Document D15:81

Non-Visual effects of light and colour

Annotated bibliography

Rikard Küller

Swedish Council f
Building Researc

D15:81

NON-VISUAL EFFECTS OF LIGHT AND COLOUR

Annotated Bibliography

Rikard Küller

This report refers to grant No 771412-6 from the Swedish Council for Building Research to the Environmental Psychology Unit, School of Architecture, Lund Institute of Technology, Lund

D15:81

ISBN 91-540-3605-4
The Swedish Council for Building Research, Stockholm 1981.

PREFACE

At a meeting held by Commission Internationale de l'Eclairage (CIE TC 3.5) in Berlin 1977 I was asked to try to summarize research related to physiological and psychological activation from light and colour. Receiving financial support from the Swedish Council for Building Research the work of the sub-committee has taken the form of an annotated bibliography.

A preliminary manuscript of the bibliography was presented at the international conference of CIE in Kyoto in 1979. The manuscript was discussed in detail at a seminar in Lund in the beginning of 1980. The same summer at a symposium on daylight in Berlin I had the opportunity to summarize the work in a paper. Since then the manuscript has been up-dated and rewritten and is hereby presented in its final form.

The material included in the bibliography concerns normal physiological and psychological effects of light and colour including effects of infrared and ultraviolet radiation. Pathological reactions lie outside the scope of the bibliography. About nine/tenths of the references are concerned with studies on human subjects.

It is the nature of a bibliography that it must stay very close to the original research material. Thus, it directs itself to light and colour specialists, and also to researchers within the environmental sciences. It is hoped that the broad scope of the bibliography will serve to further an interdisciplinary approach.

In the planning and designing of modern society, and especially as a consequence of the energy crisis, light and colour are important factors. The bibliography also directs itself to architects and lighting engineers who are trying to design the human environment.

A large number of persons have contributed to the bibliography in various ways. The projects was conceived by the late professor, John E. Flynn, in his capacity as chairman of TC 3.5, and he continued to encourage it in his very personal way.

During the course of work, I received valuable suggestions from hundreds of researchers from many countries. Several persons sent me articles and books. Unfortunately, it has not been possible to include all this material within the framework of the bibliography. I have also been allowed to partake of

ongoing bibliographic work in related areas. Numerous persons have contributed to the discussions inside and outside the CIE. I wish to express my sincere gratitude to all these persons. I also wish to thank Marianne Küller, who constituted the other half of the sub-committee.

I will take this opportunity to ask the readers to comment upon the bibliography, and, if possible, send me further reports, reprints, and references within the field.

Lund, October 21, 1981

Rikard Küller
Docent

Environmental Psychology
School of Architecture
Lund Institute of Technology
Fack
S-220 07 Lund 7
Sweden

CONTENTS

ABSTRACT

Solar radiation has a profound effect on the human organism. This effect might be transformed by artificial illumination. The aim of this bibliography is to bring together in a comprehensive form the existing knowledge regarding the normal physiological and psychological effects of light and colour, including the following topics: Effects of solar radiation on the skin; physiological effects of daylight and artificial illumination entering the eye; preferences for light, colour and visual patterns; the impact of culture and personality; light and colour in the built environment. Amongst others, the review indicates artificial light might cause stress-like reactions, if it is intense, if the spectrum considerably deviates from that of natural daylight, or if it is flickering and glaring. The bibliography was compiled at the Environmental Psychology Unit, Lund Institute of Technology, with financial support from the Swedish Council for Building Research. It constitutes a CIE TC 3.5 sub-committee report. (240 pages, 1.700 references)

INTRODUCTION

When designing human habitat architects and lighting engineers tend to assume that the only significant role of light and colour is to provide for adequate illumination without causing disability glare and to contribute to a generally pleasant visual environment. During the last 20 years it has become increasingly clear, however, that solar radiation has a profound effect on the human organism and that this effect might be modulated and transformed by artificial illumination. The reason for this is firstly that solar radiation was important for the genesis of life itself, actually without light there would be no life. The second reason is that the development of higher life and man to this day has occured under the constant influence of solar radiation affecting living tissue from the single cell of the skin to the specially adapted light-sensitive eye. Thus the amount of light, the quality of light, the distribution of light and the variation of light between day and night and winter and summer are closely tied to the genesis of man and we are gaining better understanding of some of these ties.

There is much research going on in the fields of biochemistry and physiology but also in psychology and - maybe somewhat astonishingly - in social psychology, focusing on light and the single cell, the brain, emotions and social interaction respectively. The aim of the present review is to bring this knowledge together in a comprehensive form in the interest of environmental research and design.

This is not the first attempt to bring together factors of light and colour in a wide perspective of man-environment relations - several similar undertakings will be referred to - but this review differs from previous bibliographies in at least two respects. Firstly there is an attempt at theoretical integration. Work dealing with effects of light and colour often favour one central hypothesis at the expense of others in order to account for the data. It seems however, that light and colour affects man along many different pathways and in many different ways, and therefore we must resort to a number of hypotheses if we want to account for the phenomena. Since man is one highly unified organism, these different effects are bound to interact and it follows there is a need also to include the different hypotheses into a general theoretical framework. At the present stage there is no such framework into which data from biochemistry, physiology and psychology can be put. Still one might dare to outline a sketchy model indicating at least how some of the hypotheses might fit together.

A second aspect in which this bibliography differs from others is the selection of material which in turn is a result of the theoretical model referred to above. During the course of work it became clear that the following topics should somehow be included: Effects of radiation on the human skin as far as these

effects would have any general significance for health, well-being and behaviour; primary effects on the nervous and hormonal systems of light entering the eye as well as secondary effects on mood and performance; light and colour preferences and connotations including the estimation of apparent warmth, weight, etc; light and colour in the appreciation of architecture and the built environment including interior as well as exterior space; those cases where light and colour seem to interact with other environmental factors, physical as well as social; and finally, effects of light and colour mediated by the characteristics of the organism itself like emotional state, personality traits and cultural background.

It was equally evident that other areas had to be excluded. Firstly, everything bearing directly and solely on visual performance and disability glare was to be left out as well as theories of light and colour vision, the reason for this being that this is exactly what most books on lighting and illumination are about. The reader will probably find one of these books on his own bookshelf. Although the bibliography covers effects of daylight as well as artificial light, including such parameters as intensity, spectral composition and temporal patterns, research related to the light sources per se are excluded as well as fields like colorimetry and colour rendering which are either mainly physical or mainly visual. Certainly, man is not only affected by light and colour but he uses them actively in art, architecture and in many of his everyday undertakings. However, these aspects, leading into the realms of creativity and art and the history of art, are beyond the scope of this bibliography.

Other exclusions might be more difficult to justify. This is the case for a large part of the medical literature dealing with pathological effects of light radiation on the eye or skin, for instance, visual cataract or skin cancer of photoallergies as well as studies on a cellular or molecular level including phototoxic and mutagenic effects on DNA. Although by no means uncommon, especially in industrial work environments, these problems will probably remain outside the scope of the general designer. In medicine, light radiation is also used for curative purposes like in the common skin disease psoriasis or in hyperbilirubinemia. In prematurely born babies the liver might not be sufficiently developed to dispose of the waste product called bilirubin. Left unchecked, this condition, hyper-bilirubinemia, will result in permanent brain damage. Until a few years ago the only treatment for this condition was a total blood exchange transfusion, a completely new blood supply, and the high risk that went with it. Now, treatment with artificially generated natural light is all that is required, and it offers little or no danger to the infant. References to this and other types of medical phototherapy - the use of light to treat illness - are not included.

In certain areas most of the studies have been made not on man but on animals, plants, bacteria or on specially prepared cell-cultures. Although very important for the specialist in the specific area, subhuman studies will generally be of little

interest to the environmental designer and has therefore been excluded except in a few cases, where the results are either unique or of immediate relevance. Except in those few cases all the studies referred to concern man.

In addition to the problem of relevance, there has also been problems of language and critical evaluation. Some authors, for instance, talk about red light or blue light when they refer to radiation of a certain spectral composition, a habit which is not only confusing to the reader but very often - so it seems - even to the authors themselves. When presenting and commenting on abstracts I did not find it possible to correct such inconsistencies but have instead adopted the language as used by the author. As for the quality and control of each single study I have tried to adopt a critical view but this has not been an easy task. Some of the abstracted studies have obviously lacked in experimenteral control while others have been vaguely presented making a critical evaluation impossible. Some papers, especially those of Russian origin, were available only in second hand versions. Also, it can not be denied the subject area holds something of mystical fascination which sometimes seems to have affected even very serious writers. Whenever possible original abstracts have been used. However, in many cases it has been necessary to make excerpts or summaries directly from the actual texts. A large number of the titles in the reference list have been included on the basis of abstracts or titles only.

In collecting the material several different methods have been employed. A manual search was carried out at the University Library at the University of Lund, using their different registers and selected abstracts, foremost the psychological and ergonomic abstracts. In order to include material related to the built environment a computerbased search was carried out at BYGGDOK in Stockholm in 1977. The search was followed up in 1980. Furthermore, handbooks on light, colour and photophysiology as well as collected papers from conferences were searched in detail, the most important of the latter being reports from the CIE and AIC conferences and proceedings of the various congresses of photobiology. Other reference sources include reports from conferences on Architectural and Environmental Psychology and a selection of journals on light and colour and other scientific journals. Concommitant with this search an inventory was mailed to 54 researchers and 16 research institutions in the Scandinavian countries and to 153 researchers and 18 institutions in other parts of the world; the main reason for this being a wish to include as much fresh material as possible. About half of the inventories were returned, giving references, enclosing in some cases reports or even books. A request for information also appeared in the Architectural Psychology Newsletter and the CIE-circulations.

As a result of the initial phase several hundred original books and articles were collected, and all lists of references were checked for additional material. I will not go into a detailed description of how the actual review work was carried out, nor will I try to put up a defense for the way the material has been grouped and presented. There have been practical and theoretical considerations which will hopefully be recognized by the reader, without further comment. A last note should however be made. Although a total of 1 700 titles has been included and many more discarded, this bibliography, like most others, is incomplete. It should be regarded not as a finished product but as a starting point for a better understanding of the impact on man of light and colour.

HOW THE BIBLIOGRAPHY IS ORGANIZED

The material has been grouped in three major sections, each one consisting of commentaries, a selection of summaries, and a list of additional references. Summaries and references are arranged according to the English alphabetic order. The letter v appears before w. No difference has been made between u and ü. However, the Scandinavian letters å, ä, and ö are added at the end of the alphabet.

The arrangement of the publications is based on: 1. authors' surname; 2. initials of first (given) name(s); 3. year of publication. Surnames containing a prefix, like de, le, van, von, etc, are placed according to the prefix. Publications where the name of the author is not given are placed at the end of the alphabetic order.

Summaries are also numbered consecutively throughout the bibliography. These numbers are used regularly whenever an abstracted article is being referred to in the text. Whenever an additional reference is cited this is done by giving the author's surname and the year of publication. During the course of search several important bibliographies appeared. These are referred to in the commentaries at the end of each sub-section.

SECTION 1

PHYSIOLOGICAL EFFECTS OF SOLAR RADIATION ON THE (HUMAN) SKIN

Ultraviolet radiation

There are several rather well known processes going on in the human skin which depend on the photochemical (actinic) effects of ultraviolet radiation. Ultraviolet radiation is usually considered to be in the wavelength range between 100 and 400 nanometers (nm = one millionth of a millimeter). Out of convenience this range is subdivided into three bands, ultraviolet A, ranging from 400 to 315 nm, ultraviolet B from 315 to 280 nm and ultraviolet C from 280 to 100 nm (59).

While radiation in the ultraviolet A range passes through most types of glass and produces practically no vitamin D or erythema (reddening of the skin), radiation in the ultraviolet B range has both an erythemal and pigmenting effect on the human skin and also forms the vitamin D in the body. All investigators agree that skin reflectance is very low, 2-8% in the waveband 250-300 nm for all kinds of human skin. The maximum effectiveness of the ultraviolet radiation is placed by different authors somewhere between 290 and 297 nm (2, 3, 9, 11, 17, 20, 22, 24, 39, 40, 44, 45, 51, 52, 55, 60).

Ordinary window glass absorbs essentially all radiation in the B range. Considering the facts that millions of people work behind glass, underground or in the extreme north, travel to and from work in closed vehicles and venture outdoor only in the early morning and in the late evening, when ultraviolet radiation is minimal, this situation might be regarded as serious. Also, incandescent lamps emit very little ultraviolet radiation and the small amount from ordinary fluorescent lamps is usually absorbed by the fixtures on which they are mounted. Due to this fact many people in the northern countries get very little radiation in this range, especially in winter.

Radiation in the ultraviolet C range has a strong germicidal effect. Also, superficial erythema and conjungtivities may be caused. The latter is an inflammation of the mucous membrane that lines the inner surface of the eyelid, and the exposed surface of the eye ball (59).

Rickets is caused by a deficiency of solar ultraviolet radiation which is necessary for the synthesis of calciferol and other D-vitamin. Normally these hormones are released

into the bloodstream by the skin. Without them not enough calcium and phosphorus will be laid down in growing bones. The crippling deformities of rickets are the consequence in small children while aged persons might get brittle or easily broken bones or bone softening, osteomalacia. It is now common knowledge that only small traces of ultraviolet radiation are necessary to help the body develop calciferol in amounts needed to promote calcium retention and bone growth. Some evidence concerning the minimum required dose can be obtained from the fact that rickets can be cured by repeated exposure to 1/10th MED (minimum erythemal dose), i.e. 1/10th of the dose that is required to obtain reddening of the skin. One author states that the amount of radiation involved seemed to be roughly equivalent to the radiation that would impinge upon a resident of Washington DC who took a daily 15 minute walk out of doors at lunchtime in midsummer (36). Although rickets are nowadays prevented and cured mainly through dietary intake of vitamin D, there is still inconclusive data on the relative importance of this dietary intake. In fact, several studies indicate the existence of a delicate interaction between ultraviolet radiation on one hand and the intake of vitamin D^2 and D^3 on the other (23, 36, 39, 51, 52, 55, 60).

It is possible that vitamin D deficiency may cause an increase in the incidence of dental caries (55). In experiments on hamsters and cotton rats it was shown that the nature of the illumination had a profound influence on the incidence of dental caries (13, 47). These results were followed up in a study comparing the influence of different lighting conditions on the incidence of caries in two windowless classrooms near the beginning and again near the end of the school year. Children supplied with cool-white fluorescent lighting developed significantly greater incidence of dental caries than did children exposed to full spectrum lighting (29). However, it is not advisable to draw any definite conclusion from these few studies and certainly the results if they turn out to be reliable are open to several possible interpretations.

An overdose of ultraviolet radiation may cause reddening of the skin (erythema) which in turn may lead to an increase in pigmentation and a thickening of the horny layer of the skin. In sensitive persons lacking in protective pigmentation an overdose might also give rise to a variety of photoallergies or even skin cancers (20, 52, 60). People in tropical regions avoid these dangers by their heavy dark pigmentation consisting of melanin granules in the outer layers of the skin. In the northern countries on the other hand, people often suffer from the lack of ultraviolet radiation, and because of this there has been a natural selection for an unpigmented skin (23).

Interesting from our point of view is the fact that UV-radiation might also have effects of a general physiological nature, including a lowering of the pulse rate, a fall in blood pressure, changes in skin temperature, and metabolic rate,

in reaction time and general activity level, as well as an improvement of health conditions and resistance to certain kinds of infection. Sigmund, for instance, found a considerable reduction of visual reaction time which could be observed even three weeks after the irradiation with ultraviolet had taken place (48). Zamkova and Krivitskaya were able to show that irradiated subjects had a shorter reaction time to light and sound, a lower fatigability of the visual receptor and improved working capacity (57). In one study on children in Swedish day-care centres a clear-cut correlation was demonstrated between duration of outdoor activity on one hand and resistance to infections of the respiratory passages on the other (25). In a few studies, so far carried out only on animals, ultraviolet radiation had a strong influence on consumption of alcohol (53, See also references, section 2). Thus we might be quite confident that daylight has a general physiological effect on man caused by UV-radiation of the skin. As far as is known today, vitamin D is one likely mediator of these effects (6, 7, 10, 25, 42, 48, 51, 52, 57, 58, 60).

There is no evidence, however, for the existence of an UV-selective mechanism either on the autonomic or the perceptual level. Because ultraviolet and infrared radiation are both parts of natural daylight, they are bound to occur together and when man seeks out the warmth of the sun he will at the same time get a certain amount of ultraviolet radiation. Loomis suggests, however, that a certain amount of UV-selection might take place on a cognitive level. According to him social habits like the June wedding, which tend to bring the first baby in springtime, and the habit of taking babies outdoors even in the middle of the winter for some sunshine, constitute ways of selection laid down in the cultural consciousness of people living in northern countries where the access to ultraviolet radiation is sparse. However, too much ultraviolet radiation will be harmful to the unprotected, untanned skin highly characteristic of northern people during springtime when the demands for warmth and vitamin D are at their highest. In order to avoid erythema or even more severe damage during this period, man seems to rely entirely on cultural and individual experience. Even children know that to spend too much time exposing naked skin to the sun might be painful - afterwards (23).

For a good account of the effects of ultraviolet radiation on the human skin, the readers are referred to Johnson et al 1968 (20), Urbach 1969 (52), Brundrett 1973 (3) and Magnus 1976, and also to the popular accounts in Scientific American by Loomis 1970 (23), and Wurtman 1975 (174) and the report by Tibbs 1979 (166). For an extensive list of references to all kinds of actinic effects of optical radiation consult Thorington et al 1978 (165). A discussion of the physiological basis of health standards for dwellings was given in WHO's Public Health Papers 33 (Goromosov 1968, see references, section 2). An authoritative and up-to-date review of effects of ultraviolet radiation is to be found in WHO's Environmental Health Criteria 14, 1979 (60).

