorescent light on hyperactive behaviors.
Using a repeated measure design, the investigators observed behavior during desk work
for twelve minutes per day under cool fluorescent lighting and broad spectrum lighting
each for a period of one week. Interrater reliability was reported to be .82. In addition,
subjects were rated on the Activity Rating Scale (reliability coefficient = .92). Analysis of
variance revealed no significant effect of lighting on behavior. This study, free of the methodological problems in the Mayron study, is limited by the fact that only seven subjects were followed. Statistical power tends to be low when sample size is small (Cohen, 1977). Consequently, no definitive conclusions can be drawn from either of these studies. However, the suggestion that fluorescent lighting affects attending behaviors in children raises questions about the use of these lighting systems with the aged.

One study which directly addressed the effects of light on the behavior of the cognitively impaired older adult is that reported by Miller (1985). This study, which lacked good control, explored the effects of two different types of lighting had on the agitated mealtime behavior of institutionalized patients diagnosed as having Alzheimer’s disease. Using a repeated measures design, sixteen subjects were videotaped during mealtime for the course of the project. Aside from subjects serving as their own controls, Miller did not control for any other extraneous variables which might influence behavior, such as the use of medication, staffing patterns, or other aspects of the physical environment. The two light treatments which were introduced for a period of one week each were bright fluorescent lighting and low level incandescent lamp lighting. Miller did not specify the type of fluorescent lamp used, nor the intensity of any of the lighting treatments. Two trained investigators viewed these tapes in twenty-second segments and rated subjects’ behavior using Haycox’s Dementia Behavior Scale (Haycox, 1984). Interrater reliability was established before collection of data and reported to be .92. Findings indicated that within subject comparisons reflected changes in subjects’ agitation with changing light conditions. All subjects demonstrated a decreased frequency and intensity of agitated behaviors when incandescent lighting was used. Miller did not report any statistical manipulation of the data so that it is difficult to determine if the reduction in agitation was a significant one. However, it was noted that feeding time under incandescent lamps was reduced by fifty percent, and patient consumption of food increased by a similar amount.

The existing research on light and behavior does little to clarify the effect that this
aspect of the environment has on the elderly. The studies reported are limited by the age
groups of participants, by lack of sufficient experimental control, and/or small numbers of
participants. However, based on Chance's (1982) work and extrapolating from the work
done on the effects of color on human behavior, it seems that cooler light sources, such
as broad spectrum, effect an environment more conducive to relaxation than warmer
lamps.
CHAPTER III

METHOD

Participants

The non-probability sample consisted of fifty non-institutionalized older men and women. Using the power tables for the \( t \) - test developed by Cohen (1977), it was determined that these fifty participants provide a power of 0.80. In determining power, a medium effect size \((d = .5)\) and an alpha of .05 were used.

Participants were recruited from Senior Citizen Centers located in Luzerne County, Pennsylvania. Initial approval was obtained from the Director of the Senior Centers to approach the aged who use these facilities (see Appendix A). Directors, in turn, were asked to approach individuals who used the facilities to determine their interest in participating in the study. Those individuals who indicated an interest were interviewed by the investigator to determine eligibility according to the criteria for participant selection (see Chapter I) and to explain participation in greater detail.

The sample consisted of fifty participants who ranged in age from 65 to 75 years with a mean of 69.6 years. Thirty-eight, or 76% of the sample, were female, whereas twelve, or 24%, were male. With respect to marital status, twenty-one (42%) were married and an equal number widowed. The majority (56%) lived with family while twenty-two, or 44%, lived alone. Forty of the fifty participants rated their health as good, and ten rated it as excellent.

The data describing participants' personal habits were summarized and indicated that
subjects were a somewhat homogeneous group. The time of waking ranged between 5:00 A.M. and 9:00 A.M. with a mean of 6:44 A.M. Times for retiring ranged from 7:50 P.M. to 2:00 A.M. with a mean of 11:26 P.M. These data suggest that subjects had an orientation toward day activities. Most participants (74%) drank between one and three cups of coffee per day. Thirteen, or 26%, reported that they meditated on a daily basis. In all cases, the form of meditation reported was prayer. Most participants (64%) exercised. Twenty-six of the thirty-two who exercised did so by walking daily; the remaining six participants reported a variety of activities, such as bike riding, stretching exercises, and swimming. Forty of the fifty participants took medication on a daily basis. The majority of these drugs were prescribed for hypertension (20 participants) or heart conditions (10 participants). A variety of other medications were taken and included oral hypoglycemics, anticoagulants, vasodilators, potassium supplements, anti-inflammatory agents, vitamins, and antacids. No one reported taking medications which have a known effect on level of activation or motor activity.

Thirteen, or 26%, of the participants reported having experienced a disruptive event in the two weeks prior to the testing date. These disruptive events included a wedding, sickness in the family (3 of 13), death of a family member or close friend (3 of 13), personal family problems (3 of 13), personal sickness (2 of 13), and birth of a grandchild. Subjects' habits on the day of testing were somewhat analogous to those reported on a daily basis. Six, or 12%, had meditated before data collection, and ten, or 20%, drank between one and three cups of coffee that morning. No one reported engaging in visualization activity.

The Instruments

Two instruments were used in the study: the Motor Activity Rating Scale (MARS) and
twelve alternate forms of the Activation-Deactivation Adjective Checklist (AD-ACL).

The Motor Activity Rating Scale

The Motor Activity Rating Scale was developed by Downs and Fitzpatrick (1976) to measure body position, gross motor activity, and intensity of activity. In their initial study of fourteen children, Downs and Fitzpatrick (1976) obtained high interrater reliability coefficients of .95 for body positions, .63 for changes in body movement, and .77 for changes in intensity of movement. Overall interrater reliability was reported at .78. The validity of the MARS was established by comparing actometer scores and total weighted intensity frequencies for each rater ($\tau = .88$, rater 1; $\tau = .86$, rater 2). Also, correlations were obtained for each rater between total actometer scores and the intensity of the average movement recorded ($\tau = .94$ for both raters).

A follow-up study of the reliability and validity of the MARS was done on a sample of 44 elderly nursing home subjects (Fitzpatrick & Donovan, 1979). The findings again supported the conclusion that the tool is generally reliable and valid for measuring body position, movement, and intensity of movement. The overall interrater reliability was .85. Correlations between actometer scores and MARS movement scores were significant, but low, and much lower than in the preliminary study (movement $\tau = .28$, $p < .01$; intensity $\tau = .33$, $p < .001$). This difference between samples may be due to the fact that actometers only measure activity in the plane of the face of the watch. It appears that actometers are oriented to more gross extremity movement, while the MARS is also sensitive to finer movements. This is an extremely important factor in the observation of more inactive groups, such as the elderly.