Infrared radiation

Just like the ultraviolet, the infrared radiation is subdivided into three ranges, IR A from 780 to 1.400 nm, usually called the short wave region; IR B from 1.400 to 3.000 nm, the medium wave region; and IR C from 3.000 to 1.000.000 nm (= 1 mm), the long wave region. Infrared radiation is invisible to the human eye, it can not be seen but is felt as heat. It passes through a vacuum or through clear air without any appreciable loss of energy. Only when radiation strikes an object in its path is the energy absorbed, and in being absorbed, converted into heat. All radiation can be absorbed and degraded to heat but the infrared waveband and in particular its short wave region has the strongest heating effect of all types of radiation. Shortwave infrared radiation behaves in many respects the same way as visible light. It can be reflected and concentrated into an area thus obviating many of the heat loss problems associated with other methods of heating (59).

When the surrounding temperature is above that of the body, heat will be taken up by radiation. Actually, the radiant temperature of the total environment is often as important as the ambient air temperature in determining the heat load on man. In respect to body economy, the sun is by far the most important source of radiant heating, and our own skin is the source of radiant cooling. In an evolutionary perspective this is a very old mechanism. The reptiles, who were in existence already 100 million years before the mammals made their entrance, were completely dependent on solar radiation for the maintenance of an adequate body temperature. Being "cold-blooded", they did not produce any body heat themselves, but acquired it directly from the environment.

Mammals, on the other hand, maintain a relatively constant and warm body temperature independent of environmental changes. From an evolutionary point of view this is a great advantage. It makes it possible to develop complicated organ systems that would suffer damage if the body temperature was not held within strict limits. It also allows metabolic functions to go on during the night, when the temperature of the environment is low, or to survive in the cold zones of the world. Thus, the substitution of the outer regulator of body temperature, the sun, by an inner one enabled mammals not only to conquer the cold areas of the planet but also the dark part of the 24 hour cycle. Still there are the environmental variations to be coped with, like those between day and night or summer and winter. As far as man is concerned the radiation from the environment to the skin and vice versa constitutes one important factor of heat regulation, the others being conduction, convection and evaporation.

Man has learnt to a certain extent to regulate the temperature of his environment to fit his needs. Should the body temperature, however, become excessively high or low the organism becomes alerted and tries to restore the balance. Olesen et al found,

for instance, that subjects introduced into a thermally asymmetrical room selected that uniform environment which rendered them thermally neutral (38). Actually, man spends much time orienting towards or away from sunlight, preferring a shady place during the summer but looking for a glimpse of the sun during the winter. Any person is likely to uncover himself, part his legs, raise his arms from the body or begin to sweat when he is too warm, but will pull himself together in order to minimize radiation when he is freezing.

While the primary action of infrared radiation on the skin is that of heating, this will generally lead to a vasodilation of cutaneous blood vessels. The infrared energy contained in daylight will penetrate into the skin and muscles resulting in an increased circulation of the blood. When the radiation is instead from skin to environment there will be a constriction of cutaneous blood vessels. The heating or cooling in turn will give rise to a host of other reactions involving the metabolism of the skin itself as well as the metabolism of the entire organism (5, 15, 16, 18, 21, 44, 55).

The changes in skin temperature produced by exposing the body to any type of radiation from the sun, infrared lamps, and other sources which penetrate appreciable distances into the skin, depend not only upon the optical properties of the skin but also upon thermal conductivity, the density and the thermal capacity of the living skin, as well as the influence of blood flow. The heating curve of the intact skin, when slowly heated with radiation, indicates the skin temperature first rises and then falls. This fall in the temperature results from the cutaneous vasodilation secondary to the heating. Since the dilation occurs only in the heated area it is believed due, for the most part, to the direct action of the heat upon the superficial blood vessels. Other experiments, however, indicate that this effect is not a simple one, and that the skin can be "conditioned" by previous exposures (8, 15, 16, 18, 21, 44, 54, 55).

Sensations of warmth and cold are evoked by radiation exchange between the skin and the environment. These sensations, which are important to body economy as thermal detectors for regulating body temperature, are evoked when even the slightest change in skin temperature occurs. Also important among the sensations evoked by radiation is pain. It seems the pain threshold for any level of skin temperature represents that amount of radiation which is required to raise the skin temperature to 45°C. Physiologically this means the pain threshold is dependent on skin temperature alone and not upon the rate of heating of the skin nor upon the rate of change of internal thermal gradients. It appears the cutaneous pain threshold is independent of race and culture as well as of sex and age. There is also a relationship between skin temperature and the production of burns; skin temperatures lower than 45°C do not in general produce a burn (15, 32).

It is a well established fact that body temperature will influence physical as well as mental performance on a wide range of acitivites. Concerning visual performance, for example, an interaction has been established between body temperature, level of illumination, and task difficulty. In one study, Löfberg et al found that increasing the level of illuminance during moderate heat stress might even have a negative effect on tasks where viusal concentration was less essential (26, 27). There might also be a relationship between ambient temperatures and the preference for various colours. Kearney found preferences at low temperatures were positively correlated with the wavelength of light. At high temperatures the correlation became negative (106). Some attempts have also been made to study the possible influence of body temperature on social behaviour. The results so far are not conclusive (46, 50, 81).

Thus, radiation of the human skin serves as a regulator that will influence the general activity level of the organism. This regulation is partly autonomic. The hypothalamus is the primary centre for regulation of body temperature and general body metabolism. Therefore, any description of the impact of light on man that sets out to be general must by necessity include the infrared-radiation/hypothalamus system. However, the regulation also involves mental mechanisms. We do not like to be too hot or cold. Intense cold or heat which might cause tissue damage is extremely painful, while moderate heat is experienced as comfortable. Thus, feelings of pleasure and displeasure are directly tied in with infrared radiation of the skin (16, 30, 31, 38, 49, 232).

The readers are referred to Hardy, Gagge and Stolvijk, 1970, for a good description of heat transfer in the environment as well as heat transfer and regulation in the body (16). A thorough discussion of thermal comfort will be found in Fanger 1970. Application to dwellings are discussed in Goromosov 1968 (references, section 2) and in Turner 1969 (255).

Light radiation

As we have seen, solar radiation within the ultraviolet and infrared regions will initiate numerous processes when it impinges on the human skin. But what happens in the intermediate range usually referred to as light radiation? Light radiation can be divided into a number of approximate wavelength ranges each of which generally make a certain colour impression on the human eye. The following division is widely accepted: Violet, ranging from 380 to 436 nm, blue from 436 to 495, green from 495 to 566, yellow from 566 to 589, orange from 589 to 627, and red from 627 to 780 nm (59). In contrast to many lower animals, the human skin does not contain any specific receptors sensitive to light radiation. Still, there exists some evidence that light radiation might not only have a general but also a specific effect on the human skin.

The first data on what might be called the dermo-optic sense was published in the Russian scientific literature at the end of the 19th century. A physician from Tambov, Khovrin, studied a patient who read ordinary printed and hand written texts by touch, and in the same way recognized colour tones on paper and fabrics. Later on, Leontyev, using the so called chock and avoidance technique was able to demonstrate the palm of the human hand could react to light rays. Some ten years later, in the beginning of the sixties, a well developed sense was discovered in the famous Russian subject, Rosa Kuleshova (19, 43).

In order to check different hypotheses about the dermo-optic sense an experiment was set up with 80 subjects at the Graphic Art Department at the Nizhne-Tagil Pedagogic Institute (37). The results showed that approximately every sixth person recognized the colours in pairs after 20 to 40 minutes of practice. If the training was repeated systematically over a period of a few weeks, the subjects learned to recognize five to seven colours by touch. Questioning of the subjects indicated that colour tones were distinguished subjectively primarily according to degrees of smoothness and roughness and their breaking effects on the fingers when touched.

The hypothesis that the identification was based on the perception of surface structure was ruled out by putting cellophane or glass on top of the colour samples or printed letters. The hypothesis that the identification was based on thermal differences between different colours was not confirmed in experiments using heat absorbing filters. However, as Makous points out "heat filters do not eliminate this effect, for no filter can pass light and not pass energy which can be converted to heat upon absorption" (28).

The experiments seemed to confirm that the dermo-optic sense extinguishes in darkness. The first colour tones ceasing to be sensed in darkness were orange and yellow, then light blue and dark blue. In this respect the phenomenon resembles the Purkinje effect typical for normal vision. The hypothesis about the existence of photo-receptors in the skin was, however, ruled out by using aluminium foil placed on top of the coloured papers or letters which in turn were placed on glass and lit from below. The subjects were still able to give correct and clear answers. However, if the metal foil or the hand of the subject itself was grounded, identification gradually became impossible.

Just like Rosa Kuleshova, many of the subjects began to react to the colour of the paper, with their hands in the air at a comparatively great distance. The students actually felt a barrier at the distance of between 20 and 80 centimeters above the paper, and they gradually began to recognize and distinguish the characteristics of the respective colour field. Finally, experiments with blind and visually handicapped persons showed, as a result of systematic practice, these groups could learn to read with their palms large text and numbers at a distance.

These remarkable results caused sensation not only in the Soviet Union but also in the rest of the world, especially in the United States, where a number of experiments on dermo-optic perception were initiated. Studies by among others, Youtz, confirmed the Russian results more or less, while others, one of them, Buckhout, obtained negative results (4, 56).

The studies supporting the existence of dermo-optic perception were in 1966 severely criticized by Gardner, editor for Scientific American, who also has a long personal experience in the field of magic and "mentalism". Gardner claims that all the results might be explained either by conscious deception or a lack of adequate controls (14). According to Martin Jonsson, professor of parapsychology in Utrechts, there is however no reason to believe that the main body of results regarding dermo-optic perception is fraudulent. The systematic variation of results in relation to experimental circumstances seems to rule out an explanation in terms of extra sensory perception. On the other hand, the fact there has been some difficulty in replication shows there is a rather poor understanding among the experimentalists themselves of what is really going on, thus making prediction difficult (Personal communication).

The criticism by Gardner met with strong opposition and Razran presented a bibliography of 60 recent Russian technical reports and press statements in favour of the question at stake (41). Nash utilized a suggestion made by Gardner and instead of a blindfold used a light weight box to cover the subject's head, and in spite of this, reported positive results (34, 35).

There have been some promising attempts to explain the mechanism behind dermo-optic perception. Looking at all the available facts it might very well be that several different mechanisms are at work. Novomeisky and others conclude dermo-optic sensations are connected with the action of electric charges rising under the influence of light on the coloured surface of paper, etc (37). One theory proposed by Youtz suggests that the discrimination is based on temperature differences in the skin caused through absorption of radiant energy from objects of different colour, lightness, etc (56). If the object itself is in the dark, the radiant energy might be a reflection of the energy emitted from the hand or the human body itself. By means of thermo-dynamic calculations, Makous was able to demonstrate the theoretical soundness of this suggestion and also show it is in agreement with many of the experimental results. By means of a simple laboratory demonstration including subjective reports as well as measurements of skin temperature, he was able to show it is possible for almost any subject to make a kind of crude discrimination (28).

Working along a different line, Becker and Cone were able to show that when excised patches of skin were exposed to an intense flash of light an early electrical response can be detected from its surface. The authors found the signals which occured during the first few milliseconds after the flash are

similar to electrical signals observed in the eye from cell layers containing melanin. Since they also obtained a response - although somewhat weaker - from albino skin they conclude that possibly the melanin in skin augments, but does not directly generate, the electrical response. In addition, a late response which arises hundreds of milliseconds after the flash also occured, but so far only in frog skin. Unlike the early response the late response was sensitive only to "violet" and short wavelengths of light. The authors suggest a likely mechanism for the production of the response is heat, thus if the early response is generated by the heating of the cellular structure, the melanin could well augment this effect, because it would absorb more of the flash energy (1).

In her study reported in 1971, Nash gave further support to the theory of heat radiation. With visual cues procluded by use of a head box, her subjects were able to give appropriate responses to black and red target papers more often than chance expectation. Also the subjects were able to distinguish the colour of paper targets that were uncovered or covered with plastic but not the colour of targets that were covered with picture glass. Tests performed with a Beckman IR-10 spectrophotometer showed that the cellophane sheet was almost completely transparent to infrared wavelengths while in contrast, the picture glass considerably reduced the transmission of infrared radiation (35).

After 1972 there has been very little experimentation or even discussion about the dermo-optic perception. However, in 1976, Fehér et al presented a study which seems to be related to the field of dermo-optics. Nude subjects wearing black glasses were exposed to monochromatic light. After a few minutes, pulse rate, blood pressure and body temperature were measured and compared with values obtained before exposition. The results indicated the existence of a relationship between dominant wavelength and pulse rate. In some cases blood pressure and body temperature were also affected (12).

Until further proof is put forth we might conclude that light radiation of the skin will have certain effects similar to those obtained by means of infrared radiation. Some individuals seem to have developed an extreme degree of sensitivity to these effects. Careful physiological measurement will be neeeded in order to make the conclusions more valid and reliable.

A review of the Russian studies is given by Razran 1966 (41). An overview of the dermal light sense in lower animals will be found in Steven 1963.

SECTION 1: SUMMARIES 1 - 60

1 Becker, HE. & Cone, RA. 1966. Light-stimulated electrical responses from skin. Science, 154, 1051-1053 (10 references)

When skin is exposed to an intense flash of light, an early electrical response can be detected from its surface. The signals that occur during the first milliseconds after the flash are similar to electrical signals recently observed in the eye from cell layers containing melanin. Possibly the melanin in skin augments, but does not directly generate, this early electrical response. In addition, a late response, which arises hundreds of millisconds after the flash, also occur in skin. Unlike the early response, the late response is sensitive only to violet and shorter wavelengths of light and hence is probably mediated by a pigment other than melanin.

2 Brodthagen, H. 1969. Seasonal variations in ultraviolet sensitivity of normal skin. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York, 459-467 (9 references)

Investigations reported by Ellinger in 1935 concerning the variations in light sensitivity of human skin during 1 year showed a spring maximum and a summer minimum. Furthermore, he stated that the light sensitivity in women is 20% higher than in men. By reflex-photometric studies, Lasker found a 10-20% decrease in reflection from the area of the glabella during the summer. The reported study shows that: (a) A significant decrease in UV light intensity, determined by the MCD (minimal color dose) is observed during the summer in either sex but, an increase has also been found in females during the month of August; (b) Determinations of the MCD proved to be of less value, since readings after 48 hr represented mainly the erythemal and not the pigmentary component; (c) The colour of the skin varies significantly throughout the year beacuse of an increase in the melanin content of the skin during the summer months and a decrease during the not too sunny autumn, winter and spring in Denmark; (d) Differences dependent on type of the skin content of preformed (primary) melanin influence the level of the reflectance, so that in the fair types these curves show a significantly higher level than in the black-haired types; (e) The difference in reflectance found between females and males must be explained by the fact that the vascularity of the male skin is more pronounced than that of the female skin. In Denmark it will usually be possible to develop pigmentation during the summer months whether one is red-haired or black-haired - this results in a decrease in MCD.

3 Brundrett, GW. 1973. Ultraviolet irradiation of human skin: A review of the literature on erythema. The Electricity Council Research Centre ECRC/M576, Chapenhurst, Chester (43 pages, 49 references)

The action spectrum for erythema from ultra violet irradiation is examined in detail for the waveband of particular interest to lighting engineers (290-310 nm). The 1935 CIE recommendation gives a good guide to this action spectrum but more refined recent data shows a maximum effectiveness at 290-293 nm rather than the CIE figure of 296.7 nm. Action spectrum must also be related to an erythemal dose so that absolute levels of sensitivity can be computed. 10 nWs/cm^2 at 290 nm is a mean value for facial skin. The variability in erythemal treshold dose is given for different people, for different anatomic skin locations and for seasonal changes. The normal population range is 10 to 1. Little work has been done on long exposure low intensity irradiation or on the effect of repeated doses. There is evidence of a improvement in fitness and calcium absorption following irradiation but conflicting evidence on whether this could be achieved equally well by supplementary vitamin D added in the diet. Medical opinion is divided on the usefulness of irradiation. Habituation occurs with repeated exposuresdue to skin thickening or pigmentation and protects the body from further exposures. If ultra violet irradiation becomes necessary then it would appear to be more appropriately provided by an occasional medical exposure matched to the sensivity of the subject than by a general level of continuous exposure.

4 Buckhout, R. 1965. The blind fingers. Perceptual and Motor Skills, 20, 191-194 (2 references)

An investigation of "aphotic digical color sensing" (finger vision) was conducted with students attempting to detect an odd color with their fingers when normal visual contact was eliminated. The results did not support the hypothesis that dermal color discrimination occurs in man. Interpretation of the data raises doubts about previously published statistical support of the hypothesis.

5 Bullard, RW., Banerjee, MR., Chen, F., Elizondo, R. & MacIntyre, BA. 1970. Skin temperature and thermoregulatory sweating: A control systems approach. In: Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois, 597-610 (11 references)

In studies of the regulation of human eccrine sweating the role of central body temperature and the resulting brain temperature has become well established. After some years of controversy, a marked effect of skin temperature on the rate of sweating also has become established. Studies in our laboratory have centered on both the quantitative influence of skin temperature upon the regulation of sweating, as well as on the experimental elucidation of the involved mechanisms. The evidence we have obtained leads us to conclude that skin temperature exerts an influence through two widely differing mechanisms. One of these is of a local nature whereby the temperature at the level of the sweat gland directly affects its function. The second is of a neural nature which involves thermal receptors and integration in the central nervous system. Both of these influences act

as feedback loops. In this chapter the experimental evidence we have used for developing our concepts of both the neural and local mechanisms will be presented. Secondly, we will present our ideas on how these mechanisms fit into an overall control systems model for regulation of eccrine sweating in the resting, heat exposed, man.

6 Colebrook, D. 1929. Irradiation and health. A. Ultraviolet irradiation in school children. B. Irradiation of varicose ulcers. Medical Research Council, Special Report Series No 131, His Majesty's Stationary Office, London (47 pages, 6 references)

A. 101 children were irradiated by light from a carbon arc lamp with a high output of ultraviolet rays. 94 children were exposed to a similar lamp from wich radiation of wavelength shorter than 3.200 A.U. was cut off by window glass. 92 children received no irradiation. Records were kept of height and weight, of incidence and duration of colds and allied conditions, of attack rate of infectious diseases, of occurrence of chilblains, and of progress in school work. Comparison of these result show (a) for control and unscreened lamp groups, an advantage to the former group in every respect except in progress in school work in which the figures are equal; (b) for control and screened lamp groups, an advantage to the former group in every case except in incidence of whooping cough and progress in school work in which the advantage is to the screened lamp group; (c) for screened and unscreened lamp groups, an advantage to the former group in all points except the average "duration per cold" in which the figures are equal, and gain in height in which the advantage is to the unscreened lamp group. In many of the results, the numerical differences are very small and in no case are they large enough to signify either a harmful or a beneficial influence in either type of irradiation.

7 Colebrook, D. 1946. Artificial sunlight treatment in industry - A report on the results of three trials - in an office, a factory and a coalmine. Medical Research Council, Industrial Health Research Board, Report No 89, His Majesty's Stationary Office, London (41 pages, 20 references)

An enquiry into the effects of ultra-violet light treatment on the health of clerical and industrial workers was carried out in three separate communities during the winter months of 1944 and 1945. The criteria used were: (a) sickness absence in each of the three communities; (b) the duration of colds in the clerical and factory workers; and (c) injury and total absence among the miners. In each community, the group of persons irradiated with the full range of rays from mercury arc lamps was compared with two control groups, viz.: (a) a treated group irradiated with lamps of the same type, but from which the shorter ultra-violet rays were cut off, and (b) an untreated group. Thus, the treated control group shared with the fully treated group the experience of attendance at the clinic and of irradiation with the long rays, i.e. rays of wave-length 3.300 A.U. and longer, for which no therapuetic effect, save possibly with massive doses, has been claimed. Half of the members of the treated control group in addition received a maintenance dose of vitamin D.

8 Cunningham, DJ. 1970. An evaluation of heat transfer through the skin in the human extremity. In: Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois, 302-315 (12 references)

The characteristics of heat transfer throught the skin are an important consideration to the physiologist in view of the importance of this tissue in modulating heat exchange between the body and the environment. This is particularly emphasized when considering the overall heat exchange between the human extremity and the environment under conditions of thermal stress. Recently we reported forearm conductance values obtained with a locally applied flow calorimeter. In a further extension of these studies we have measured the rate of conductance on other sites of the arm over a wide range of applicator temperatures. In addition, water bath calorimetry studies on the hand were carried out at bath temperatures ranging from 18 to 45°C, to determine the rate of heat gain or heat loss by the hand at several water temperatures. Our second approach to the study of heat flow through the tissue of the extremity has been a theoretical one. A mathematical model of the arm was written indicating the routes of heat flow within the arm, between the arm and the trunk, and the arm with the environment. Simulation of the two experimental procedures were carried out using the model in order to gain further insight into the physical characteristics of heat transfer in the extremity.

9 Daniels, F. 1969. Optics of the skin as related to ultraviolet radiation. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, Oxford, 151-157 (23 references)

While it has long been argued that the Negro is protected from ultraviolet radiation by a thick stratum corneum, actual measurement of separated stratum corneum indicates that there is no difference in thickness between Negro and white. However, the stratum corneum is variously melanized in different people. While not providing ultraviolet protection by its thickness, the stratum corneum has turned out to be even more complex and fascinating than had been expected, and further studies of its optical properties should be rewarding. The studies of epidermal transmission indicate that in white human skin there is significant transmission of sunburn radiation of the dermis. Even if only 1% is transmitted, in Texas where in summer the minimal erytham time may be 10 min, not less than a quarter of an MED should be delivered directly to the dermis in about 4 hours around noon.

10 Dantsig, NM., Lazarev, DN. & Sokolov, MV. 1967. Ultraviolet installations of beneficial action. In: Commission Internationale, Compte Rendu, Seizieme Session, Washington, June 1967, Volume A, Bureau Central de la Commission, Paris, 225-231 (11 references)

If the human skin is not exposed to solar radiation (direct or scattered) for long periods of time, disturbances will occur in the physiological equilibrium of the human system. The result will be functional disorders of the nervous system and a vitamin-D deficiency, a weakening of the body's defenses and an aggravation of chornic diseases. Sunlight deficiency is observed more particularly in persons living in the polar regions and in those working underground or in windowless industrial buildings. The simplest and at the same time

most effective measure for the prevention of this deficiency is the irradiation of human beings by means of ultra-violet lamps. Such irradiation is conducted either in special rooms called photaria or directly in locations were persons are regularly present - in workshops, schools, hospitals etc... As a rule, the daily dosage of ultra-violet does not exceed half the average dose which produces a just perceptible reddening of an untanned human skin. It is preferable to use fluorescent lamps which use phosphor and have a maximum emission of 315 nm. The beneficial effect of ultra-violet irradiation has been confirmed by many years of experience. Ultra-violet irradiation is also benefical for agricultural animals. In addition to the lamps used for irradiation of human beings, high-pressure mercury lamps in a quartz envelope are used to irradiate animals. Irradiation doses vary according to the species and age of the animals. New portable measuring insturments for the evaluation of ultra-violet irradiation in terms of its biological action have been developed.

11 Everett, MA., Sayre, RM. & Olsen, RL. 1969. Physiologic response of human skin to ultraviolet light. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, Oxford, 181-186 (15 references)

It is evident that the recent research on UV erythema conducted independently by several investigators necessitates a re-evaluation of concepts regarding the erythema reaction. It appears that in the spectral range 250-310 nm, ultraviolet erythema is directly wavelength dependent (the shorter the wavelength the less the MED) but is modified by such factors as anatomic location, time of observation, size of the field of exposure, angle of the incident light and thickness of the stratum corneum. Interruption of the UV beam or stripping of the stratum corneum produced no difference in response to either long or short wavelength UV. With these accumulated data for ultraviolet erythema providing a physiological bakground, the application of recent ultramicroscopi, histochemical and microbiochemical techniques to the problem of erythema should lead to early clarification of this fascinating physiological reaction.

12 Fehér, M., Nemcsics, A. & Alföldy, A. 1976. The influence of coloured environment on various physiological and patho-physiological parameters. AIC Color Dynamics 76, Budapest, 236

The nude experimentees were exposed to light reflected from a metal mirror. They wore black glasses to sense the illumination only through their skin. After 3 to 5 minutes of illumination with monochromatic light we measured their pulse, blood pressure and body temperature and compared them with the values obtained before illumination. Even this short time of illumination was sufficient for producing changes in the pulse rate (sometimes also in the blood pressure and body temperature). These changes were different after illumination with different colours.

13 Feller, RP., Edmonds, EJ., Shannon, IL. & Madsen, KO. 1974. Significant effect of environmental lighting on caries incidence in the cotton rat. Proceedings of the Society for Experimental Biology and Medicine, 145, 1065-1068 (12 references)

The effect of differences in environmental lighting on dental caries in the cotton rat was studied. The animals were exposed to either incandescent, cool-white fluorescent, or artificial sunlight environments over an 18-day period while ingesting a diet containing approximately 6% sucrose. Both the incidence and extent of caries were significantly ($p < 0.001$) higher in animals housed under cool-white fluorescent lighting than for either of the other two groups.

14 Gardner, M. 1966. Dermo-optical perception: A peak down the nose. Science, 151, 654-657 (27 references)

The author who is a scientific editor and also has a long experience of magic and "mentalism" claims that all the studies supporting the existence of dermo-optical perception might be explained away due to lack of adequate control. All the significant results might actually be caused by conscious deception; a peek down the nose. It is impossible, according to the author, to prepare a blindfold that does not permit a tiny aperture, on each side of the nose, through which light can enter the eyes. Other precautions used in this type of studies might be explained away in terms of previously memorized information. As a means of adequate control a light-weight aliminium box is suggested, that fits over the subject's head.

15 Hardy, JD. 1956. Influence of thermal radiation on human skin. In: Proceedings of the First International Photobiological Congress. Veenman & Zonen, Wageningen, 205-225 (26 references)

So far as is known, the only important action of thermal radiation on the skin is that of heating and cooling. By this is meant that these radiations have a non-specific effect rather than clearly demonstrable photochemical effects, such as the photosynthesis upon which plants depend for life. Nevertheless, secondary to heating and cooling the skin, many physiologic effects can be demonstrated. Sensations of warmth, cold, heat, and pain can be evoked as well as vasodilation and constriction of cutaneous blood vessels. These effects, in turn, give rise to a host of other reactions which affects metabolism of the cells of the skin and thus influence the health of that essential organ. In respect to the body economy, the sun is by far the most important source of radiant heating, and our own skin is the source of radiant cooling. Knowledge of the spectral distribution of the radiation coming from the sun and from the skin is important to an understanding of the physiological effects of these radiations.

16 Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). 1970. Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois (944 pages, 1.603 references)

Historical introduction (2 chapters). Heat transfer in the environment (11 chapters). Heat transfer in the body (11 chapters). Analysis of the passive system (3 chapters). The controlling system - temperature signals (9 chapters). The controlling system - signal integration and effector systems (8 chapters). The closed loop system: Physiological regulation (8 chapters). The closed loop system: Behavioral regulation (8 chapters).

17 Hausser, KW. & Vahle, W. 1969. Sunburn and suntanning. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, Oxford, 3-21

Previously reported studies on the dependence of light erythema (sunburn) and pigment formation (suntanning) on the wavelength of the applied radiation have been repeated and expanded. The previous observation that all visible light and the long wavelength ultraviolet light is ineffective has been confirmed. At about 300 nm there is a sharp effectiveness maximum with a steep drop towards long wavelengths, and a flatter drop towards short wavelengths. At about 280 nm there is a minimum and at 250 nm a secondary effectiveness maximum. The results are independent of skin color of the experimental subject within wide limits and hold also for a Negro. The erythema formation due to various wavelengths is qualitatively different. The increase of intensity of redness with increasing dose is steeper with longer wavelengths than with short ones. The time course also differens and is faster wich shorter wavelengths. The transformation of erythema into pigmentation that occurs after som time is stronger with the longer wavelengths. Measurements of absorption in skin show agreement with old observations of Hasselbalch that light transmission of skin rapidly drops where marked erythema formation begins. Our previous assumption that the decrease in effect of shorter wavelengths is due to very great absorption which prevents penetration of the light to sufficient depth is made more probable by the fact that the effectiveness minimum at 280 nm corresponds to our absorption maximum, and that the skin shows a secondary transmission maximum at 250 nm. Apparently the absorption relationships of the skin are determining for the qualitative differences in erythema and pigment formed in response to irradiation with various wavelengths. Some experiments on skin fluorescence are also described. The marked variations in the erythema producing capacity of sunlight occuring with season and time of day are due to the fact that the steep rise in erythema effectiveness lies in a narrow band of wavelengths around which the ultraviolet end of the sun's rays varies. The results of these studies together with other data are used to obtain theoretic considerations for radiobiology.

18 Iggo, A. 1970. The mechanisms of biological temperature reception. In: Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois, 391-407 (36 references)

The significant features of the thermoreceptors are the following: 1. A temperature dependency of the frequency discharge, so that for any particular unit the response is maximal at a midpoint in the range of temperatures that excite; 2. A dynamic sensitivity which results in a frequency of discharge more than five times greater than the maximal resting discharge. The dynamic

and static response curves are similar in shape, with more or less coincident maxima; 3. The dynamic sensitivity is directional, i.e. some receptors are excited by a fall in temperature (cold receptors) and vice versa for the warm receptors; 4. The pattern of discharge may be a significant parameter for the coding of information, particularly in the primate cold receptors; 5. All the thermoreceptors have an insensitivity to nonthermal stimuli and can readily be distinguished from slowly adapting mechanoreceptors by testing their differential sensitivity; 6. There is an absence of good electrophysiological evidence for thermoreceptors in the central nervous system. One problem of identifying central thermoreceptors is the need to be able to apply some kind of differential test - it may be insufficient simply to equate thermal sensitivity with thermoreception. 7. The detailed mechanisms by which the thermoreceptors act as transducers are unknown, but it can be presumed that the receptor terminal or accessory cells act to set up a generator potential which in its turn initiates impulses in the afferent fiber; 8. There is no doubt, however, that there are cutaneous and lingual temperature detectors which have a high selective sensitivity or specificity. These thermoreceptors probably play a major part in the transmission of information about the temperature of the external surface of the body and tongue. There is still insufficient evidence to establish whether there are proprioceptive thermoreceptors in the deeper tissues of the body.

19 Ivanov, A. 1964. Soviet experiments in "eye-less vision". International Journal of Parapsychology, 6, 5-23 (7 references in Russian)

The ability of Rosa Kuleshova to "see" with her finger-tips - to identify colors and to read print - when blindfolded was first reported in an article published in a local paper in Nizhniu Tagil and subsequently reprinted in a Moscow popular science magazine. Eventually, the girl's "peculiar faculty" attracted widespread attention in Soviet scentific circles. Rosa was carefully tested by various scientific organizations using various methods. By invitation from the magazine's editor, five scientists contributed to a symposium presenting hypotheses to account for Rosa's ability to "see" with her finger-tips. One hypothesis was that the subject, in reading and identifying colors with her finger-tips does what one would do if the eye's retina were located there. Another hypothesis was that the faculty was a case of extra-sensory perception; given certain conditions, man can acquire the faculty of discerning objects in the outside world without the aid of the organ of sight. Finally, the hypothesis of dermal-optic perception was advanced. Subsequent to the publication of the symposium, the possibility of thought suggestion was ruled out by additional experiments with the subject. It was stated that a well-pronounced dermal-optic sense is a rare but not a new phenomenon and that examples of it are found in the literature. It was proposed that photo-sensitive substances similar to those existing in the retina are also contained in the skin. Tactile "sight" is an electromagnetic or an electric phenomenon. Rosa's faculty may be accounted for by the fact that the dermal-optic sense allows the subject to identify colors and print by indirection, to translate the language of tactile sensations into that of visual sensations.

20 Johnson, BE., Daniels, F. & Magnus, IA. 1968. Response of human skin to ultraviolet light. In: Giese, AC. (ed). Photophysiology IV. Current Topics. Academic Press, New York, London (63 pages, 327 references)

Introduction; historical review. Skin as a special organ: Human skin, The skin of experimental animmal. The optics of the skin: Anatomical ccnsiderations, Measurements on skin. Sunburn: The reaction in human skin, Erythema studies with sunlight and artificial sources, Pigmentation, Hyperplasia, The reactions of animal skin to ultraviolet radiation, Histological and Histochemical studies, Biochemical changes in ultraviolet-irradiated skin, Photoreactivation in ultraviolet-irradiated skin, Discussion. Clinical Photopathology. Chronic effects of ultraviolet radiation on human skin. "Aging", solar elastosis. Carcinogenesis.

21 Kenshalo, DR. 1970. Cutaneous temperature receptors - Some operating characteristics for a model. In: Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois, 802-818 (53 references)

Theories of the neurological basis for differentiation among cutaneous sensory qualities have varied from the proposal of specific receptor structures in the skin that govern stimulus selectivity to those based solely on temporal and spatial patterns of peripheral nerve activity. Electrophysiological evidence dictates the conclusion that, while patterns of nerve impulses are important in the neural code of cutaneous qualities, there is also a high degree of selective sensitivity exhibited by cutaneous afferent nerves to various forms of stimulation. But histological methods have generally failed to provide a structural basis for stimulus selectivity. At least two hypothesesmay be developed to account for the stimulus selectivity exhibited by cutaneous, peripheral afferent nerves. According to one, The Specific Terminal Hypothesis, some principle within the nerve terminals or their membranes governs the selective sensitivity shown by the fibers. According to the other, the Specific Tissue Hypothesis, the characteristics of the nonneural tissue on which the afferent fibers terminate determine the energy form effective for stimulation. The evidence, pro or con, relative to either hypothesis is meager. That tending to favor the Specific Tissue Hypothesis and cutaneous smooth muscle as a model temperature receptor has been reviewed here.

22 Koller, LR. 1965. Ultraviolet radiation. John Wiley & Sons, New York, London (312 pages, numerous references)

The book answers fundamental physical and biological questions concerning the ultraviolet portions of the spectrum. It contains extensive chapters on: Arcs; Incandescent sources of radiation; Solar radiations; Transmission; Reflection; Applications and effects of ultraviolet radiation; Detectors of ultraviolet radiation.