The tool includes six body positions: upright, sitting, lying down, leaning, bending over, and kneeling; eight body movements: head, right arm, left arm, both arms, right leg,
left leg, both legs, and both arms and legs active; and three intensity gradations: minimal, moderate, and high (see Appendix G). In using the scale, recordings of body position and body movement with its accompanying intensity rating, are made every fifteen seconds for a specified period (see Appendix H). The movement score includes the following: position change score, the total number of times the subject changed body position; the body movement score, a sum of all body movements observed; the intensity rating score, sum of all intensity gradations: minimal (1), moderate (2), high (3); the body movement intensity score, sum of all body movements times the intensity rating score. The body movement intensity score was used as a measure of motor activity or restlessness.

The Activation-Deactivation Adjective Check List

The Activation-Deactivation Adjective Check List (AD-ACL) is a self-report measurement of transient levels of activation. The original scale was developed by Thayer (1967) in a study of 211 male and female college students in which subjects were asked to respond to twenty-eight activation adjectives on a scale ranging from definitely feel (4) to definitely do not feel (1). Four dimensions emerged which represent four points on a hypothetical activation continuum: General Activation, those adjectives which represent a middle range of feelings; High Activation, those adjectives associated with anxiety or stress; General Deactivation and Deactivation-Sleep, those adjectives which represent the low range of activation feelings. The score for the scale is calculated by summing the response scores to the adjectives pertaining to each of the factors.

The validity of the scale was established by correlation of the self-response to physiological measurements of activation in a series of three studies (Thayer, 1967). Skin conductance and heart rate were found to be the best combination of the four physiological systems measured and demonstrated correlations of .58 (p < .01) with General
Activation, -.56 ($p < .01$) with General Deactivation, -.68 ($p < .01$) with Deactivation-Sleep, and .60 ($p < .01$) with High Activation.

Reliability and order effects were determined in a study of 145 college students who were divided into four equal groups (Thayer, 1967). Two groups completed the original AD-ACL and two groups completed a shortened AD-ACL which contained only 30 activation-descriptive adjectives. Each group received a check list with two of the activation adjectives repeated a second time. This allowed for calculation of test-retest reliability coefficients for eight of the activation adjectives. Test-retest coefficients computed for the eight activation adjectives ranged from .87 to .57 with a median coefficient of .75.

Twelve alternate forms of the Activation-Deactivation Adjective Check List as developed by Hoskins (1978) were used in the study (see Appendix F). In the construction of these forms, Hoskins used the twenty-six adjectives in Thayer's scale an equal number of times to develop sixteen different combinations of eight adjectives. These different combinations were tested in a pilot study of married couples and working adults.

Hoskins found high loadings for all adjectives on their factors: .72 to .97 for General Activation; .77 to .97 for Deactivation-Sleep; .76 to .91 for High Activation; .61 to .95 for General Deactivation. Internal consistency was also found to be high: .96 for General Activation; .92 for Deactivation-Sleep; .93 for High Activation; and .95 for General Deactivation. The factors were not found to be bipolar.

Based upon the analysis of the pilot study, Hoskins constructed twelve alternate forms of the scale. The factor of General Deactivation was not included. Each form consists of nine adjectives, three from each of the factors of General Activation, Deactivation-Sleep and High Activation. To reduce set response, some items are reverse scored (Hoskins, 1978).

In using this scale, the subject is instructed to determine the extent to which the adjective in each factor describes his or her feeling at that moment. Each adjective is scored on a four-point scale of definitely feel (4), feel slightly (3), cannot decide (2), and
definitely do not feel (1). The score for each factor is found by summing the response scores to the adjectives pertaining to that factor (Hoskins, 1978). The score on the High Activation factor was used as a measure of restlessness.

The twelve alternate forms have been used with older adults. Mason (1987), in her study of eighteen healthy non-institutionalized women aged 65 to 80 years, found statistically significant circadian periods in the factors of General Activation and Deactivation-Sleep.

Procedure for Data Collection

The researcher's purpose and the methods to be used were explained to prospective participants at recruitment. Written material was given during the initial explanation (see Appendix B). Interested participants were asked to sign a written consent form (see Appendix C). At this point, the Personal Data Sheet was administered by the researcher (see Appendix D). Those participants who met the criteria specified under delimitations were asked to proceed with the study.

Those participants who indicated an interest in the study, but who wished to consider participation in more detail, were given the investigator's home and work phone number and were asked to call within one week indicating their interest in the study.

Selected participants arranged a one hour testing session with the investigator. Hours for the testing sessions were between 10:00 A.M. and 12:00 noon to ensure that participants were being tested at a somewhat similar point in their arousal cycle (Mason, 1987). All testing was done in an Observation Laboratory located on the third floor of Stark Learning Center, Wilkes College. This lab measures eight feet wide by fourteen feet long by ten feet in height (see Appendix E). The walls are beige in color and the floor is covered with light gray carpeting. There are four windows along one side of the room, all of
which are covered by black light-attenuating shades. The opposite wall has a one-way mirror for participant observation during testing periods. At the time of the experiment, the room was furnished with a light brown metal chair, two small tables, and a kitchenette (stove and sink). A clock is located above the observation mirror and a blackboard is affixed to the wall adjoining this mirror. The room is sound-proof and equipped with an intercom system. A thermostat is located in the lab and was set at a relatively constant temperature of 72 degrees Fahrenheit throughout the experiment. Adjoining the testing room is the observation room where the investigator and research assistant remained throughout the experiment. This room was furnished with a table and two chairs.

With the exception of the different fluorescent test lights, all light entering the lab was eliminated using black light-attenuating shading on the windows. All doors to the lab were closed during testing. Both broad spectrum fluorescent lighting and the warm white fluorescent lighting were generated by General Electric lamps in fixtures directly attached to the ceiling above the participants. Each of the two fixtures had its own switch located outside the laboratory. The broad spectrum fluorescent lighting was generated by a Chroma 50 lamp, (F96T12/C50/HO) and the warm white fluorescent lighting by a SPX30 lamp (F96T12/SPX30/HO) (General Electric, 1987). The Chroma 50 lamp has a spectral power distribution which is more evenly distributed over the spectrum and delivers 110 watts per lamp. In a 40 watt lamp, the Chroma 50 light delivers 50 lumens per watt (General Electric, 1987). The SPX30 has a distribution which peaks toward the warm end of the spectrum and delivers 110 watts per lamp. In a 40 watt lamp, the SPX30 light delivers 81.5 lumens per watt (General Electric, 1987) (see Appendix L).