23 Loomis, WF. 1970. Rickets. Scientific American, 223(6), 76-91 (4 references)

Rickets is caused by a deficiency of solar ultraviolet radiation, which is necessary for the synthesis of calciferol, the calcifying hormone released in the bloodstream by the skin. Without calciferol not enough calcium is laid down in growing bones, and the crippling deformities of rickets are the consequence. The history of rickets is closely associated to the industrial development in Europe. Due to the far northern location of the entire European land mass and the sunless alleys of old European cities, the introduction of industrial smog in many places cut down the remaining ultraviolet radiation to such an extent that actually rickets may be regarded as the earliest air pollution disease. The article summarizes the important steps towards understanding and curing rickets, discussing its biological and social significance. It might be regarded as the main evolutionary factor determining the degree of skin pigmentation in different regions of the world. Also, it might have influenced marital behavior in those regions were an infant born in the dark season was almost certain to develope rickets. Fish, unlike birds and mammals, are able to synthesize calciferol without ultraviolet light. Due to this fact arctic animals as well as the Eskimos must obtain their calciferol orally from their staple diet of fish. Today, the addition of ergo-calciferol to milk has essentially eradicated the disease in Europe and America. However, the author argues that this treatment is artificial and therefore the conclusion that rickets is caused by "Vitamin D deficiency", i.e. by not undertaking the treatment, must be regarded as wrong; the correctly identified cause of rickets being a deficiency of ultraviolet radiation. Actually, to call calciferol "vitamin D" must also be wrong because no specific substance should be called a dietary vitamin unless it is present in normal foods in significant amounts. Instead, calciferol should be regarded as a steroid hormone.

24 Lorincz, AL. 1954. Pigmentation. In: Rothman, S. (ed). Physiology and biochemistry of the skin. University of Chicago Press, Chicago, (48 pages, 311 references)

Skin color: Methods of measurement. Determining factors; primary pigments, light-scattering phenomenon, anatomical variations. Racial differences. Skin pigments other than melanin: trichosiderin, melanoid, carotene, hemoglobin pigments. Melanin: Definition and functions, Elementary composition and general properties, Enzymatic nature of formation, Meirowsky phenomenon, Tyrosinase concept for melanine formation; chemistry of tyrosinase reaction, role of redox potential, points of tyrosinase action, properties of tyrosinase, Inhibitors of melanin formation; direct enzyme poisons, competitive inhibitors, induction-period-prolonging factors, compounds reacting with melanin precursors, reducing agents, incompletely understood inhibitors, Melanurai. Biology of dendritic melanocytes: Anatomical and embryological considerations, Nature of melanin granules, Phenomenon of pigment spread. Nutritional factors in melanin formation: Trace metals, Amino acids, Vitamins. Endocrine factors in melanin formation: Pituitary, Thyroid, Adrenal, Gonodal. Neural factors in melanin formation. Factors influencing skin melanin content. Sun-tanning.

25 Lykken, KB. & Olsson, N. (undated). Utevistelse ger daghemsbarn lägre frånvaro i ÖLI (förkylningssjukdomar). Work report (in Swedish). ArvikaSjukhus, 671 00 Arvika (4 pages, 8 references)

In a study on children in Swedish day-care centres a clear-cut correlation was demonstrated between duration of outdoor activity on one hand and resistance to infection of the respiratory passages on the other.

26 Löfberg, HA., Löfstedt, B., Nilsson, I. & Wyon, DP. 1973. The effect of heat and light on the mental performance of school children - introduction to a climate chamber experiment. In: Küller, R. (ed). Architectural Psychology. Proceedings of the Lund Conference. Studentlitteratur, Lund & Dowden, Hutchinson & Ross, Stroudsburg, 64-67 (2 references)

Experiments on the effect of moderate heat stress on the mental performance of school children is extended to test situations where both heat, light and noise are studied. This paper gives an introduction to the first climate chamber experiment in which both illuminance and room temperature are systematically varied.

27 Löfberg, HA., Löfstedt, B., Nilsson, I. & Wyon, DP. 1976. Combined temperature and lighting effects on the performance of repetitive tasks with different visual content. In: Commission Internationale de l'Eclairage, Compte Rendu, 18e Session, London 1975. Publication CIE No 36, Paris, 450-455 (13 references)

In a climate chamber experiment on the combined effects of temperature and illuminance on the performance of 144 ten-year old children, three illuminances (60, 250 and 1 000 lux) were combined with two levels of heat stress, one equivalent to normal room temperature (c 22°) and one to a moderate level of heat stress (C 27°). The results of performance tests with Landolt rings of different sizes and of an addition test are reported. In the addition test both a high (C = 0.90) and a low (C = 0.42) level of contrast were used. At the neutral temperature the illuminance had no effect on the addition test with high contrast, but the expected positive effect on a visually more difficult task such as Landolt rings with 1' gap was found. This effect was highly significant. During moderate heat stress, especially in the afternoon, it was found that a high level of illuminance had a negative effect on the tasks where visual concentration was less essential. In the addition test with low contrast, raised illuminance had a positive effect on performance. For the visually most difficult task (1' Landolt rings) there also was a significant increase in performance even at moderate heat stress. No significant interactions between sex, IQ or personality and temperature and lighting were found in these tests.

28 Makous, WL. 1966. Cutaneous color sensitivity: Explanation and demonstration. Psychological Review, 73(4), 280-294 (33 references)

Past reports that humans can, in complete darkness, sense with their fingers the colors objects would have if illuminated, have understandably been received with skepticism. A previously proposed hypothesis, based on differential rate of absorption of infrared radiation by different layers of the skin, is inconsistent with the thermodynamics of the situation. Quantitative analysis of the system consisting of a room-temperature surface juxtaposed to the higher temperature skin, however, leads to the conclusion that large differences in emissivity of different room-temperature surfaces almost certainly could be detected by the associated effects on skin temperature. Easily repeatable demonstrations show that this is true, and a few simple temperature measurements confirm the theoretical identification of the mechanism.

29 Mayron, LW., Ott, JN., Amontree, EJ. & Nations, R. 1975. Caries reduction in school children. Applied Radiology/Nuclear Medicine. July/August (3 pages, 11 references)

The six-year molars of first- and second-grade school children were regarded as a neopopulation of teeth in which caries incidence and susceptibility could be studied. These teeth were examined before and after a nine-month school year during which school rooms were lit only by cool-white fluorescent light or by full-spectrum fluorescent light plus radiation shielding. Initially, the two populations of children (52 and 46, respectively) were equivalent in the distribution of children with and without caries in these teeth (8 with and 44 without compared to 4 with and 42 without). At the end of the time period, the relationship skewed to 27 with and 25 without for the cool-white population, and 10 with and 36 without for the full-spectrum population ($p<0.005$). Further analysis of the data revealed significantly high caries development over the time period in the cool-white group in first-graders and in second-graders who had been under cool-white light the prior year as well.

30 McIntyre, DA. 1976. Thermal radiation from light and its effect on comfort. In: Commission Internationale de l'Eclairage, Compte Rendu, 18e Session, Londres 1975, Bureau Central de la CIE, Paris, 445-450 (9 references)

The trend towards the use of higher lighting levels raises the problem of the effect of thermal radiation from the lighting installation on the thermal comfort of the occupants. Overhead radiation affects comfort in two ways; it increases the overall warmth of a person, and the asymmetric nature of the radiation may itself produce discomfort. These effects may be quantified in terms of the mean radiant temperature and the vector radiant temperature. Experimental results are quoted to show that complaints may be expected when the vector radiant temperature exceeds 10°C (equivalent to a radiation vector of 60 W/m^2). Measurements on several different types of lamps show that the thermal radiation may be predicted from the illuminance; for fluorescent lamps the relation is 8 W/m^2 per 1.000 lx. The effect on warmth may be compensated by reducing the design air temperature by 0.3°C per 1.000 lx; an illuminance of 7.000 lx will produce a vector radiant temperature of 10°C and possible complaints. Equivalent figures are quoted for other lamp types.

31 McIntyre, DA. & Griffiths, ID. 1973. Radiant temperature and comfort. In: Thermal comfort and moderate heat stress. Proceedings of the CIB Commission W45 (Human requirements). Symposium held at the Building Research Stations, 13-15 September 1972, Department of the Environment, Building Research Establishment, Her Majesty's Stationary Office, 113-132 (26 references)

The influence of thermal radiation on warmth and comfort has often been more a matter of controversy than argument. Recent work at Capenhurst has attempted to deal with the problem in its various constituents: (a) The relative effect of mean radiant temperature and air temperature on warmth; (b) Subjective differences between predominantly convective and predominantly radiant environments of the same warmth; and (c) The influence of asymmetry in radiation on warmth and other subjective responses. The paper puts the Capenhurst experiments into their context in the wider literature, and the implications for both measurement techniques and heating systems are briefly discussed.

32 Meehan, JP., Stoll, AM. & Hardy, JD. 1954. Cutaneous pain threshold in the native Alaskan Indian and Eskimo. Journal of Applied Physiology, 6, 397-400 (9 references)

As no significant difference in pain threshold was found to exist between the Indian, Eskimo and white subjects, it must be concluded that 1) in these groups cultural differences are not such as to affect the pain threshold as determined by this method, and 2) the ability of the Alaskan Indian and Eskimo to expose his skin to extreme cold without pain is not associated with an elevation of this theshold. It is possible, however, that exposure to cold stimulation might reveal a relative elevation of the "cold" pain threshold in the Alaskan Indian and Eskimo as compared to the populations of warmer climates. Information on this point is not available at this time. Aslo, the similarity of the pain thresholds in the three groups does not mean that reactions to situations in which pain is a prominent feature will be similar.

33 Monahan, EM. 1976. Application of Gibson's theory of sensory integration to the training of the blind or visually occluded individuals in the distinguishing of primary colors. Dissertation Abstracts International, 36 (11A), 7344-7345

Blind individuals have been at psychological, sociological and economical disadvantage due to their inability to discriminate among colors. James J. Gibson theorized a system of sensory integration in which he considered the senses to be perceptual systems. He further theorized that the perceptual systems overlap one another, and are mutually exclusive. This study evaluated the application of Gibson's theory of sensory integration to the training of blind or visually occluded individuals in the distinguishing of primary colors. The literature review indicated that researchers have delved into the area of obstacle perception by the blind and color discrimination without the use of eyesight. Despite research findings which indicate that the blind often display and can be taught obstacle perception and color

discrimination without the use of eyesight, there is no evidence of an attempted synthesis of this research. Gibson's theory of sensory integration holds that individuals can learn to sense their environment more effectively. In the literature reviewed there is no indication of an attempt to apply Gibson's theory of sensory integration to teaching the blind and visually occluded to distinguish primary colors. The findings of this study suggest that Gibson's theory of sensory integration is applicable to the development of a teaching modality to train blind or visually occluded individuals to distinguish among primary colors.

34 Nash, CB. 1969. Cutaneous perception of color. Journal of the American Society for Psychical Research, (63-64), 83-87 (7 references)

The purpose of this experiment was to determine (1) whether subjects could distinguish between black and red paper touched with the fingertips but concealed from vision, (2) whether the color could be identified when the paper was covered with transparent cellophane .03 mm, in thickness, and (3) whether the color could be identified when the paper was covered with glass one-eighth inch in thickness. Each of thirty-six subjects were tested in three runs in which he touched the target paper directly; in three runs in which he touched the cellophane cover of the target paper; and in three runs in which he touched the glass cover of the target paper. The run consisted of twenty-five trials, the twenty-five target papers being placed in random order in a stack within a cardboard box. The box was open on the side next to the experimenter and closed on the side next to the subjects except for an opening through which he could insert his hand. The results on the tests in which the target papers were directly touched were at the .01 level of probability. This is also the case in the second test, where the target papers were covered with transparent cellophane. Results of the third test, where the targets were covered with glass, are not significant. While the results could be attributed to ESP, they are suggestive of an energy transfer between the paper target and sense organs in the skin which was transmitted through the .03 mm cellophane, but not through the one-eight inch glass.

35 Nash, CB. 1971. Cutaneous perception of color with a head box. Journal of the American Society for Psychical Research, (65), 83-87 (6 references)

Subjects who wore a head box to preclude visual cues could distinguish the color of red or black paper when it was uncovered or covered with thin clear plastic .03 mm thick, but not when it was covered with picture glass 1/8 inch in thickness. Greater infrared radiation was transmitted by the plastic than by the glass. Presumably neither the plastic nor the glass would produce a differential between the two colors of paper with respect to touch or ESP. These facts suggest that nonvisual identification of color was accomplished by cutaneous perception of infrared radiation and not by touch or ESP. The results are in accord with the hypothesis that the different infrared emissivities of different colors would differ in the skin temperatures they induce.

36 Neer, RM., Davis, TRA., Walcott, A., Koski, S., Schepis, P., Thorington, L. & Wurtman, RJ. 1971. Stimulation by artificial lighting of calcium absorption in elderly human subjects. Nature, 229, 255-257 (21 references)

Ordinary window glass absorbs essentially all radiation of the wavelength necessary for the in vivo synthesis - between 275 and 310 mm - of vitamin D^{4-7}. Millions of people work behind glass, underground or in the extreme north, travel to and from work in closed vehicles, and venture outdoors only in the early morning or late evening, when ultraviolet radiation is minimal. Incandescent bulbs emit little ultraviolet radiation; the small amount from ordinary fluorescent bulbs is usually absorbed by the fixture in which they are mounted. Changes in calcium absorption were examined after exposure of eighten male subjects aged 57 to 80 years to a fluorescent lamp designed to duplicate daylight. About 5% of it's total radiant power was in the range between 290 and 380 nm. The subjects stayed indoors for four months and avoided food rich in vitamin D. The results suggest that relatively small amounts of ultraviolet light can stimulate calcium absorption among elderly men. The amounts involved seem to be roughly equivalent to those that would impinge on a resident of Washington DC who took a daily 15 min walk out of doors on lunch time in midsummer. The data also suggest that there is seasonal variation in calcium absorption at least among individuals who are exposed to little sunlight.

37 Novomeiskii, AS. 1965. The nature of the dermo-optic sense. International Journal of Parapsychology, 7, 341-367 (11 references in Russian)

In order to check different hypotheses about the dermo-optic sense an experiment was set up including 80 subjects at the Graphic Arts Department of the Nizhne-Tagil Pedagogic Institute. Experience showed that approximately every sixth person recognized well the colors in pairs even after 20 to 30 minutes of exercises. If the exercises were repeated systematically over a period of two or three weeks, then individual subjects learned to reconize up to five to seven colors of the spectrum by touch. The hypothesis that the identification should be based on the perception of surface structure was ruled out by putting cellophane or glass on top of the colour samples or printed letters. The hypothesis that identification is based on thermal differences between the different colours could not be confirmed in experiments using heat-absorbing filters. The experiments confirmed that the dermo-optic sense extinguishes in darkness. The first color tones whose indices ceased being sensed in darkness were red, orange and yellow, then afterwards light blue and dark blue. In this respect it resembles the Purkinje effect, typical for vision. The hypothesis about the existence of photoreceptors in the skin was however ruled out by using aluminium foil placed on top of the colored paper or letters, which was placed on glass, and lit from below. However, if the metal foil or the hand itself were grounded identification became impossible. Performance improved when the objects for identification were placed on an insulating tray and when a rubber mat was put under the chair and feet of the subject. The conclusion suggest itself that dermo-optic sensations are connected with the action of electric charges, arising

under the influence of light on the colored surface of paper. Many students began to react to the color of the paper with their hand in the air at a comparatively great height. Also, the experiments showed that, as the result of systematic exercises, the blind and visually handicapped apparently can learn to read with their palm large text and numbers at a distance.

38 Olesen, S., Fanger, PO., Jensen, PB. & Nielsen, OJ. 1973. Comfort limits for man exposed to asymmetric thermal radiation. In: Thermal comfort and moderate heat stress. Proceedings of the CIB Commission W45 (Human requirements). Symposium held at the Building Research Stations, 13-15 September 1972, Department of the Environment, Building Research Establishment, Her Majesty's Stationary Office, 133-148 (22 references)

Sixteen college-age subjects were tested individually in a climate chamber. A pair of opposite walls could be held at different temperatures, while keeping the mean-radiant temperature constant. Each subject, virtually naked, selected that uniform environment which rendered him thermally neutral. The asymmetry was then increased in steps at half-hour intervals until the temperature difference between opoosite walls was 40°C. Judgements of perception of asymmetry and discomfort from asymmetry were obtained for three orientations of the subject. A formula is derived for the upper limit of comfortable local radiant exposure for clothed persons in thermal neutrality.

39 Paulsson, LE. 1979. UV-radiation from fluorescent tubes. National Institute of Radiation Protection, Stockholm (20 pages, 4 references)

Ultraviolet radiation was measured spectroradiometrically on the surface of standard fluorescent tubes of several types and makes. Results are presented written as absolute values or as a maximum permissible exposure time for human skin at an illumination of 1000 lx. A minority of the tubes was potentially capable of producing acute skin erythemas during a working day in highly illuminated areas. The amount of UVB-radiation from fluorescent tubes was found to be dominantly affected by the absorption properties of the tube glass.

40 Ponnamperuma, C. 1968. Ultraviolet radiation and the origin of life. In: Giese, AC. (ed). Photophysiology. Current Topics, Volume III. Academic Press, New York, London, 253-267 (22 references)

Life in the universe: extraterrestrial life, chemical evolution, abundance of life in the universe, how did life begin? The primitive atmosphere, Rise of oxygen, The solar spectrum, Experiments: survey of previous work, recent experiments, hydrogen cyanide, formaldehyde, condensation reactions, nucleosides and nucleotides, peptides, Conclusion.

41 Razran, G. 1966. Dermo-optical perception of human extraoccular color sensitivity: A clarification of current Soviet research and an article in Science. Soviet Psychology, 5, 4-13 (62 references)

As a reply to recent criticism by Martin Garner in Science 1966 and others the article summarizes research in USSR on dermo-optic perception and also concludes that account must be taken of the fact that the Russian scientists have reported two types of human extra-ocular color sensitivity: one that becomes manifest in the dark, and one that is active only in presence of visible light.

42 Ronge, HE. 1948. Ultraviolet irradiation with artificial illumination. A technical, physiological, and hygienic study. Acta Physiologica Scandinavica, 15, Suppl 49 (191 pages, 275 references)

A brief survey of ultraviolet radiology. Hygienic applications of ultraviolet radiation. Dosimetric principles and basic design. Technical arrangement of the UV-illumination system. Radiation climate of the experimental rooms. Physical metods employed. A comparison with daylight ultraviolet conditions. A general scheme of the investigation. Effects on some constituents of blood. Effect on physical fitness. Effect on air-borne bacteria. Effect on absenteeism. General discussion.

43 Rosenfeld, A. 1964. Seing color with the fingers. Life, 12, June, 74, 76-78 (no references)

The article summarizes many of the experiments and demonstrations done on dermo-optic perception in USSR and USA and also gives an account of a visit to a clinic in Moscow and a demonstration by the famous Russian subject, Rosa Hileshova. Also, the dermo-optic ability of some other Russian and American subjects are described. The article also gives an account of studies made by Alexei Leontyev, Abram S. Novomeiskii, Gergory Razran and Richard P. Youtz. It is concluded that although there is, in some respects, reason to be doubtful, the existence of dermo-optic perception can not be denied. However, the explanation of this phenomenon will have to await further research.

44 Rothman, S. 1954. Physiology and biochemistry of the skin. University of Chicago Press, Chicago (741 pages, numerous references)

Mechanical properties; Electrical behavior; Percutaneous absorption; Circulation and vascular reactions; Sensory functions; Sweat secretion; Composition of eccrine sweat and aqueous surface film; pH of sweat and skin surface; Insensible water loss; The role of skin in Thermoregulation; The sweat-retention syndrome; Sebaceous-gland excretion; Composition of the lipid surface film; Nitrogenous constitutents, general data; Epidermal proteins; The keratinization process; Collagen, reticulin and elastin (Z. Felsher); Connective-tissue ground substance (GC. Wells); Carbohydrates; Lipid Constituents; Water and Electrolytes; Pigmentation (AL. Lorincs); Enzymes (AB. Lerner); Carbon dioxide delivery; Biology of epidermal cells (H. Pinkus); Hair growth (P. Flesch); Nutritional influences (AL. Lorincs); Pathophysiology of Blister formation. 8 contributers, 28 chapters including bibliographies.

45 Ruff, HR. 1976. Biological UV control. The role of erythema. In: Commission Internationale de l'Eclairage, Compte Rendu, 18e Session, Londres 1975, Bureau Central de la CIE, Paris, 785-795 (12 references)

A survey of accepted and suggested biological efficacies indicates that a full understanding of changes produced by natural or artificial radiation would be promoted by a knowledge of the amount of each reaction produced. A table shows the basis of biological subjective units for weighted radiated power (vitons) and weighted irradiance (Finsen), which can be calculated by combining the spectral power distribution from lamps with these biological efficacies. Finsen meters can measure the selected irradiance. Erythema has the advantage that it can be detected visually and cross checked by skin tests. Experiments confirm that the irradiance-time reciprocity law can be applied for exposures up to 8 hours and suggest that the efficacy data should be continued to 400 nm. It is suggested that knowledge of individual skin sensitivity would be useful for preventing severe sunburn. A calculator has been developed to put into perspective the effects of individual sensitivity variation and skin adaptation and recovery.

46 Schneider, FW., Lesko, WA. & Garrett, WA. 1980. Helping behavior in hot, comfortable and cold temperatures: A field study. Environment and Behavior, 12(2), 231-240 (14 references)

A field study was conducted in which the helping behavior of 440 adults was measured under hot, comfortable, or cold temperatures. A subject was given an opportunity to help an experimenter by (1) answering a questionnaire, (2) picking up dropped groceries, (3) looking for a lost contact lens, or (4) picking up a dropped book while the experimenter walked on crutches. No support was found for the hypothesis that hot and cold temperature inhibit the display of helping behavior.

47 Sharon, IM., Feller, RP. & Burney, SW. 1971. The effects of light of different spectra on caries incidence in the golden hamster. Archives oral. Biology, 16, 1427-1432 (12 references)

Golden hamsters, exposed to fluorescent light which simulated both the visible and ultraviolet spectra of natural outdoor light, had one-fifth as many caries as animals exposed to conventional fluorescent light. Total body, gonad and submandibular glands weights were greater for the animals raised under the simulated natural light. Differences in gonad and submandibular gland development were histologically demonstrated with haematoxylin and eosin stained sections. Thus, light affected caries incidence, submandibular gland development and sexual maturity.

48 Sigmund, R. 1956. Die Wirkung ultravioletter Strahlen auf die Reaktionszeit des Menschen, Strahlentherapie, 101, 623-629 (18 references)

In order to ascertain the influence of ultraviolet rays, measurements of the time of reaction to optical stimulations have been carried out with healthy children and adults. There was a considerable reduction of the time of reaction which could be observed even three weeks after the irradiation.

49 Stevens, JC., Adair, ER. & Marks, LE. 1970. Pain, discomfort, and warmth as functions of thermal intensity. In: Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois, 892-904 (26 references)

The three psychological dimensions of pain, discomfort and warmth all follow the general rule in the domain of the human senses that judged sensory magnitude grows as a power function of the magnitude of the physical stimulus. Each of the three dimensions can be characterized in terms of the sizes of the constants of the power equation. 1. Pain aroused by brief, intense irradiation of small spots on the forearm or the forehead grows as a power function of the difference between pain-inducing flux and the flux necessary for a just-sensible pain. The exponent equals unity. Over the range studied, this result agrees well with the dol scale of pain. 2. Discomfort aroused by the thermal exposures of the whole front surface of the body grows as a power function of the increase in the operative temperature from the temperature that feels comfortable. For discomfort in the warm, the exponent (about 0.7) is less than half as large as that for discomfort in the cold (about 1.7). 3. Warmth aroused by irradiation of the front of the body grows as a power function of the difference between the warmth-inducing flux and the minimum-sensible flux. A power function was obtained for each of five stimulus durations between 2 and 12 sec. As a function of duration, the exponent varies from a little below to a little above unity. Over the range studied, apparent warmth changed little with increased duration, even though superficial skin temperature rose continuously. Several possible physiological explanations of this fact are examined with the aid of a computer simulation of the thermal events that take place in the skin.

50 Teicher, WH. & Kobrick, JL. 1954. Effects of prolonged exposure to low temperature on visual motor performance, flicker fusion, and pain sensitivity. US Army, Qm Res Dev Cent environ Protection Div Rep, N 230

Five subjects lived under constant low temperature in a chamber for 41 days. This seemed to have no effect on the CFF. The radiant heat pain threshold was raised, and did not recover normal sensitivity. Visual motor performance was markedly and immediately imparied, but recovered gradually to a lower limit.

51 Thorington, L., Parascandola, L. & Cunningham, L. 1971. Visual and biologic aspects of an artificial sunlight illuminant. Journal of the Illuminating Engineering Society, October, 33-41 (53 references)

A modest approach has been made to the simulation of the natural spectrum at 5500K in a practical fluorescent lamp. Extensive research studies involving the artificial sunlight spectrum in practical fluorescent lamps have shown significant differences in biological responses for plants, animals, people and microbes as compared with conventional office and commercial interior lighting spectra. This, together with the fact that vision is served better, rather than

compromised, by such a full spectrum illuminant at least suggests serious consideration of the adoption of the natural light spectrum as the criterion for the daytime lighting of our artificial environments.

52 Urbach, F. (ed). 1969. The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York (704 pages, numerous references)

The book comprises 70 articles and discussions on the following topics: Chemical and biological effects of ultraviolet radiation, Artificial production of ultraviolet radiation, Optics of the skin, Biologic action spectra, Production and measurement of ultraviolet erythema, Model systems for ultraviolet erythema, Pigmentation, Physics of the atmosphere, Measurement of natural ultraviolet radiation, Physiological effects of solar ultraviolet radiation, Pathologic effects of ultraviolet radiation (general), Symposium on photo-toxicity and photoallergy, Pathologic effects of ultraviolet radiation (cancer), Phototherapy and protection from ultraviolet radiation.

53 Wilson, P., Webb, MGT. & Becket, PGS. 1976. Induction of alcohol selection in laboratory rats by ultraviolet light. Journal of Studies on Alcohol, 37(7), 976-979 (10 references)

Rats exposed to ultraviolet light with maximum emission at 350 nm showed a stable intake of alcohol over water. A control group of animals exposed to white fluorescent light did not drink more alcohol than water.

54 Wright, G. 1954. Sensations of warmth due to light: Some factors affecting the sensory threshold. In: Proceedings of the first international photobiological congress. Veenman & Zonen, Wageningen, 235-237 (2 references)

When determining the threshold energy for a sensation of warmth one must consider not only the intensity of the incident light, but also the area of skin that is irradiated and the duration of the exposure. There are indeed three types of threshold, intensity-, area-, and duration-threshold, which vary interdependently. There is also gross individual variation. These factors must be taken into account when one compares the sensitivities of two sites - in this paper, the epigastrium and the back of the hand.

55 Youmans, WB. 1957. Fundamentals of physiology. The Year Book Publishers, Chicago (no references)

Contains a description of the physiological and biochemical effects of heat radiation (pp 170-173) and ultraviolet radiation (pp 455-456, 466) on the human skin.

56 Youtz, RP. & Broome, RS. 1969. Cutaneous color discrimination (DOP) at two stimulus temperatures. Proceedings of the 77th Annual Convention of the American Psychological Association, (4), 17-18 (12 references)

The present research measured Ss' abilities to discriminate, without touching the stimulus, between two stimulus surfaces differing in brightness when the stimuli were: (A) at room temperature of 79°F, or (B) at 50°F. The stimuli were 1/8 in. polished aluminum plates, 9 x 14 in. On one side of each plate, half (7 x 9) was left polished and the other half was sprayed with a thin layer of flat-black paint. The result is that the S reports a fairly strong sensation of "cool" when her hand is over the black surface in Condition B. The rate of heat loss by the skin is apparently an adequate stimulus for the sensation "cool". In Condition B, with the plate at 50°F, the heat loss was at a higher rate than in Condition A with the plate at 79°F.

57 Zamkova, MA. & Krivitskaya, EI. 1966. Effect of irradiation by ultraviolet erythema lamps on the working ability of school children. Gig. i Sanit., Vol 31, April, 41-44 (Translation by Duro-Test Corporation) (11 references)

The biological action of ultraviolet radiation has been rather profoundly studied, its favorable effect on the human organism has been shown by a number of authors. Several investigators emphasize the need for artificial compensation of seasonal ultraviolet deficiency in the natural environment. The data permit certain conclusions. Systematic irradiation by EUV lamps in the dosage employed (according to the instructions of USSR Academy of Medical Sciences) has an undoubted favorable effect, expressed in a number of favorable shifts. The irradiated pupils had a shorter reaction time to light and sound, a lower fatigability of the visual receptor, and improved working capacity. The improvement of academic standing in the experimental class is probably also connected with these favorable shifts. All this provides grounds for widely recommending the irradiation of school children by EUV lamps during the seasons of diminished natural radiation. This irradiation may be arranged without disturbing the usual program of school activities.

58 Anonymous. 1974. Light of life. Environmental Design, 14(4), 6-9 (no references)

In several types of disease treament can be accomplished through the administration of radiation directly on the skin. Only small traces of ultraviolet radiation are necessary to help the body develop the calciferol (also called Vitamin D) in amounts needed to promote calcium retention and bone growth. A deficiency of calciferol may result in rickets in small children and in aged people in brittle or easily broken bones. In prematurely born babies the liver might not be sufficently developed to dispose of a waste product called bilirubin. Left unchecked this condition, hyperbilirubinemia, will result in permanent brain damage. However, treatment with artificial light approximating daylight will in a few days time clear the condition completely. Also, it has been demonstrated that certain virus infections respond to light treatment. The fact that light can modify body chemicals like calciferol and bilirubin makes the author suggest that light also may be modifying many other body chemicals.

59 ———— 1975. Lighting Manual, N.V. Philips, Eindhoven (12 pages, sections 16 and 17, no references)

This handbook contains a section on ultraviolet radiation describing the properties of different UV-bands. It also gives information on the following sources of ultraviolet radiation: actinic lamps, black-light lamps, sunlamps, germicidal lamps and ozone lamps as well as advise for their proper application. There is also a section on infrared radiation.

60 ———— 1979. Ultraviolet Radiation. Environmental Health Criteria 14, World Health Organization, Geneva (110 pages, 318 references)

This document is based primarily on original publications listed in the reference section together with several recent reviews of the health aspects of UVR. The topics discussed are as follows: Properties and measurement of ultraviolet radiation. Biological effects of ultraviolet radiation on unicellular organisms, mammalian cells and tissue, and invertebrates. The biological action of ultraviolet radiation on vertebrate animals. Effects of ultraviolet radiation on man. Evaluation of health risks to man. Guidelines for health protection. Summary and recommendations for further studies.

SECTION 1: ADDITIONAL REFERENCES

Abernathy, RS. 1961. Biological effects of sunlight. Amer J Dis Childhood, 101

Abillon, E. et al. 1973. Effect of wavelength on production of previtamin D. J Pharmaceut Sci, Oct, 62, 1688-1691

Aitken, JM. et al. 1972. The physiological regulation of the seasonal variations in phosphorus and calcium metabolism. Proc Physiol Soc, July, 93-94

Allen, RM. 1945. Effect of ultraviolet radiation on physical fitness. Arch Phys Med, 26, 641-644

Allende, MF. 1972. The enigmas of pigmentation. J Amer Med Assoc, 220(11), 1443-1447

Andrianova, AI. 1970. Prophylactic ultraviolet irradiation of preschool children of Moscow. Gig I Sanit, Oct, 35, 30-33

Anghelova, O. et al. 1968. Studies in serotonine metabolism under the conditions of sea and mountain climates as well as of experimental ultraviolet irradiation for the purpose of deriving inferences for how to make the most of their prophylactic effect. Mauch Tr Vissh Med Inst Sofua, 47, 61-69

Austerweil, L. 1966. Eine neue Deutung des Behaglichkeitsbegriffes. Heizung, Lüftung, Haustechnick, 17(7), 241-243

Bachem, A. 1955. Time factors of erythema and pigmentation produced by ultra violet rays of different wavelengths. J Invest Dermat, 25(4), 215-218

Bachem, A. 1956. Ophthalmic ultraviolet action spectra. Am J Ophthalmol, 41, 969-975

Barrett, SM. & Rice-Evans, P. 1964. Sensitivity of hands to visible light. Nature, 203, 993

Baudach, H. 1961. Remissionsmessungen an menschlicher und tierischer Haut nach UV-Bestrahlung. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology, Proceedings of the third international congress on photobiology. Elsevier Publishing Company, Amsterdam, London, New York

Beadle, PC. 1977. The epidermal biosynthesis of cholecalciferol (Vitamin D_3). Photochem & Photobiol, 25(6), 519-527

Beadle, PC. 1977. Sunlight, ozone and vitamin D. Brit J Deramtol, 97(5), 5858-5891

Bedford, T. 1961. Researches on thermal comfort. Ergonomics, 4, 289-310

Bedocs, L. & Hewitt, H. 1970. Lighting and the thermal environment. JIHVE, 37, 217-231

Bekemeier, H. 1961. Zur Wirksamkeit des in der Haut durch ultraviolette Strahlen erseugten Vitamins D. In: Christensen, BC. & Buchmann, C. (eds). Progress in Photobiology, Proceedings of the third international Congress of photobiology. Elsevier Publishing Company. Amsterdam, London, New York

Bekemeyer, H. 1969. Evolution of skin color and photosynthesis of vitamin D in the skin. Deut Med Wochen, 94(4), 185-189

Belikova, VK., Zabulueva, AP. & Galperin, EL. 1975. Evaluation from the standpoint of hygiene of the zoning of the territory of the USSR in respect to UV radiation levels. In: The biological effects of UV radiation, Nauka, Moscow, 161-165 (in Russian)

Bellis, JM. 1966. Hypnotic pseudo-sunburn. Amer J Clin Hypn, 8, 310-312

Berger, D., Urbach, F. & Davies, RE. 1967. The action spectrum of erythema induced by ultraviolet radiation. Proceedings of the 13th International Congress of Dermatology, Springer Verlag, Berlin, 1112-1117

Bing, HI. 1943. Effects of ultraviolet rays in depth and duration. Acta Med Scan, 114, 217-222

Bing, HI. 1954. Reflex changes in striated muscle tone as a result of ultraviolet radiation of the skin, with some observations on the mechanism. Acta Med Scan, 149, 457-462

Blois, MS. 1968. Vitamin D, sunlight, and natural selection. Science, 159, 652

Blum, HF. 1945. The physiological effects of sunlight on man. Physiol Review, 25, 483-530

Blum, HF. 1961. Does the melanin pigment of human skin have adaptive value? Quart Rev Biol, 36(1), 50-63

Blum, HF. & Terus, WS. 1946. The erythemal threshold for sunburn. Am J Physiol, 146(1), 107-117

Bocenkova, TD. 1971. The application of prophylactic UV-irradiation to workers in buildings of a new type. In: Ultraviolet radiation, Medicina, Moscow, 245-251 (in Russian)

Bongard, MM. & Smirnov, MS. 1965. The "skin vision" of R. Kuleshova. Biofizika, 10(1), 148-154 (in Russian)

Bovie, WT. & Klein, A. 1919. Sensitization to heat due to exposure to light of short wavelengths. Journal of Gen Physiology, 1, 331-336