To ensure equal light intensity under the two different lamps, a GE #214 light meter was used to measure the relative energy under each lamp (see Appendix M). It was determined that a ratio of four Chroma 50 lamps to two SPX30 lamps provided an equal light intensity of approximately thirty footcandles under each lighting condition. The measure of intensity was taken at eye level in a sitting position and reflects an energy level to
which people are exposed in a home environment (Longhurst, 1967). Light intensity was measured prior to each testing situation. Readings remained within an accepted range of twenty-eight to thirty-two footcandles. At no time was it necessary to replace the original lamps.

Upon arrival at the observation lab, participants were greeted by the investigator and research assistant and given the opportunity to use bathroom facilities. The participants were seated in the room adjoining the lab. This room was illuminated with incandescent lighting supplied by a General Electric 40 watt incandescent lamp. At this point, the researcher administered the Testing Day Information Questionnaire (see Appendix I). Participants were given pencils and four alternate forms of the AD-ACL each numbered in the upper right hand corner. They were then comfortably seated in the observation room and given uniform instructions (see Appendix J).

Using a randomized block design (Kirk, 1968), participants were exposed to one of the two light conditions for a period of twenty minutes each. The random assignment of treatment conditions helps to eliminate an order of treatment effect (Polit & Hungler, 1987). The twenty-minute period was selected for the following reasons: McDonald (1982), in her study of light and arthritic pain in females found that subjects began to respond to the light condition within fifteen minutes; Fenton and Penney (1985), in their study of the effects of fluorescent and incandescent lighting on autistic and intellectually handicapped children, allowed two minutes for adjustment to the experimental treatment conditions before data collection; Heline (1972) states that humans react synergistically to color within five minutes; and Burnham, Hanes and Bartleson (1963) point out that light adaptation occurs within a few seconds following dark adaptation.

At the ten-minute point and the fifteen-minute point, participants were asked by the investigator to complete one alternate form of the AD-ACL. The ten-minute and fifteen-minute points were selected in order to accommodate older participants' longer reaction time to environmental stimuli (Birren, Woods & Williams, 1980).
Motor activity was measured independently by the investigator and research assistant using the MARS every four minutes for a period of two minutes at these time intervals: from the beginning of each data collection period through the beginning of minute two; from the beginning of minute four through the beginning of minute six; from the beginning of minute eight through the beginning of minute ten; from the beginning of minute twelve through the beginning of minute fourteen; from the beginning of minute sixteen through the beginning of minute eighteen. Measurements were taken in fifteen second segments over the two minute time frame (see Appendix H). A third assistant called out these time periods using a watch with a second hand. Body movement intensity was calculated for each minute of the two-minute time frame. This procedure resulted in a total of ten measures of body movement intensity under each light condition for each rater. These ten measures were then averaged for a mean body movement intensity score. In addition, measures were obtained of the total number of body position changes under each light condition.

At the completion of the testing period, participants were asked to join the researcher in the room adjoining the lab. Here they were exposed to incandescent lighting and given the opportunity to use bathroom facilities, if needed. The twenty-minute rest period and exposure to incandescent lighting helped to insure that participants responded to the second lighting condition only, with little or no contamination from the first experimental treatment.

Following this twenty-minute rest period, participants were returned to the lab for exposure to the second lighting condition. The procedure was identical to that described under the first treatment with only the type of fluorescent light treatment being changed.

At the completion of testing, participants joined the investigator outside the lab for a debriefing period. The results of testing were explained and answers given to any questions posed. Participants were asked to describe how they felt under each light treatment and if either condition promoted relaxation (see Appendix K).
Pilot Study

The procedure for data collection was established and evaluated in a pilot study of three (3) subjects. The purpose of this pilot was two-fold: to establish interrater reliability between the investigator and research assistant, using the MARS, and to correct any problems with data collection procedures.

Level of activation was measured at the start of the testing period and every five minutes thereafter for a total of five measures per treatment. It was noted that one participant had difficulty understanding directions for completing the AD-ACL, and two subjects reported being unfamiliar with the term "activated." Special care was taken to go over directions in detail with subsequent participants.

Motor activity was measured independently by the investigator and research assistant every four minutes for a period of two minutes under both light conditions. Data were tabulated on the total number of body position changes and the mean body movement intensity under each lighting condition. The scores for the three subjects under both light conditions provided a total of six scores for each rater on body position change and mean body movement intensity.

Interrater reliability was estimated using the method developed by Guilford (1954). Using this formula, the k raters rank the N person from high to low and then use the following formula:

\[ r = 1 - \frac{k (4N + 2)}{(k - 1) (N - 1)} + \frac{12S^2}{k (k - 1) (N^2 - 1)} \]

where:
- \( r \) = the average intercorrelation among individual judges, and more importantly, the reliability of one judge.
- \( k \) = the number of judges (raters)
- \( N \) = the number of individuals (persons being rated)
- \( S \) = the sum of ranks for any individual

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The Spearman-Brown Prophecy formula was then used to determine the reliability estimate of both raters:

\[ r = \frac{nr}{1 + (n - 1) r} \]

Using this procedure the interrater reliability for total number of position changes was found to be .96, and .90 for mean body movement intensity. These correlation coefficients are high and indicate good interrater reliability (Nunnally, 1978). On the basis of these findings, it was determined that data collection could proceed. However, an adjustment was made regarding the time frame for the collection of motor activity data. Because subjects' motor activity demonstrated such wide variability from fifteen-second to fifteen-second segment, it was decided to continue to collect motor activity data as planned for the pilot study, and to calculate body movement intensity scores for each minute of the five, two-minute time frames. The original proposal called for motor activity data collection at only two points: the ten and fifteen minute time periods. It was felt that much information regarding subjects' true motor activity would be lost if this plan were followed.
CHAPTER IV

FINDINGS

The data were analyzed in the following manner. The body movement intensity score was calculated as specified by Downs and Fitzpatrick (1976). The investigator and research assistant scored subjects independently. Notations of all body movements with their accompanying intensity gradations were taken under each lighting condition for a period of two minutes at these time intervals: from the beginning of each data collection period through the beginning of minute two; from the beginning of minute four through the beginning of minute six; from the beginning of minute eight through the beginning of minute ten; from the beginning of minute twelve through the beginning of minute fourteen; from the beginning of minute sixteen through the beginning of minute eighteen. The sum of body movements was multiplied by the sum of the intensity gradations. These products represent body movement intensity scores and were calculated at one minute intervals under both lighting conditions for each rater. This procedure resulted in ten (10) body movement intensity scores for each treatment, and for each rater. Each raters' ten scores were then averaged for each lighting condition, resulting in a mean body movement intensity score.