Branda, EF. et al. 1978. Skin color and nutrient photolysis: An evolutionary hypothesis. Science, 201, 625-626

Brandt, HJ. 1976. Physiological and psychological importance of daylight for man and inferences for construction planning. Gesundheits-Ingen. 97(6), 143-146

Breit, R. & Kligman, AM. 1969. Measurement of erythemal and pigmentary responses to ultraviolet radiation of different spectral qualities. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York

Brues, AM. 1975. Rethinking human pigmentation. Amer J Phys Anthropol, 43(3), 387-392

Buchanan, AR., Helm, HC. &Stilson, DW. 1960. Biomedical effects of exposure to electromagnetic radiation. I. Ultraviolet. Wright-Patterson Air Force Base, WADD Technical Report, Dayton, OH, 60-376

Buchmüller, K. 1961. Untersuchungen über das Reflexions- und Emissionsvermögen sowie die Durchlässigkeit der lebenden menchlischen Haut im Spektralbereich $\lambda \approx 3\text{-}15$ µm. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress on photobiology. Elsevier Publishing Company, London, New York

Bücker, H. 1961. Neuere Ergebnisse zur Erythem- und Pigmentwirkung optischer Strahlung. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress on photobiology. Elsevier Publishing Company, London, New York

Buettner, KJK. 1969. The effects of natural sunlight on human skin. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York, 237-249

Bunker, JWM. & Harris, RS. 1937. Precise evaluation of ultraviolet therapy in experimental rickets. New Engl J Med, 216(4), 165-169

Burckhart, W. 1956. Symposium über die grundlegenden Wirkungen der nicht ionisierenden Strahlung auf die Haut. Slussbericht. In: Proceedings of the first international photobiological congress, 1954, Veenman & Zonen, Wageningen, 428-429

Bursill, AE. 1958. The restriction of peripheral vision during exposure to hot and humid conditions. Quarterly Journal of Experimental Psychology, 10, 113-129

Böje, O., Nielsen, M. & Olesen, J. 1948. Undersögelser over betydningen af ensidig strålingsafköling (Studies on the effect of unilateral cooling by radiation) (in Danish). Boligopvarmningsudvalgets meddelelse No 9, Köpenhamn

Challoner, AVJ. et al. 1976. Vascular changes in human skin after ultraviolet irradiation. The British Journal of Dermatology, 94(5), 487-494

Cheatum, BA. 1967. The effect of a single suberythemic biodoes of ultraviolet radiation upon the strength of college women. J Ass Phys Ment Rehab, 21, 131-133

Cheatum, BA. 1968. Effects of a single biodose of ultraviolet radiation upon the speed of college women. Res Quarterly Amer Assoc Health & Phys Education, 39, 482-485

Chrenko, FA. 1953. Heated ceilings and comfort. JIHVE, 20, 375-396

Chrenko, FA. 1953. Heated ceilings and comfort. JIHVE, 21, 145-154

Chrenko, FA. 1955. Assessment of subjective reactions in heating and ventilation research. Heat Vent Engr, 29(337), 12-16

Chrenko, FA. 1964. Threshold intensities of thermal radiation evoking sensation of warmth. Journal of Physiology, 173, 1-12

Claesson, S., Juhlin, L. & Wettermark, G. 1958. The reciprocity law of ultra violet irradiation effects. Acta Dermato-Venereologica, 38, 123-136

Coblentz, WW. 1931. The spectral erythemic reaction of the human skin to ultraviolet radiation. Proc Natl Acad Sci, 17, 401-405

Coblentz, WW. & Stair, R. 1934. Data on the spectral erythemic reaction on the untanned human skin to ultra violet radiation. US Bureau of Standards Journal of Research, 12, 13-14

Coblentz, WW., Stair, R. & Hogue, JM. 1932. The spectral erythemic reaction of the untanned human skin to ultraviolet radiation. US Bureau of Standards Journal of Research, 8, 541-547

Cripps, DJ. et al. 1970. Cutaneous arteriolar dilatation elicited by ultraviolet irradiation. J Invest Dermatol, 54(4), 332-337

Cripps, DJ. & Ramsay, CA. 1970. Ultra violet action spectrum with a prism grating monochromator. British Journal of Dermatology, 82, 584-591

Daniels, F. 1959. The physiological effects of sunlight. J Invest Dermatol, 32, 147-153

Daniels, F. 1961. Quantitative measurements of the reactions of human skin to ultraviolet light. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress on photobiology. Elsevier Publishing Company, London, New York

Daniels, F. 1964. Sun exposure and skin aging. New York State J Med, 64, 2066-2069

Daniels, F. 1964. Man and radiant energy: solar radiation. In: Dill, DB., Adolph, EF. & Wilbur, EG. (eds). Handbook of physiology. Section 4: Adaptation to the environment. Am Physiol Soc Washington DC, 969-987

Daniels, F. 1972. Physiological and pathological extracutaneous effects of light on man and mammals, not mediated by pineal or other neuroendocrine mechanisms. Intl Conf on Photosensitization and Photoprotection, November, Tokyo

Daniels, F. et al. 1968. Sunburn. Scientific American, July, 38

Dantsig, IN. 1974. Dental caries and UV deficiency. (in Russian) Stimatologija, 1, 13-19

Dantsig, IN. 1974. Effect of ultraviolet irradiation on the conditioned defence reflex of active avoidance. Bull Eksper Biol & Med, 78, 9-11

Dantsig, NM. 1966. Use of UV radiation for hygienic and therapeutic - prophylactic purposes. UV Radiation, Moscow, 203-211

Dantsig, NM. 1967. Development of the hygiene of lighting in the USSR. Gig i Sanit, 32, 45-50

Dantsig, NM. 1970. Erythemal installations for continuous utilisation . Lighting Research and Technology, 2(4), 276

Dantsig, NM. 1972. Hygienic aspects of daylight and sunlight inside buildings and in urban areas. Svetotekhnika, 18, 9-11

Dantsig, NM. 1975. The hygienic basis for preventing light starvation among ships' crews. In: The biological effects of UV radiation, (in Russian), Nauka, Moscow, 168-171

Dantsig, NM. & Belikova, VK. 1949. Some health problems of fluorescent lighting. Part 1. Gig i Sanit, 10, 28

Dantsig, NM., Mac, LI. & Belikova, VK. 1958. The resistance of animal organisms to infection under the influence of ultraviolet radiation. (in Russian). In: Ultraviolet radiation. Medgiz, Moscow

Dat, GH. 1955. The subjective effects of general irradiation, Brit J Phys Med, 18, 14-16

Davis, TP. 1961. The heating of skin by radiant energy. In: Herzfeld, CM. (ed). Temperature, its measurement and control in science and industry. Part 3. Biology and medicine. Reinhold, New York, 146-169

Davis, TRA. et al. 1971. Calcium absorption in elderly human subjects: Stimulation by artificial lighting including ultraviolet. Nature, 229(5282), 255-257

Dawson, WS. (undated). Is your light polluted? Cancer Control Journal Vol 3(6) and Vol 4(1), 27-30

Day, GH. 1955. The subjective effects of general irradiation. Brit J Phys Med, 18, 14-16

Daynes, RA. et al. 1977. Evidence for the generation of suppressor cells by ultraviolet radiation. Cellul Immunol, 31(1), 182-187

DeLuca, HF. 1976. Recent advances in our understanding of the vitamin D endocrine system. J Laboratory & Clin Med, 87(1), 7-26

Demina, DM. 1957. Bewertung der Wirksamheit von longwelliger Ultraviolettstrahlung im Vergleich zur Wirkung von Vitamin D_2 in der Prophylaxe der D-Vitamin Mangels. J Hyg Epidem Microbiol Immunol, (Praha), 1, 459-471

Dériberé, M. 1954. Irradiation du corps humain par les rayons infrarouges. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 408-409

Devjatka, DH. et al. 1977. Dependence of vitamin C content in animal tissues on the dose of UV radiation. Ukr Biokhim Zh, 49(4), 3-7

Dogniaux, R. 1954. Activité érythémale du rayonnement solarie en Belgique. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 286-292

Du Bois, EF. 1937. Mechanisms of heat loss and temperature regulation. Stanford University Publ Univ Ser M Sc, 3, 323 (Lane Medical Lectures)

Dubronravov, SN. & Fishelev, YR. 1964. On "dermal sight". (in Russian) Byulleten eksperimental'noy biologii i meditziny, 8, 13-16

Duggar, B. (ed). 1936. Biological effects of radiation. (2 volumes). MacGraw Hill, New York

Dunnigan, MG. et al. 1975. The relative roles of ultraviolet deprivation and diet in the aetiology of Asian rickets. Scottish Med J, 20, 217-218

Duplessis, Y. 1974. La vision parapsychologique des couleurs. EPI. Paris

Ebaugh, FG. & Thauer, R. 1950. Influence of various environmental temperatures on the cold and warmth thresholds. Journal of Applied Psychology, 3(4), 173-182

Eckholdt, K. 1961. Die optischen Eigenschaften der Menschlichen Haut im IR-Bereich. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress on photobiology. Elsevier Publishing Company, London, New York

Ehrenwald, H. 1932. Über eien photo-dermatischen Tonusreflex auf Bestrahlung mit farbigen Lichtern beim Menschen. Klinische Wochenschrift, 11, 2142-2143

Ehrenwald, H. 1933. Über den Strahlensinn des Menschen. Klinische Wochenschrift, 12, 1473

Ellinger, F. 1935. Die biologischen Grundlagen der Strahlenbehandlung. Urban & Schwarzenberg, Berlin

Ellinger, F. 1939. The influence of UV light on the body weight. Radiology, 32, 157-160

Ellinger, F. 1957. Medical Radiation Biology. Part III: Biology of ultraviolet radiation. Thomas C. Publishers, Springfield, Illinois

Emmersson, WE. 1974. Don't sit near the window. ASHRAE Transactions, June

Epel, BL. 1973. Inhibition of growth and respiration by visible and near-visible light. Photophysiology, 8, 209-229

Epstein, JH. 1965. Ultraviolet light in office practice. Post Graduate Med, 37, 170-174

Epstein, JH. 1966. Ultraviolet induced kinin formation in normal human skin, Clinical Research, 14, 266

Everett, MA., Olsen, RL. & Sayre, RM. 1965. Ultra violet erythema. Arch Dermat, 92(6), 713-719

Everett, MA., Yeargers, E., Sayre, RM. & Olsen, RL. 1966. Penetration of epidermis by ultraviolet rays. Photochem Photobiol, 5, 533-542

Fanger, PO. 1970. Thermal comfort. Danish Technical Press, Copenhagen

Fitzpatrick, TB., Pathak, MA., Harber, LC., Seiji, M. & Kukita, A. 1974. Sunlight and man. International conference on photosensitization and phoroprotection, University of Tokyo Press

Forck, G. 1969. Ultraviolet irradiation in dermatology (excluding heliotherapy). In: Urbach, F. (ed). 1969. The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York

Frain-Bell, W. 1977. Solar radiation: short and long term effects. Practitioner, 219(1310), 188-192

Frank, GM. 1950. Special features of the biological action of ultraviolet of various wavelengths. In: Ultraviolet radiation and hygiene (in Russian). Moscow, Izd AMN SSR, 7

Frank GM. (ed). 1975. A study of the biological effects of ultraviolet. Acad Sciences USSR, Scientific Council on Biological Problems of Physics, Nauka, Moscow

Freeman, RG. et al. 1962. Sunlight as a factor influencing the thickness of epidermis. J Invest Dermatol, 19, 295-298

Freeman, RG., Owens, DW., Knox, JM. & Hudson, HT. 1966. Relative energy requirements for an erythemal response of skin to monochromatic wave lengths of ultraviolet present in the solar spectrum. J Investg Dermatology, 47(6), 586-592

Freemon, FR. 1967. Vitamin D and skin pigments. Sicence, 158(3801)

French, CN. 1965. Tactile-vision. Thermal and texture cues in the discrimination of black and white. Nature, 208, 1352

Friedman, H. 1962. Solar radiation. Astronautics, August, 14

Fusaro, RM. 1969. Cutaneous light sensitivity due to fluorescent lights. Minnesota Med, February, 299-300

Fusara, RM., Runge, WJ., Lynch, FW. & Watson, CJ. 1966. Sunlight protection in normal skin. Arch Dermat, 93, 106-111

Gagge, AP., Hardy, JD. & Rapp, GM. 1965. Exploratory study of comfort for high temperature sources of radiant heat. ASHRAE Transactions, 91(2), 19-26

Gagge, AP., Rapp, GM. & Hardy, JD. 1967. The effective radiant field and operative temperature necessary for comfort with radiant heating, Transactions of the American Society of Heating, Refrigerating and Airconditioning Engineers, 73, Part I.1.2, 1-9

Gagge, AP., Stolwijk, JAJ. & Hardy, JH. 1967. Comfort and thermal sensations and associated physiological response at various ambient temperatures. Environmental Research, 1, 1-20

Gagge, AP., Stolwijk, JAJ. & Nishi, Y. 1969. The prediction of thermal comfort when thermal equilibrium is maintained by sweating. ASHRAE Transactions. Presented at the Semi-Annual Meeting of ASHRAE, July, Denver Colorado

Galanin, NF. 1952. Radiant energy and its healt significance (in Russian) Leningrad

Galanin, NF. 1958. The problem of compensation for the natural ultraviolet insufficiency in the north. (in Russian). In: Ultraviolet radiation, Medgiz, Moscow

Galanin, NF. & Pirkin, VM. 1971. The rational utilization of the sun's radiant energy with a view to preventing ultraviolet deficiency. (in Russian). In: Ultraviolet radiation, Medicina, Moscow, 209-212

Gans, O. & Schlossman, H. 1925. Über den Einfluss kurzwelliger (ultravioletter) Strahlen auf die Permeabilität der Haut (zugleich ein Beitrag zur Genese der Calciumverscheibung). Dermat Wchnschr, 80, 469-475

Garrett, A. 1973. Strobing light sources and UV radiation in kinetic art. Federation of British Artists Quarterly, 2(3), 23-24

Generalov, AA. 1967. Hygienic substantiation of the regimen of children by natural UV radiation in the southeastern sector of central Asia. Pediat, 46, 74-75

Generalov, AA. 1973. Regimen of prophylactic ultraviolet irradiation in taking sun. Gig i Sanit, 38, 105-106

Goldberg, IM. 1963. On whether tactile sensitivity can be improved by exercise. Soviet Psychology and Psychiatry, 2, 19-23

Goldfeld, AJ. & Kazbekova, EP. 1939. Collected works on the biological action of ultraviolet radiation (in Russian). Medgiz, Moscow

Gorkin, ZD. et al. 1938. The effect of ultraviolet irradiation upon the training for the 100 m. sprint. Fiziol Zh SSSR, 25, 695-701

Gorkin, ZD. & Al-Bitskaya, EF. 1966. The effect of ultraviolet irradiation on the functional status of the basic nervous processes of the human cerebral cortex. Gig i Sanit, 31, 17-20

Gorkin, ZD. et al. 1967. The current status and future perspectives of the use of ultraviolet rays in the prevention of light deficiency. Vestn Akad Med Nauk SSSR, 22, 58-62

Gorter, E. & Holland, L. 1934. On rickets. The Journal of Pediatrics, 4(1), 1-11

Green, AES. et al. 1974. A study of solar erythema radiation doses. Photochem & Photobiol, 20, 473-482

Griffith, W. & Veitch, R. 1971. Hot and crowded: Influence of population density and temperature on interpersonal affective behavior. Journal of Personality and Social Psychology, 17, 92-99

Griffiths, ID. & McIntyre, DA. 1971. Ceiling heating and comfort I. Electricity Council Research Centre, Report No 463, London

Griffiths, ID. & McIntyre, DA. 1974. Subjective responses to overhead thermal radiation. Human Factors, 16(3), 415-422

Grunner, O. 1966. Threshold of erythema skin reaction to UV irradiation in necroses. Activ Nerv Sup (Praha), 8, 219

Gusev, NM. & Dunaev, BA. 1971. The utilization of ultraviolet radiation in building. (in Russian). In: Ultraviolet radiation, Medicina Moscow, 218-221

Haddad, JG. & Hahn, TJ. 1973. Natural and synthetic sources of circulating 25-hydroxyvitamin D in man. Nature, 244, 515-516

Hanke, W. 1961. Die Bedeutung von Latenzzeiten für UV-Strahlen-bedingte Veränderungen am lebenden Gewebe. In: Christensen, BC. & Buchmann, C. (ed). Progress in photobiology. Proceedings of the third international congress on photobiology. Elsevier Publishing Company, London, New York

Hansen, KG. 1969. Transmission through skin of ultraviolet and visible radiation 280-500 nm. In: Urbach, F. (ed). The biologigal effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York

Harber, LC. 1976. Reflections and perspectives concerning cutaneous photobiology. Arch Dermatol, 112, 1668-1670

Hardy, JD. 1934. The radiation of heat from the human body. III. The human skin as a black-body radiator. Journal of Clinical Investigation, 13, 615-620

Hardy, JD. 1949. Heat Transfer. In: Newburgh, LH. (ed). Physiology of heat regulation, Sounders, Philadelphia, 78-108

Hardy, JD. 1970. Thermal comfort: Skin temperature and physiological thermoregulation. In: Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation, Thomas C. Publishers, Springfield, Illinois, 856-873

Hardy, JD., Hammel, HT. & Murgatroyd, D. 1956. Spectral transmittance and reflectance of excised human skin. Journal of Applied Physiology, 9, 257-264

Hardy, JD. & Muschenheim, C. 1934. The radiation of heat from the human body: IV. The emission, reflection and transmission of infra-red radiation by the human skin. Journal of Clinical Investigation, 13, 817-831

Hardy, JD. & Muschenheim, C. 1936. Radiation of heat from the human body: V. The transmission of infra-red radiation through the skin. Journal of Clinical Investigation, 15, 1-9

Hardy, JD. & Oppel, TW. 1937. Studies in temperature sensation. III. Sensitivity of the body to heat and the spatial summation of the end organ responses. Journal of Clinical Investigation, 16, 533-540

Hardy, JD., Wolff, HG. & Goodell, H. 1952. Pain sensations and reactions. Williams and Wilkins Company, Baltimore

Harrison, RG. et al. 1970. Influence of wavelength on biological effects - "radiation action sites" in the skin. Brit J Radiol, 43(511), 501-502

Hartung, J. 1969. Ultraviolet therapy at the North Sea coast. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, 657-661

Hausser, KW. & Vahle, W. 1922. The dependence of light induced erythema and pigment formation upon the frequency (or wavelength) of the inducing radiation. Strahlentherapie, 13, 41-71 (in German)

Hausser, KW. & Vahle, W. 1927. Sunburn and suntan. Wiss Veröffent. Siemens-Konzern, 6, 101 (in German)

Hendler, E. & Hardy, JD. 1960. Infra-red and microwave effects on skin heating and temperature sensation. Institute of Radio Engineers Transactions on Medical Electronics, (ME-7), 143-152

Hendler, E., Hardy, JD. & Murgatroyd, D. 1961. Skin heating and temperature sensation produced by infra-red and microwave irradiation. In: Herzfeld, CM. (ed). Temperature, its measurement and control in science and industry. Part 3. Biology and medicine, Reinhold, New York, 211-230

Hensel, H. 1970. Temperature receptors in the skin. In: Hardy, JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois, 442-453

Hess, AF. & Anderson, WT. 1927. The antirachitic activity of monochromatic and regional ultra-violet radiations. J Amer Med Assoc, 89, 1222-1225

Hill, L. & Eidenow, A. 1923. Biological action of light. I. The influence of temperature. Proc R Soc (Biol), 95, 163-180

Hodkinson, HM. et al. 1973. Sunlight, vitamin D. and osteomalacia in the elderly. Lancet, Apr, 28

Holmberg, M. 1978. Ultraviolet radiation. Statens Strålskyddsinstitut, Stockholm (in Swedish)

Honigsman, H. et al. 1974. Epidermal lysosomes and ultraviolet light. J Invest Dermatol, 63, 337-342

Horkay, I. et al. 1967. Effect of ultraviolet light on the epidermis. Acta Morph Akad Sci Hung, 15, 71-80

Huxley, HG. 1973. The effect of varying the hours of light on the incidence of dental caries in rats. New Zealand Dental Journal, 69, 212-213

Iakovlev, VI. 1967. Experience in the prophylactic use of low doses of ultraviolet irradiation in preschool children in Sverdlovsk. Pediatriia, 46, 26-28

Ishikawa, K. & Shimazu, T. 1976. Daily rhythms of clycogen synthetase and phosphory lace activities in rat liver: Influence of food and light. Life Sciences, 19, 1873-1878

Jackson, R. 1972. Solar and senile skin: changes caused by aging and habitual exposure to the sun. Geriatrics, 27(8), 106-112

Jacobson, SZ., Frost, BJ. & King, WL. 1966. A case of dermo-optical perception. Perceptual and Motor Skills, 22, 515-520

Jacques, JA., Kuppenheim, MF., Dimitroft, J., McKeechan, W. & Huss, J. 1955. Spectral reflectance of human skin in the region 235-700 nm. Journal of Applied Physiology, 8(4), 212-214

Jagger, J. 1967. Introduction to research in ultraviolet photobiology, Prentice Hall, Englewood Cliffs, NJ

Jansen, MT. 1954. Skin reflectometry as applied to irradiation experiments. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 252-256

Jausion, H. & Decaud, J. 1954. Infra-rouge et peau humaine. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 416-417

Johnson, BE. 1960. Potentiation of hair-growth by UV light. Nature, 187(4732), 159-160

Johnson, BE. 1968. Ultraviolet radiation and lysosomes in skin. Nature, 219, 1258-1259

Kaidbey, KH. et al. 1978. Sunburn protection by longwave ultraviolet radiation-induced pigmentation. Arch Dermatol, 114(1), 46-48

Kalla, AK. 1972. Parent-child relationship and sex differences in skin tanning potential in man. Humangenetik, 15, 39

Kameneckaja, TM. & Mitrofanova, GF. 1975. The condition of certain neurohumoral regulatory systems follwoing UV radiation at different wavelengths. In: The biological effects of UV radiation, Moscow, Nauka (in Russian)

Keatinge, WR. 1970. Direct effects of temperature on blood vessels: their role in cold vasodilation. In: Hardy. JD., Gagge, AP. & Stolwijk, JAJ. (eds). Physiological and behavioral temperature regulation. Charles C. Thomas Publisher, Springfield, Illinois, 231-236

Khovrin, AI. 1898. A rare form of hyperaesthesia of the higher sense organs. Voprosy nervnopsikhicheskoy meditsiny, Vol 3, Nos 2-4, Kiev (in Russian)

Kligman, AM. 1969. Early destructive effect of sunlight on human skin. JAMA 210(13), 2377-2380

Knepple, R. 1956. Die infrarote Strahlung der Atmosphäre als Ursache für das Zustandekommen des Schwülegefühls. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 404-408

Knox, JM. et al. 1967. Effects of ultraviolet light on skin cholesterol. J Invest Derm, 49, 632-636

Knudsen, EA., Christiansen, JV. & Brodthagen, H. 1961. Seasonal variations in light-sensitivity. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress of photobiology. Elsevier Publishing Company, London, New York

Knudson, A. 1932. Amount of ultraviolet radiation needed to cure rickets with respect to area of skin exposed. Am J Di Child, 44, 524

Knudson, A. & Benford, F. 1938. Quantitative studies of the effectiveness of ultraviolet radiation of various wave-lengths in rickets. J Biol Chem, 124, 287-299

Kobayashi, T. et al. 1977. Effect of wavelength on the photochemical reaction of ergo-calciferol (vitamin D_2) irradiated by monochromatic ultraviolet light. J Nutr Sci Vitaminol (Tokyo), 23(4), 281-290

Koeningsfeld, H. 1921. Stoffwechsel und Blutuntersuchungen bei Bestrahlung mit künstlicher Höhensonne, Z f Klin Med, 91, 159

Kolaleva, MP. 1973. Role of ultraviolet and solar radiations in the overall treatment of hypertension in its initial stages. Vopr Kurortol Fizioter Lech Fiz Kult, 38, 116-118

Krainik, R. 1954. Action des rayons ultra-violet sur le metabolism du cholestérol. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 394-395

Kricagin, VI. 1958. Standardization of ultraviolet radiation used for prophylactic purposes. In: Ultraviolet radiation, Moscow, Megiz, 208 (in Russian)

Krochmann, J. 1977. Physics of radiation in the field of optics and illuminating engineering; photobiological effects. Work report. Technische Universität Berlin, Institut für Lichttechnik, Berlin

Kuppenheim, HF. 1954. Spectral reflectance of the human skin in the ultraviolet, visible, and infrared range, and its interpretation. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 228-232

Langen, D. 1938. Experimentelle Studien über die Erythembildung der Sonnen und Himmelsstrahlung. Strahlentherapie, 63, 142-168

Langdon, M., Humphreys, A. & Nicol, JF. (eds). 1973. Thermal comfort and moderate heat stress. Building Research Establishment Report 2, Her Majesty's Stationary Office, London

Langkilde, G., Alexandersen, K., Wyon, DP. & Fanger, PO. 1973. Mental performance during slight cool or warm discomfort. Arch Sci Physiol, 27, 511-518

Latarjet, R. 1944. Le probleme du dosage du rayonnement ultraviolet en therapeutique et en biologie. Cahiers de Physique, 23, 22-27

Latarjet, R. 1948. Les rayonnement ultra violet des lampes fluorescentes d'eclairage et ses consequences biologiques. Revue d'Optique, 27(6), 333-338

Leach, WM. 1970. Biological aspects of ultraviolet radiation. Natl Tech Info Serv (USA), ## PB-194-611, September

Lehmann, G. 1961. Die Wirkung kurzdauernder intensiver UV-Bestrahlung. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress on photobiology. Elsevier Publishing Company, London, New York

Lehmann, G. et al. 1932. Der Einfluss der Ultraviolettbestrahlung auf den Arbeitsstoffwechsel und die Arbeitsfähigkeit des Menschens. Arbeitsphysiol, 5, 278-341

Lehmann, G. & Rajewski, B. 1956. Die Steigerung der Leistungsfähigkeit durch monochromatische Ultra-Violet-Bestrahlung. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 382-385

Lele, PP., Weddel, G. & Williams, CM. 1954. The relationship between heat transfer, skin temperature and cutaneous sensibility. Journal of Physiology, 126, 206-234

Leontyev, AN. 1959. Problems of mental development. Academy of Pedagogical Sciences, Moscow, 53-127 (in Russian)

Levin, RE. et al. 1977. Ultraviolet radiation - considerations in interior lighting design - Part 1. J Ill Eng Soc (USA), 6(2), 80-88

Lind, AR. 1960. The effect of heat on the industrial worker. Ann Occup Hyg, 2, 190

Lipkin, M. 1956. The effects of tissue damage caused by ultraviolet irradiation upon the cutaneous pain threshold. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 226-228

Little, MA. et al. 1971. Circardian variations in thermal and metabolic responses to heat exposure. Journal of Applied Physiology, 31, 556-561

Litwin, J. 1972. The effect of light on the aging of human diploid fibroblats. Exp Geront, 7, 381

Loomis, WF. 1967. Skin-pigment regulation of vitamin D biosynthesis in man. Science, 157, 501-506

Luckiesh, M. 1931. An erythemal basis for dual purpose lighting. Trans IES (USA), 26, 701-710

Luckiesh, M. 1946. Applications of germicidal erythemal and infra-red energy. Van Nostrand, New York

Luckiesh, M., Holladay, LL. & Taylor, AH. 1930. Reaction of untanned human skin to ultra violet radiation. J Opt Soc Am, 20(8), 423-432

Luckiesh, M., Holladay, LL. & Taylor, AH. 1939. Erythemal and tanning effectiveness of UV energy. Gen Electr Rev, 42, 274-278

Lutz, W. 1917. Zur Kenntnis der biologischen Wirkung der Strahlen auf die Haut, mit spezieller Berücksichtigung der Pigmentbildung. Arch f Dermat u Syph, 124, 233-286

Lynch, PJ. 1976. Sunlight and aging of the skin. Cutis, 18(3), 451-453

Löfstedt, B. 1966. Human heat tolerance. Dissertation at the University of Lund

Macpherson, RK. 1960. Physiological responses to hot environments. Med Res Council, Special Rep Ser No 298, London

Magnus, IA. 1961. Action spectra in human skin. In: Christensen, BC. & Buchmann, B. (eds). Progress in photobiology. Proceedings of the third international congress on photobiology, Elsevier Publishing Company, London, New York

Magnus, IA. 1976. Dermatological photobiology. Clinical and experimental aspects. Blackwell Scientific Publications

Marks, LE. & Stevens, JC. 1968. Perceived warmth and skin temperature as functions of the duration and level of thermal irradiation. Percept & Psychophys, 4, 220-228

Marsden, SB. 1968. Vitamin D, sunlight, and natural selection. Science, 159, 652

Maughan, GH. & Smiley, DF. 1929. Irradiations from a quartz mercury vapour lamp as a factor in the control of common colds. Am J Hyg, 9, 466

Mayron, LW., Ott, JN., Amontree, EJ. & Nations, R. 1975. Light, radiation, and dental caries. Incidence of dental caries in school children as a function of light quality and radiation shielding. Academic Therapy, 10(4), 441-448

McIntyre, DA. 1973. A guide to thermal comfort. Applied Ergonomics, 4(2), 66-72

McIntyre, DA. 1973. Thermal radiation from lighting installations. Building Services Engineer, 41, 12-16

McIntyre, DA. 1974. The thermal radiation field. Building Science, 9, 247-262

McIntyre, DA. 1976. Radiant heat from lights, and its effect on thermal comfort. Lighting Research and Technology, 8(3), 121-128

McIntyre, DA. & Griffiths, ID. 1972. Ceiling heating, and comfort II. Electricity Council Research Centre Report No 475, London

McIntyre, DA. & Griffiths, ID. 1975. The effect of uniform and asymmetric thermal radiation on comfort. Clima 2000. 6th International Congress of Climatistics, Milan

McNall, PE. & Biddison, RE. 1970. Thermal comfort sensations of sedentary persons exposed to asymmetric radiant fields. ASHRAE Transactions, 76, Pt 1, No 2134, 123-136

McNall, PE., Jaax, J., Rohles, FH., Nevins, RG. & Springer, WE. 1967. Thermal comfort (thermally neutral) conditions for three levels of activity. ASHRAE Transactions, Vol 73, Part 1

McNall, PE. & Schlegel, JC. 1968. The effect of asymmetric radiation on the thermal and comfort sensations of sedentary subjects. ASHRAE Transactions, 74

McNall, PE. & Schlegel, JC. 1968. The relative effects of convection and radiation heat transfer on thermal comfort (thermal neutrality) for sedentary and active human subjects. ASHRAE Transactions, 74, 131-143

Mechin, JA. et al. 1976. Action of melatonin on caries development in rats. J Dental Res, 55(3), 555

Mel'nik, TF. et al. 1976. Use of hardening ultraviolet irradiation to prevent some diseases in children. Pediat, 5, 78

Merlin, VS. (ed). 1967. Itogi i perspektivy sovetskoi psikhologii na Urale (Results and prospects of Soviet psychology in the Urals). Perm, USSR. Pedagogical Inst

Meshka, VA. et al. 1972. The effects of sunbaths at the Palanga health resort on the neuro-autonomic reactivity of the healthy organism. Vopr Kurortol Fizioter & Lech Fizicheskoy Kultury, 37, 112

Meyer, AEH. & Seitz, EO. 1949. Ultraviolet radiation. Walter de Gruyter & Co, Berlin (in German)

Miescher, G. 1957. The histology of photoreactions of the skin. Dermatol, 11(3), 345-357

Mills, LF., Lytle, CD., Andersen, FA., Hellman, KB. & Bockstahler, LH. 1975. A review of biological effects and potential risks associated with ultraviolet radiation as used in dentistry, DHEW Publication (FDA) 76-8021, 1-27

Milova, A. et al. 1970. The effect of ultraviolet radiation upon the visual organ of man. Albrecht v Grafes Arch Klin Exp Ophthal, 181, 25-30

Mo, T. et al. 1974. A climatology of solar erythema dose. Photochem & Photobiol, 20, 483-496

Muhlback, R. 1968. Artificial ultraviolet rays - their effect on the organism and their use in orthopedics. Beitr Orthop Trauma, 15, 444-452

Munch, W. 1970. Radiation exposure of humans in establishments with bright artificial lighting. Arch Klin Exper Dermatol, 237, 520-537

Munro, AF. & Chrenko, FA. 1949. The effect of radiation from the surroundings on subjective impressions of freshness. J Hygiene, 47, 288-296

Mutzhas, MF. 1978. Photobiologische Bewertung der kosmetischen UV-Bestrahlung. Ärztl Kosmetologie, 8, 363-376

Nash, CB. 1965. Dermal vision or ESP? Journal of Parapsychology, 29, 300-301

Nash, C. 1973. ESP and cutaneous perception. Journal of the Society for Psychical Research, 47(757), 207-208

Neer, RM. 1975. The evolutionary significance of vitamin D, skin pigment, and ultraviolet light. Amer J Phys Anthropol, 43(3), 409-416

Neer, RM. 1977. Environmental effects of serum 25-hydroxyvitamin D levels in healthy men. Science

Newberg, ND. 1963. "Sight" in the fingers. Priroda, May, Moscow (in Russian)

Newburgh, LJ. 1949. Physiology of heat regulation and the science of clothing. WB Saunders Company, Philadelphia

Nikolaeva, EN. 1967. Skin sensitivity to UV irradiation in persons working in the open air and indoors. Gig i Sanit, 32, 27-31

Novomeiskii, AS. (ed). 1966. Problems in the psychology of personality and cognition. Nizhnii Tagil, USSR: Sverdlovsk Pedagogical Inst (in Russian) 9 of the 27 papers are devoted to dermal vision)

Nyuberg, ND. 1964. Finger sight - the phenomenon of Roza Kuleshova. Proceedings of the Federation of American Societies for Experimental Biology, Translation Supplement, Vol 22, T701-T705

Ohkawara, A. et al. 1967. Ultraviolet light and glycogen formation in the human epidermis. Arch Dermatol, 95, 416-421

Ohkawara, A. et al. 1972. Glycogen metabolism following ultraviolet irradiation. J Invest Dermatol, 59, 264

Olson, RL., Sayre, RM. & Everett, MA. 1965. Effect of field size on ultraviolet minimal erythemal dose. J Invest Dermatol, 45, 516-519

Olson, RL., Sayre, RM. & Everett, MA. 1966. Effect of anatomic location and time on ultraviolet erythema. Arch Dermatol, 93(2), 211-215

Oppel, TW. & Hardy, JD. 1937. Studies in temperature sensation: I. A comparison of the sensations produced by infra-red and visible radiation. Journal of Clinical Investigation, 16, 517-524

Oppel, TW. & Hardy, JD. 1937. Studies in temperature sensation: II. The temperature changes responsible for the stimulation of the heat end organs. Journal of Clinical Investigation, 16, 525-531