Using the formula specified by Guilford (1954), interrater reliability was calculated for these mean scores for each light treatment. The following coefficients were obtained: under the warm fluorescent light, $r = .71$; under the broad spectrum fluorescent light, $r = .83$. These coefficients represent good interrater reliability (Nunnally, 1978). Therefore, both raters' mean body movement intensity scores were averaged for statistical
testing (Waltz & Bausell, 1981).

The body position change data were analyzed in the following manner. Using the MARS, notations of subjects' changes in body position under each light treatment were made independently by the investigator and research assistant. These changes were summed for each rater under both light treatments. Pearson Product Moment Correlations were computed on these sums for each light treatment. The following coefficients were obtained: under the warm white fluorescent light, $r = .93$; under the broad spectrum fluorescent light, $r = .98$. These coefficients are high, and therefore both raters' total position change scores were averaged for statistical testing (Nunnally, 1978).

For hypothesis testing, a correlated $t$-test was computed on the mean body movement intensity scores under the warm white versus the broad spectrum fluorescent lighting. A correlated $t$-test was computed on the total body position changes under both light treatments.

The level of activation score was calculated in the following manner. The high activation scores for each subject at the ten and fifteen minute point under each light condition were averaged. This score represented the high activation score under each lighting condition. A correlated $t$-test was calculated for the mean high activation score under the warm white fluorescent light versus the mean high activation score under the broad spectrum fluorescent light.

**Hypothesis Testing**

**Hypothesis One**

Elderly persons exposed to broad spectrum fluorescent lighting will exhibit less motor activity than those exposed to warm white fluorescent lighting.
The mean body movement intensity score under the warm white fluorescent light was 535.16 (SD = 325.74), and 520.09 (SD = 332.22) under the broad spectrum fluorescent lighting. The results of the one-tailed correlated $t$-test are described in Table 1. The t-value of .388 was not found to be statistically significant. Consequently, hypothesis one was not supported.

Table 1

<table>
<thead>
<tr>
<th>Treatment</th>
<th>X</th>
<th>SD</th>
<th>DF</th>
<th>t-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm White</td>
<td>535.16</td>
<td>325.74</td>
<td>45</td>
<td>.388</td>
</tr>
<tr>
<td>Broad Spectrum</td>
<td>520.09</td>
<td>332.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Four cases deleted with missing values
* $p = .35$, one-tailed

Hypothesis Two

Elderly persons exposed to broad spectrum fluorescent lighting will report a lower level of activation than those exposed to warm white fluorescent lighting.

The mean High Activation score under the warm white fluorescent light was 4.52 (SD = 1.76), and 4.39 (SD = 1.69) under the broad spectrum fluorescent lighting. The results of the one-tailed correlated $t$-test are described in Table 2. The t-value of .503 was not found to be statistically significant. Consequently, hypothesis two was not supported.
Table 2

T-test on the Mean High Activation Scores under Warm White versus Broad Spectrum Fluorescent Lighting

(N = 50)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>X</th>
<th>SD</th>
<th>DF</th>
<th>t-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm White</td>
<td>4.52</td>
<td>1.76</td>
<td>49</td>
<td>.503</td>
</tr>
<tr>
<td>Broad Spectrum</td>
<td>4.39</td>
<td>1.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p = .30, one-tailed

Additional Analyses

Additional analyses focused on the number of position changes under both lighting conditions, differences in general activation and deactivation-sleep under both lighting conditions, and on relationships between demographic characteristics of participants and their personal habits, and the measures of high activation and motor activity.

Because independent ratings of position changes by the investigator and research assistant correlated highly (warm white fluorescent $r = .93$; broad spectrum fluorescent $r = .98$), these scores were averaged for statistical analysis. The t-value of .513 in the one-tailed correlated $t$-test computed on these data was not found to be statistically significant. It was concluded that subjects' position changes, that is, from sitting to standing, etc., were no more frequent under the warm white as opposed to the broad spectrum fluorescent lighting.

Subjects' scores on the sub-scales of general activation and deactivation sleep, were analyzed for any differences under the two lighting conditions. The mean General Activation score under the warm white fluorescent light was 8.61 (SD = 2.69) and under the
broad spectrum fluorescent light was 8.53 (SD = 2.78). The t-value of .249 in the one-tailed correlated t-test computed on these data was not found to be statistically significant. Likewise, there was no statistically significant difference between scores on the Deactivation-Sleep sub-scale. The mean Deactivation-Sleep score under the warm white fluorescent light was found to be 4.4 (SD = 2.10) and under the broad spectrum fluorescent light was 4.13 (SD = 2.19). The t-value of 1.11 for these data was not statistically significant. When looking at scores on all three sub-scales of the AD-ACL, it is apparent that subjects were feeling in the middle range of feelings under both lighting conditions. On the average, neither treatment induced feelings of tension or sleepiness.

Pearson Product Moment correlations were computed for body movement intensity scores under both lighting conditions, and age, gender, amount of coffee consumed, time of waking, bedtime, presence of disruptive events, exercise, and meditation. The average High Activation Factor under both lighting conditions was also correlated with these same variables. No statistically significant correlations were found. In every case coefficients were near zero.

As stated in the theoretical rationale, the concept of motor activity and high activation were felt to represent two measures of restlessness. The Pearson Product Moment Correlation between the mean body intensity score and the mean High Activation score under the broad spectrum fluorescent light was .006 and .014 under the warm fluorescent light. Consequently, it was determined that these two concepts share little variance and did not covary as was expected.

At debriefing participants were asked for their lighting preference and how they felt under each lighting condition. Thirty-three, or 66%, preferred the broad spectrum fluorescent light, while fourteen, or 28%, preferred the warm white fluorescent light. Three participants (6%) had no preference. In testing the significance of the proportion of subjects who preferred the broad spectrum fluorescent lighting, the Z value of 2.25 was found to be significant at the .01 level (Kachigan, 1986).
Of the thirty-three who preferred the broad spectrum lighting, sixteen stated that it seemed brighter, five stated that it seemed softer or less bright, six felt it was more relaxing, three described the light as more "lively" or as able to keep them awake, two stated they could see better, and one participant reported feeling better under the broad spectrum light. Of the fourteen who preferred the warm white fluorescent light, six reported that it seemed brighter, two reported that it seemed less bright, three said it wasn't as glaring and they could read better under it, one participant stated it was more relaxing, one person felt she could see better under it, and one person described the warm white fluorescent lighting as "like the sun."

When asked how they felt under each light treatment, the majority of subjects reported feeling relaxed: 20, or 40%, felt relaxed under the warm white light and 31, or 62%, felt relaxed under the broad spectrum. Seventeen, or 34%, of the sample reported feeling relaxed under both conditions. Only five subjects (10%) reported feeling anxious; this occurred in three cases under the warm white fluorescent light and in two cases under the broad spectrum light.
CHAPTER V

DISCUSSION

Restlessness has just recently been described in the geriatric nursing literature (Norris, 1986). Norris (1975), has defined the concept as an increase in motor activity brought on by perception of an arousing stimulus in one's internal or external environment. The measurement of this complex phenomena, as well as its relationship to specific environmental stimuli, is not clearly understood. In this study, motor activity and level of activation were used to measure restlessness. A relationship between an increase in motor activity in the elderly and the use of warm white fluorescent lighting was proposed. The relationship was not supported. A relationship between a high level of activation in elderly subjects and warm white fluorescent lighting was proposed. This relationship was not supported. It was also noted that body movement intensity and a high level of activation shared no variance. Subjects did indicate, however, a clear preference for the broad spectrum lighting. The Z-value of 2.25 was found to be significant at the .01 level. A discussion of these results will focus on the interrelationship of the theoretical framework to several methodological problems.

Several factors may explain the failure to find any significant difference in high activation scores or body movement intensity scores under the two lighting conditions. First, subjects' feelings regarding energy state fell primarily in the General Activation category. The mean High Activation score under warm white fluorescent light was only 4.52 (SD = 1.758) and 4.39 (SD = 1.691) under the broad spectrum fluorescent lighting. These scores represent the low end of the possible range of scores on that factor (3 to
Similar results were obtained with scores on the Deactivation-Sleep factor. The mean score under warm white fluorescent light was 4.4 (SD = 2.10) and 4.13 (SD = 2.19) under broad spectrum fluorescent lighting. Again, these scores fall on the low end of the possible range of scores for that factor (3 to 12). In contrast to scores for the High Activation and Deactivation-Sleep factors, scores on the General Activation factor were 8.61 (SD = 2.69) under warm fluorescent and 8.53 (SD = 2.786) under the broad spectrum fluorescent light.

These scores indicate that participants were feeling in the middle range of activation and were not experiencing excessive tension or drowsiness. In addition, the scores on the High Activation factor demonstrated little change from the ten to fifteen minute testing points (mean change score under warm fluorescent light = .16, SD = 1.658; broad spectrum fluorescent light = .18, SD = 1.699).

It is important to note the large standard deviations for motor activity that were found under both light treatments. Subjects were very heterogeneous on this variable. Obtaining statistical significance becomes difficult with such large variances (Iverson & Norpoth, 1976). The body movement intensity scores which demonstrated a difference of only 5.07 across treatments were not found to be statistically different.

A possible explanation for this lack of difference between conditions may be the lighting treatments themselves. Berlyne (1960) in his discussion of activation theory defines the arousal potential of a stimulus as the degree to which the stimulus can disturb the organism. Neither lighting condition may have been a strong enough stimulus to evoke feelings of high activation or to increase motor activity. Because both treatments involved white light there may have been a lack of systematic variance across treatments to affect any real difference between treatments. The introduction of more spectrally attenuated lights such as red or blue may yield more definite results.

A second factor affecting results may have been the testing situation itself. It will be recalled that the laboratory design was chosen because it provides a high degree of
control over competing environmental stimuli. Participants were given several magazines to read, but the testing situation may have been one of sensory deprivation for this group. Fiske and Maddi (1961) in their discussion of the arousal potential of different stimuli state that when central nervous system activation is low, as is the case in situations of sensory deprivation, the organism may increase internal stimulation by moving about so as to increase proprioceptive inflow. In this study data were not collected on baseline body movement intensity because the purpose was to compare the effect of two different fluorescent lights on motor activity. Consequently, it is not known whether the movement observed during the testing period was greater, less, or similar to, the subject's average movement intensity. If the motor activity observed was greater than usual for the subject, the movement observed may have been an attempt to increase level of activation rather than a response to the experimental intervention of lighting conditions. In general, participants were eager for completion of data collection and boredom, while not reported at debriefing, may have been a factor. On the other hand, if the motor activity observed was less than normal or within a normal range, it would verify subjects' statements at debriefing that they felt primarily relaxed under both light conditions. Future research might focus on comparisons of level of activation and motor activity under varying conditions, including natural sunlight, and the establishment of baseline data.

A third factor which may have influenced results is the choice of instruments. While all participants were able to read, some adjectives on the Level of Activation Scale were confusing to them. Several subjects found it difficult to respond to adjectives such as "activated" and "clutched-up." Furthermore, the researcher noted that on several occasions directions for completing the scale had to be repeated. Participants were anxious to respond in a "correct" manner and this anxiety may have interfered with directions for completing the scale. A suggestion for future research is to administer this scale verbally to participants.

The Motor Activity Rating Scale was sensitive to participants' bodily movements.
Neither rater failed to categorize particular movements. However, the selected time frame for data collection under each light treatment was intense. Both raters reported a sense of fatigue following each twenty-minute testing period. A shortened time period for data collection, however, would probably not result in an accurate score for movement intensity due to the tremendous variability in movement over short periods of time. The use of video tapes might be advantageous in the collection of this type of data. Another suggestion for future research is the development and use of mechanical instrumentation for the measurement of body movement.

A final factor to be considered is the theoretical framework itself. It is possible that the study could benefit by considering different personality traits, such as extraversion or anxiety, as intervening variables in level of activation and motor activity. Previous research has documented a relationship between extraversion and increases in restless behavior during sensory restricted periods (Hocking & Robertson, 1969; Lambert & Levy, 1972; Zuckerman, Persky, Hopkins, Murtaugh, Basu & Shilling, 1966). The high sensation seeker, when presented with a monotonous non-stimulating environment, has a tendency to move about in an effort to increase sensory stimulation. The low-sensation seeker may not experience the discomfort of sensory restriction as would the high-sensation seeker. In a more recent study by Mehrabian and Friedman (1986), fidgeting tendency, a propensity to engage in repetitious activity, was associated with unpleasant and arousable traits as opposed to a pleasure or stimulus screening trait in 230 undergraduate students who served as subjects. In a similar vein, there is evidence that introverts are more sensitive to stimulation than extraverts and thus experience higher activation levels in a given task environment (Eysenck, 1983; Smith, 1983).

It has also been suggested that introverts prefer "cool" colors, while extraverts prefer "warm" colors (Birren, 1984). Research by Choungourian (1967) provides only modest support for this claim. In this study of 120 undergraduate students who were classified as "introverts", "normals", or "extraverts", using the E scale of the Maudsley Personality
Inventory (Eysenck, 1959), there was a tendency for extraverts to prefer warm colors more often than introverts. It was also noted that males in all groups preferred warm colors. Considering this literature on personality types, stimulation, and color preference, it is suggested that attention be given to these traits in the design of future research.

Of equal importance is the consideration of factors other than personality traits or the external environment as causal links in the development of restlessness. Although this study focused on the external physical environment, restless behavior is a frequent accompaniment to changes in habitual practices, personal space, and physiological homeostasis (Norris, 1978). These factors deal with the internal environment, or one's perception of the external environment, and may include fatigue and boredom, pain and anxiety, role deprivation or transition, and a variety of conditions which induce physiological imbalance such as hemorrhage, drug reactions, elevated body temperature, or thyrotoxicosis, to name but a few. Norris (1986) further delineates three specific factors which are related to restlessness: changes that affect rhythmicity, pharmacological considerations, and central nervous system changes. The latter two factors were dealt with in the selection of subjects. Individual changes in patterns are more difficult to address. Disturbances in rhythmicity include interruptions in social rhythms or activities of daily living, changes in one's emotional experience or perception, and changes in mentation and psychomotor functioning (Norris, 1986). Over 25% of the participants in this study reported having experienced a disruptive event in the two weeks prior to the testing date. These events are a possible source of interruption in one's established daily pattern and may need to be controlled in future studies.

Despite the lack of evidence for any statistical difference between lighting conditions, it is interesting to note that a statistically significant proportion of the sample (66%) preferred the broad spectrum fluorescent lighting to the warm white fluorescent lighting. This finding supports what has been reported in the literature, namely, that lighting with a higher color rendering index, such as broad spectrum, will give a higher apparent
brightness and perceptual satisfaction to the environment (Aston & Bellchambers, 1969; Flynn & Spencer, 1977; Maas, Jayson & Kleiber, 1974). This is an important consideration with older people who experience changes in visual acuity and color discrimination with age (Hughes & Neer, 1981). The use of daylight simulating lamps, that is, those with higher color rendering properties, has been shown to improve color discrimination performance in the elderly as opposed to more spectrally attenuated lamps (Boyce & Simons, 1977). The use of broad spectrum lamps in the environment of the elderly may help them negotiate their living areas with more ease and is recommended on the basis of the findings of this study.
CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

A basic assumption which underlies nursing practice is that humans and their environment continually interact and elicit responses from each other. The researcher's purpose in this study was to consider one aspect of the inanimate environment, the spectral power distribution of light, and its proposed relationship to one behavior in the elderly, restlessness. Level of activation and motor activity were selected as measures of restlessness.

Light is the visible portion of the electromagnetic spectrum and has an obvious function in facilitating visibility. Light is also capable of eliciting behavioral responses vis-à-vis its particular spectral power distribution, intensity, and temporal patterns. All three of these factors are altered with the use of artificial lighting sources. This study focused on the spectral power distribution of two different fluorescent light sources: warm white fluorescent lighting which has energy concentrated toward the red end of the spectrum, and broad spectrum fluorescent lighting which has energy more evenly distributed across the spectrum, including the blue end of the spectrum.

Previous research has demonstrated that the color red elicits feelings of tension and anxiety, while blue has a more calming effect. Activation, the phenomenological awareness of general bodily energy state, was proposed to represent these feelings. Hoskins' (1979) alternate forms of Thayers' (1967) Activation-Deactivation Adjective Check List
were used to measure level of activation.

Empirical evidence also suggests a relationship between level of activation and motor activity. Cortical stimulation of the reticular activating system leads to increased arousal, thought processes, and motor activity (Kroeber-Riel, 1979). Motor activity was measured by use of the Motor Activity Rating Scale (Downs & Fitzpatrick, 1976).

It was hypothesized that:

1. Elderly persons exposed to broad spectrum fluorescent lighting will exhibit less motor activity than those exposed to warm white fluorescent lighting.

2. Elderly persons exposed to broad spectrum fluorescent lighting will report a lower level of activation than those exposed to warm white fluorescent lighting.

Fifty women and men between the ages of 65 and 75 years participated in the study. Participants were homogeneous with respect to their normal waking time (between 5:00 and 9:00 A.M.), their ability to move about freely, and their medication profile in that no one took drugs which affected level of activation or mobility. All subjects had normal color perception.

A randomized block design was used in which each participant was exposed to each lighting condition for a period of twenty minutes in a laboratory setting. Measures of level of activation were taken at the ten and fifteen minute periods under each condition. The researcher and her assistant independently measured motor activity for five, two minute periods under each lighting condition. A correlated $t$ - test was computed for the mean of the high activation factor under the warm white and broad spectrum fluorescent lights. A correlated $t$ - test was computed for the body movement intensity score under both warm white and broad spectrum fluorescent lights. Pearson Product Moment Correlations were calculated for the mean high activation score and body movement intensity score under each light, and between these scores and demographic characteristics.
Conclusions

In this study of fifty healthy older adults, aged 65 to 75 years, the mean body movement intensity score under the warm white fluorescent light was found to be 535.16 (SD = 325.74) and 520.09 (SD = 332.22) under the broad spectrum fluorescent lighting. The computed t-value of .388 was not found to be statistically significant. It was concluded that there was no statistically significant increase in motor activity under the warm white as opposed to the broad spectrum fluorescent lighting.

The mean High Activation score under the warm white fluorescent light was found to be 4.52 (SD = 1.76) and 4.39 (SD = 1.69) under the broad spectrum fluorescent lighting. The computed t-value of .503 was not found to be statistically significant. It was concluded that there was no statistically significant increase in level of activation under the warm white as opposed to the broad spectrum lighting. No significant correlations were found between high activation and body movement intensity scores or between these scores and demographic characteristics.

In the post experiment interview it was determined that subjects preferred the broad spectrum fluorescent lighting to the warm white fluorescent lighting. The most frequently cited reason was that the broad spectrum light seemed brighter.

Recommendations

Although this study failed to demonstrate a relationship between fluorescent lighting and restlessness in the older person, it does suggest several questions for further research.

In the discussion of the design of this study, it was noted that there may have been a lack of systematic variance across treatments. Both treatments involved white light. The
introduction of more spectrally attenuated lights, such as red or blue, or the comparison of fluorescent with incandescent or natural light might increase the systematic variance and yield more statistically significant results. Several research questions which may be asked are: Is red light related to a higher level of activation and motor activity in the elderly as compared to blue light? Is the use of broad spectrum fluorescent lighting related to a decrease in restless activity in the elderly as compared to other types of lighting? Does exposure to natural sunlight have an effect on restlessness in the elderly?

The difficulty encountered with the Motor Activity Rating Scale was noted in the discussion of the methods used. The use of this scale over long periods of time can be fatiguing to the researcher. Alternate methods for measuring activity in the elderly may need to be explored or developed. Some suggestions are the use of video tapes or the development of mechanical instrumentation. A comparative study of different methods would be of great value to researchers interested in measuring the motor activity of older persons. This type of research would also have direct and immediate application to the clinical area.

Finally, it was suggested that the theoretical framework of the study might be improved by introducing intervening variables which mediate restless activity. Some of these factors may be personality traits such as extroversion-introversion. It might be equally important to explore factors other than light that contribute to restlessness. Questions which may be asked are: Are there personality traits such as extroversion-introversion which mediate the response to light in the environment? What are some of the alternative factors that may contribute to restlessness in the elderly?
BIBLIOGRAPHY


APPENDIX A
LETTER FROM AGENCY

LUZERNE / WYOMING COUNTIES
BUREAU FOR THE AGING
AN AREA AGENCY ON AGING

January 18, 1980

Ms. Ann Kolanowski, M.S., R.N.
Associate Professor and Chairperson
Dept. of Nursing
Wilkes College
Wilkes-Barre, PA 18766

Dear Ms. Kolanowski:

As per our recent phone conversation, I am most happy, on behalf of the Bureau For The Aging, and our Senior Citizens Center Members to give permission to have some of them, on a voluntary basis, participate in your proposed study on the effect that different fluorescent lights have on the elderly.

Center Managers have been informed by a memo from me, that you will be contacting them in the near future. I know that they will give you their full cooperation.

At the conclusion of your study, I would appreciate receiving the results of your findings.

As always, we appreciate the fine contribution the nursing students and your department have made to our centers in the field of health care. We are looking forward to another successful working relationship with you and Wilkes College during 1988.

PWHcap

cc: Charles T. Adams
    Rose Yarmel
The Relationship Between Different Types of Artificial Lighting and Behavior in the Elderly.

There is evidence that some forms of artificial lighting are related to certain behavior in older people. Research is needed to determine how different fluorescent lights affect older adults who spend a good deal of time under these lamps. This information will be useful to nurses who care for older people. If you are between 65 and 75 years of age, you may be eligible to participate in a study of fluorescent lighting and behavior.

Eligibility:

In addition to age, other criteria for participation include: not living in an institution such as a nursing home; able to carry out activities of daily living and self-care independently; not currently taking any sleeping pills, tranquilizers, or drugs for Parkinson's disease; not having any severe visual problem or color blindness; and having a waking schedule such that you arise between the hours of 5:00 A.M. and 9:00 A.M.
Participation:

Participation in the study involves approximately one hour of your time at the Wilkes College Observation Lab, Stark Learning Center, Wilkes-Barre, Pa. At the beginning of the data collection period, you will be asked to complete a personal data sheet. Once inside the lab, the investigator will change the type of fluorescent lighting being used in the lab during two, twenty-minute periods. At a specific time during each of these periods, you will be asked to complete a brief nine item questionnaire on your level of energy at that time. The investigator will make notations of your behavior during the testing period. The researcher will show you how to complete the questionnaire and will be available to you during the testing period.

Informed Consent and Confidentiality:

Be assured that you may withdraw from the project at any time. The consent form points out that your anonymity will be maintained. The data will be coded and analyzed as part of a group. The only document with information that will identify you is the consent form, which will be kept separate from the data.

Results:

The researcher will be pleased to share the results with you after the testing period. She will also provide you with a summary of the results of the entire study, if you are interested.
For More Information:

If you would like to volunteer to participate in this study, or if you need additional information about it, the researcher can be reached at the telephone number below:

Investigator: Ann M. Kolanowski
Address: [BLANK]
Telephone: [BLANK]

Thank you for your interest in this study.
APPENDIX C

CONSENT FORM

I hereby consent to be a participant in the research project, "The Relationship Between Different Types of Artificial Lighting and Behavior in the Elderly." I have been informed and understand the purpose and nature of my participation in the study. I understand that all information will remain confidential and that the data will be analyzed as group data using code numbers to maintain my anonymity. I also understand that, should I decide to do so, I am free to withdraw from this project at any time.

While there are few direct benefits to me as a participant, other than the advancement of knowledge in this area, I understand that there are no associated risks. Finally, I understand that the researcher will furnish me with results of the study, should I wish such a summary.

Date: _________________ Signature: _____________________
Address: _______________________
Telephone: (717)________________

Investigator: Ann M. Kolanowski, Ph.D. Candidate
Division of Nursing
New York University

Address: [Redacted]

[Redacted]

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APPENDIX D

PERSONAL DATA SHEET

1. Age: ____

2. Sex: ____Female  ____Male

3. Marital Status:  ____Single  ____Married  ____Divorce
                     ____Separated  ____Widowed

4. Living arrangements:  ____Live Alone  ____Live with Family
                         ____Other  Specify:____

5. When do you usually awake?  ____A.M.  ____P.M.

6. What is your usual bedtime?  ____A.M.  ____P.M.

7. Rate your health:  ____Excellent  ____Good  ____Fair  ____Poor

8. Are you able to walk about freely without assistance (cane, walker, or the like)?
   Yes____  No____
   Please explain, if no:
9. Are you able to dress yourself without assistance?  Yes _____  No _____
   Please explain, if no:

10. Are you able to bathe yourself without difficulty?  Yes _____  No _____
    Please explain, if no:

11. Are you able to comb your hair without difficulty?  Yes _____  No _____
    Please explain, if no:

12. Do you have any medical problems that interfere with your moving about?
    _____ severe arthritis
    _____ fracture
    _____ Parkinson's Disease
    _____ Other:
    Specify: __________

13. List any medications you now take:

14. How much coffee or tea do you drink in a day?
    _____ none
    _____ 1 - 3 cups
    _____ over 3 cups

15. Are you legally blind?  Yes _____  No _____

17. Any recent disruptive events? If yes, explain:

18. Do you engage in any of the following activities: If so, please explain:
   Meditation: ________________________________
   ________________________________
   Visualization: ____________________________
   ________________________________
   Exercise: (jogging, walking, swimming, etc.)
   ________________________________
   ________________________________
APPENDIX E

OBSERVATION LAB

FIGURE

FLOOR PLAN OF OBSERVATION LAB

K = KITCHENETTE
C = CHAIR
T = TABLE
W = WINDOW
D = DOOR
O = OBSERVATION WINDOW

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APPENDIX F

ACTIVATION-DEACTIVATION ADJECTIVE CHECK LIST

Date and Time: ____________________________
Code Number: ____

Each of the words below describes a particular feeling. Please use the rating scale next to each word to describe your feeling at this moment.

EXAMPLES:

relaxed **x** x ? no  
If you circle the double check (**x**) it means that you definitely feel relaxed at the moment.

relaxed **x** x ? no  
If you circle the single check (x) it means that you feel slightly relaxed at the moment.

relaxed x x ? no  
If you circle the question mark (?) it means that the word does not apply or you cannot decide if you feel relaxed at the moment.

relaxed **x** x ? no  
If you circle (no) it means that you are definitely not relaxed at the moment.

Work rapidly, but please mark all the words. Your first reaction is best.

JITTERY **x** x ? NO
ENERGETIC **x** x ? NO
ACTIVATED **x** x ? NO
WAKEFUL **x** x ? NO
DROWSY **x** x ? NO
SLEEPY **x** x ? NO
ANXIOUS **x** x ? NO
TENSE **x** x ? NO
FULL-OF-PEP **x** x ? NO
APPENDIX G

MOTOR ACTIVITY RATING SCALE

Definition of MARS Symbols

A. TOTAL BODY POSITION
   -Upright, Vertical body position; body supported by lower extremities; torso upright.
   -Lying down. Horizontal body position.
   -Leaning. Body trunk raised less than 90 degrees from primary supporting surface, supported by self or object.
   -Sitting. Weight of body resting on lower part of trunk, back raised greater than or equal to 90 degrees.
   -Leaning over. Dangling; any portion of body extends beyond the lower part of the trunk.
   -Kneeling. Supporting the body on the knees and lower legs.

B. INTENSITY GRADATIONS
   -Minimal activity. Specific to the individual category, generally a minimal amount of activity, including fine motor activity.
   -Moderate activity. Specific to individual category, generally a moderate amount of activity greater than the fine motor activity, but less than strenuous motor activity.
   -High activity. Specific to individual category, generally including forceful, strenuous, explosive types of activity.

C. BODY MOVEMENT
   -Head active.
   -To bend or turn head slowly.
   -To nod head vertically or horizontally.
   -To vigorously shake head.
   -Both arms or hands active.
   -Right upper extremity active. -Left upper extremity active.
   -Twiddling thumbs, twisting hair, picking at self, or object.
   -Swinging arms from side to side, bending arms to pick up object.
   -Waving arm, punching or throwing, raising arm or hand forcefully, hitting self or objects.
   -Legs active. -Right leg active. -Left leg active. -Arms and legs active.
   -Wiggling toes, rotating feet, mildly shaking legs or feet, walking slowly.
   -Changing position of legs, walking at a moderate pace.
   -Kicking, flexing, and extending lower extremities, walking quickly, running, jumping.
   -Walking slowly while picking at self or object.
   -Walking at moderate pace while swinging arms from side to side.
   -Running or jumping.
APPENDIX H

FORM FOR USE WITH MOTOR ACTIVITY RATING SCALE

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APPENDIX I

TESTING DAY INFORMATION QUESTIONNAIRE

1. When did you awake today? _____ A.M. Date: _____ Time: ______

2. What medication have you taken so far today?
(Please List).

3. Approximately how much coffee or tea did you drink today?

4. Have you had a disruptive event in the past two weeks? (Such as loss of loved one, financial problems). Please explain.

5. Did you engage in any of the following today:
   Meditation ________________
   Visualization ________________
   Exercise ________________
APPENDIX J

INSTRUCTIONS TO PARTICIPANTS

Please be seated in this room. As I explained, you will be in this room for two, twenty-minute periods. During this time you may get up and move about as you please. I have several books and magazines for you to read if you wish.

During each twenty-minute interval I will turn on a different type of lighting in this room. I am interested in your behavior under these different lights. During each twenty-minute testing period, at the ten-minute and fifteen-minute point, I will instruct you to complete one of the level of energy forms. These forms are numbered in the upper right hand corner and I will refer to this number when I speak to you.

At the completion of the first testing period, I will ask you to join me in the room outside the lab. You may use the rest room facilities as needed. At the end of this twenty-minute rest period, I will ask you to return to the lab for the second, twenty-minute testing period. The procedure will be identical to the first testing period. At the ten-minute and fifteen-minute point I will ask you to complete one of the level of energy forms. The research assistant and I will again observe your behavior.

At the completion of the second testing period, I will review your results and answer any questions you may have.
APPENDIX K

POST - EXPERIMENT QUESTIONNAIRE

1. Please describe how you felt under the first light:
   Sleepy  _____  Relaxed  _____  Bored  _____  Anxious or Tense  _____
   Other  _____

2. Please describe how you felt under the second light:
   Sleepy  _____  Relaxed  _____  Bored  _____  Anxious or Tense  _____
   Other  _____

3. Which light did you prefer?  First  _____  Second  _____
   Please Explain Choice:

4. Additional Comments:
APPENDIX L

SPECTRAL POWER DISTRIBUTIONS
OF THE CHROMA 50 AND SPX 30
FLUORESCENT LAMPS
APPENDIX M

GE POCKET LIGHT METER

The General Electric Type 214 Light Meter is a portable instrument for making field measurements of illumination. It features correction for the color quality of the light and cosine - correction for incident angle of light. Readings on the 20-50 footcandle part of the 10-50 footcandle scale have an accuracy of ±10%.