Ott, JN. 1966. A revaluation of ultraviolet as a vital part of the total spectrum. Contacts, April

Ott, JN. 1968. A rational analysis of ultraviolet as a vital part of the light spectrum influencing photobiological responses. Optometric Weekly, September 5

Parfenov, AP. 1963. Sunlight deficiency in man. Gos izd med lit, Leningrad (in Russian)

Pathak, M., Riley, FC., Fitzpatrick, TB. & Curven, WL. 1962. Melanin formation in human skin indcuded by long-wave ultraviolet and visible light. Nature, 193, 148-150

Pathak, M., & Stratton, K. 1969. Effects of ultraviolet and visible radiation and the production of free radicals in skin. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York, 207-222

Pedersen, PE. 1980. Ultraviolet stråling fra belysningsanläg og dens virkninger. Statusrapport nr 1-5, Lysteknisk Laboratorium, Lyngby, Denmark

Petersen, WF. 1947. Man, weather, sun. Springfield, Illinois

Peterson, RW. 1974. Correlation of the spectral distribution of selected phototherapy light sources with erythemal action spectra. Opt Soc Amer, 1974 Spring Meeting Program, 537

Petropoulos, EA. et al. 1974. Biological effects of hight altitude as related to increased solar radiation, temperature fluctuations and reduced partial pressure of oxygen. Progress in Biometeorol, (1A), 646-662

Pick, HL. 1964. Perception in Soviet psychology. Psychological Bulletin, 62, 21-35

Pincussen, L. 1937. Effect of ultraviolet and visible rays on carbohydrate metabolism. Arch Phys Therapy, X-ray, Radium, 18, 750-755

Pitts, DG. 1974. The human ultraviolet action spectrum. Amer J Optom & Phsyiol Optics, 51, 946-960

Pitts, DG. et al. 1971. The effects of ultraviolet on the eye. Amer Indust Hyg Assoc J, 32, 235-246

Plathner, CH. & Taatz, H. 1959. Untersuchungen über die Kariesanfälligkeit bei syrischen Goldhamstern unter dem Einfluss von Höhensonne und Kohlenhydraten. Deutche Zahn-, Mund- und Kieferheilkunde, 30, 121-126

Poh-Fitzpatrick, MB. 1977. The biologic actions of solar radiation on skin with a note on sunscreens. J Dermatol Surg Oncol, 3(2), 199-204

Polyankova, AN. 1977. Effectiveness of UV-radiation on workers in a windowless textile factory. Gig i Sanit, Moscow, (1), 103-104

Post, PW. 1975. Introduction: the study of pigmentation. Amer J Phys Anthropol, 43(3), 383-386

Poulton, EC. & Kerslake, DM. 1965. Initial stimulating effects of warmth upon perceptual efficiency. Aerosp med, 36, 29-32

Poyton, HG. 1968. The effects of radiation on teeth. Oral Roentgenol, 26(5), 639-645

Poznanskaya, NB. 1938. Dermal sensitivity to visible and infrared radiation. Fiziologicheskiy zhurnal SSSR, 24 (4), 774-783

Prato, GP. et al. 1969. Ultraviolet rays in the prevention of dental caries. Revista di Clin Pediatr 82, 259-267

Pratt, JG. et al. 1940. Extrasensory perception after sixty years. Holt, New York

Provins, KA. 1966. Environmental heat, body temperature and behaviour. A hypothesis. Australian Journal of Psychology, 18, 118-129

Pugh, LGCE. & Chrenko, FA. 1966. The effective area of the human body with respect to direct solar radiation. Ergonomics, 9(1), 63

Quevedo, WC. et al. 1975. Role of light in human skin color variation. Amer J Phys Anthropol, 43(3), 393-408

Robertson, DF. 1972. Solar ultraviolet radiation in relation to human sunburn and skin cancer. Thesis, University of Queensland, Australia

Robertson, DF. 1975. Calculated sunburn responses. In: Impacts of climatic change on the biosphere. Springfield, Virginia, National Technical Information Service, Part 1, Chapter 2, Appendix J (CIAP Monograph 5)

Rohles, FH. 1971. Psychological aspects of thermal comfort. ASHRAE Transactions, January, 86-90

Rohles, FH. 1979. The effect of time of day and time of year on thermal comfort. In: Bensel, CK. (ed). Compass for Technology, Proceedings of the 23rd Annual Meeting of the Human Factors Society, Boston Massachusetts, Oct 29 - Nov 1, 129-132

Romains, J. 1919. Vision Extra-Rétinienne. Paris. Eyeless Vision Ogden CK. (Transl). 1924, Putnam, New York

Ronge, HE. 1951. Hygienic indications for the use of ultraviolet radiation in lighting practice. In: Halbertsma, NA. & Jansen, J. (eds). Commission Internationale de l'Eclairage. Volume II. Communications Individuelles. Bureau Central de la CIE, New York, Zp1-8

Rorsman, H. 1976. Normal response to sunlight. Läkartidningen, 73(44), 3782-3783

Rosin, YA. & Frank, GM. 1966. Physiological effect of ultraviolet radiation. Ultra fioletovoye Izlucheniye, Moscow, 120-130

Rotter, M. 1978. Clinical hygiene and ultraviolet radiation. Deut Med Wochen, 103(16), 684

Rottier, PB. 1953. The erythematogenous action of ultraviolet light on human skin. I. Some measurements of the spectral response with continuous and intermittent light. J Clin Invest, 32, 681-689

Rottier, PB. 1954. Ultraviolet radiation and skin: Some facts and some problems. In: Proceedings of the first international photobiological congress. Veenman & Zonen, Wageningen, 192-204

Rottier, PB. 1961. The vascular reaction of human skin to irradiation with long wave ultraviolet (366mμ) and visible light (405 and 436 mμ). In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress in photobiology. Elsevier Publishing Company, London, New York, 329-330

Rottier, PB. 1961. The normal sensitivity of human skin to 250 and 300 mμ ultraviolet radiation and its dependence on the thickness of the str. corneum. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress in photobiology. Elsevier Publishing Company, London, New York, 331-332

Rottier, PB. 1969. The ratio of the 260/300 NM med's in the judgement of skin sensitivity to short wave ultraviolet radiation. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press. London, New York, 187-195

Rottier, PB. 1970. What is Rottier 250 nm UV erythema theory? Arch Klin & Exper Dermatol, 239(2), 148-149

Rottier, PB., & van der Leun, JC. 1966. Hyperanemia of the deeper cutaneous vessels after irradiation of human skin with large doses of ultraviolet and visible light. British Journal of Dermatology, 72, 256-260

Ruff, HR. 1972. The erythemal basis of the photobiological effects of lighting on man. LUTERG Report 61/3, Loughborough Univ Technology

Ruff, HR. 1972. Artificial sunlighting for leisure and recreation. Lighting Research and Technology, 4(1), 9-17

Ruff, HR. & Jones, GM. 1972. Erythema dose: Irradiance/time reciprocity law. LUTERG Report 85/4, Loughborough Univ Technology

Ruperts, CS. 1964. Photoreactivation of ultraviolet damage. In: Giese, AC. (ed). Photophysiology. Volume II. Academic Press, New York, London, 283-328

Rusznyak, L. 1968. Biological effects of UV radiation generated with the living organism. Experienta, 24, 863-864

Satoh, Y. 1973. Biological response of human skin to ultraviolet rays. J Ill Eng Soc Japan, 57(4), 222-228

Sayre, RM., Olson, RL. & Everett, MA. 1966. Quantitative studies on erythema. J Invest Dermat, 46, 240-244

Schmieger, H. 1974. Biologic effects of solar radiation on man. Effects on the skin. Progress in Biometeorology, 1(1A), 378-380

Scholander, PF., Irving, L., Hemmingsen, EA. & Bradstreet, E. 1969. Ultraviolet absorption in the cornea of arctic and alpine animals. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York, 469-471

Schröder, G. & Steck, B. 1973. The subjective evaluation of the total radiation intensity of fluorescent lighting installations (in German). Lichttechnik, 25(1), 17-21

Scotto, J. et al. 1976. Ultraviolet exposure patterns. Environmental Research, 12(2), 228-237

Seidl, E. 1956. Ultraviolett Bestrahlung und Muskeltraining. Strahlentherapie, 101, 630-633

Seidl, E. 1961. Unsere Untersuchungen über die Wirkungsweise des ultravioletten Lichtes beim gesunden Erwachsenen. UV-Bestrahlung und Vitamin C-Spiegel. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress of photobiology, Elsevier Publishing Company, London, New York, 345-349

Seidl, E. 1969. The influence of ultraviolet radiation on the healthy adult. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York, 447-458

Seidl, E. 1969. "Blitzgerät" therapy. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York, 663-672

Seiji, M. et al. 1966. Enzyme inactivation by ultraviolet irradiation and protective effect of melanin in vitro. J Invest Dermatol, 47, 507-511

Seyderhelm, R. 1934. Über einen durch ultraviolette Bestrahlung aktivierbaren, antianaemisch wirkenden Stoff im Blute, Klin Wschr, 11, 628

Shannon, IL., Thornby, JI., Madsen, KO. & Edmonds, EJ. 1975. Failure of environmental lighting to influence dental caries rate. Proceedings of the Society for Experimental Biology and Medicine, 149, 626-627

Sharova, MA. 1974. New hygienic criteria for evaluating the natural lighting of the classrooms of school buildings. Gig i Sanit, 2, 27-30

Sharova, MA. 1977. Hygienic basis for the time of using natural lighting in children's preschool institutions and general education schools in the various light-climate regions of the USSR. Gig i Sanit, 9, 23-31

Shemyakin, AN. (ed). 1967. Voprosy psikhologii (Problems of psychology) Sverdlovsk, USSR, Ural State University (In the section on "sensation and perception" the summaries of 4 papers on the dermo-optic sense are included)

Shlegel, JC. & McNall, PE. 1968. The effect of asymmetric radiation on the thermal and comfort sensations of sedentary subjects. ASHRAE Transaction,s 74(2)

Shtymov, ST. (ed). 1965. Materialy issledovaniya Kozhno-opticheskoi chuvstvitel'nosti (Research materials on dermo-optic sensitivity) Chelyabinsk, USSR, State Pedagogical Inst (Presents 4 papers on dermo-optic sensitivity)

Sliney, DH. 1972. The merits of an envelope action spectrum for ultraviolet radiation exposure cirteria. Amer Indust Hyg Assoc J, 644-653

Sliney, DH. & Wolbarsht, M. 1980. Safety with lasers and other optical sources. Plenum Press, New York, London

Snyakin, PG. 1964. Development of interconnection of optic and dermal light perception in man. (in Russian). Byulleten eksperimental'noy biologii i meditziny, 8, 16-21

Solokov, MV. 1968. Spherical and space quantitites for evaluating the biological action of optical irradiation. Studia Biophys (Berlin), 9, 105-112

Spode, E. 1954. Wirkung optischer Strahlung auf das Blutbild. In: Proceedings of the first international photobiological congress. Veenman & Zonen, Wageningen, 388-391

Sprague, CH. & McNall, PE. 1970. The effects of fluctuating temperature and relative humidity on the thermal sensation (thermal comfort) of sedentary subjects. ASHRAE Transactions, 2136, 146-156

Steck, B. 1972. Die Einwirkung der optischen Strahlung (Licht, UV und IR) auf den Organismus des Menschen. Abhandlungen der Osram-Gesellschaft 11, 416-428

Steck, B.1975. Über photobiologische und psycho-physische Gesichtspunkte für Beleuchtungsanlagen und Solarien. Doctoral dissertation, Technische Universität, Berlin

Steinberg, DD. 1966. Light sensed through receptors in the skin. American Journal of Psychology, 79, 324-328

Steven, DM. 1963. The dermal light sense. Biol Rev, 38, 204-240

Stevens, JC. & Marks, LE. 1967. Apparent warmth as a function of thermal irradiation, Percept & Psychophys, 2, 613-619

Stolwijk, JAJ. & Hardy, JD. 1965. Skin and subcutaneous temperature changes during exposure to intense thermal radiation, Journal of Applied Physiology, 20, 1006-1013

Stone, PT., Harker, SDP., Coley, WZ., Ruff, HR. & Jones, G. 1974. The skin response to different physical qualities of ultraviolet light radiation. In: Stone et al. Human reaction to high intensity lighting. LUTERG Report No 156, Department of Human Sciences, Loughborough, Section 4, 137-182

Sysin, AN. et al. 1966. Physiological assessment of artificial illumination of different spectral composition. Vest Akad Med Nauk, SSSR, 21- 41-46

Szabo, E. & Horkay, I. 1967. Effects of ultraviolet light on the epidermis. Acta Morphologica Acad Sci Hung, 15(1), 71-80

Talanova, IK. 1967. Irradiation of children in a photaria with erythema lamps. Vop Kurort Fizioter, 32, 339-343

Talanova, IK. & Zabalueva, AP. 1972. Evaluation of the extent to which children are provided with UV radiation in the middle and northern latitudes. In: Questions of experimental and clinical spa treatment and physiotherapy, 20, 323-329 (in Russian)

Teichner, WH. 1967. The subjective response to the thermal environment. Human Factors, 9(5), 497-510

Thorington, L. (ed). 1976. Study Group E. Non sensory effects of optical radiation. In: Commission Internationale de l'Eclairage. Compte Rendu 18e Session, Londres 1975, Bureau Central de la CIE, Paris, 784

Timashev, SA. 1966. Application of indirect ultraviolet irradiation. Svetotek, 12(5), 18-19

Timbal, J. et al. 1975. Circadian variations in the sweating mechanism. Journal of Applied Physiology, 39(2), 226-230

Toda, K. et al. 1972. Alteration of racial differences in melanosome distribution in human epidermis after exposure to ultraviolet light. Nature, 236, 143

Tredici, TJ. 1969. The effects of ultraviolet radiation on the eye. US Air Force School of Aerospace Med, Areospace Med Div (AFSC), SAM-TR-69-10

Tronnier, H. 1969. Evaluation and measurement of ultraviolet erythema. In: Urbach, F. (ed). The biological effects of ultraviolet radiation (with emphasis on the skin). Pergamon Press, London, New York

Tronnier, H. et al. 1968. Practical dermatologic viewpoints on light protection and depigmentation. Aesther Med (Berlin), 17, 221-228

Underwood, CR, & Ward, EJ. 1961. The radiation area of the erect human body with respect to the sun. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress on photobiology. Elsevier Publishing Company, London, New York, 353-356

Urbach, F. et al. 1968. The action spectrum of UV induced erythema. J Invest Dermatol. 50, 355

Urbach, F. et al. 1976. Cutaneous photobiology: Past, present and future. J Invest Dermatol, 67(1), 209-224

van Dam, G. 1954. Medical section. Final report. In: Proceedings of the first international photobiological congress, Veeman & Zonen, Wageningen, 434-436

van der Leun, JC. 1961. Lowering of the temperature of human skin after irradiation with ultraviolet. In: Christensen, BC. & Buchmann, C. (eds). Progess in photobiology. Proceedings of the third international congress of photobiology, Elsevier Publishing Company, London, New York

van der Leun, JC. 1964. (a) Delayed pigmentation and UV erythema. (b) Lowering of the temperature of human skin after irradiation by UV. In: Bowen, EJ. (ed). Physiology and biochemistry of the skin after irradiation by UV

van der Leun, JC. 1965. Theory of ultraviolet erythema. Photochem & Photobiol, 4, 453-458

van der Leun, JC. 1965. Delayed pigmentation and ultraviolet erytmea. Photochem & Photobiol, 4, 459-464

van der Leun, JC. (undated). On the action spectrum of ultraviolet erythema. Res Progress in Org Biol & Med Chem, 3, 711-736

Vissian, L. et al. 1974. Sun and the skin. Nouvelle Presse Med, 3, 1760-1769

Volkova, NV. 1967. Experience in the use of erythemic ultraviolet radiation in the general lighting system of a machine shop. (in Russian) Gig i Sanit, 32, 109-111

von Kolnitz, H. 1940. Blood and blood pressure changes following carbon arc irradiation. II. The correlation between blood histamine and blood pressure. American Journal of Physiology, 126, 399-400

von Reis, G. & Sjöstrand, F. 1938. Über die Einwirkung von Hautreizungen mit Senföl und ultravioletter Bestrahlung auf die periphere Blutvertailung. Skandinav Arch f Physiol, 79, 139-155

Vorobjeva, IA. 1961. About certain pecularities of biological action of UV rays with different wave length. In: Christensen, BC. & Buchmann, C. (eds). Progress of photobiology. Proceedings of the third international congress of photobiology. Elsevier Publishing Company, London, New York, 172-173

Warinn, AP. 1978. The ultraviolet erythemas in man. British Journal of Dermatology, 98(4), 473-476

Weale, RA. 1973. UV light and the human eye. Federation of British Artists Quarterly, 2(1), 18-19

Weddell, G. & Miller, S. 1962. Cutaneous sensibility. Annual Review of Physiology, 24, 199-222

Willis, I. 1971. Sunlight and the skin. J Amer Med Assoc, 217(8), 1088-1093

Willis, IS. et al. 1972. Effects of long ultraviolet rays on human skin: Photoprotective or photoaugmentative? J Invet Dermatol, 59, 416-420

Willis, I. et al. 1977. UVA erythema in skin: Is it a sunburn? J Invest Dermatol, 68(3), 128-129

Wyon, DP. 1974. The effects of moderate heat stress on typewriting performance. Ergonomics, 17(3), 309-318

Wyon, DP., Andersen, I. & Lundqvist, GR. 1972. Spontaneous magnitude estimation of thermal discomfort during changes in the ambient temperature. J Hyg (London), 70, 203-221

Wyon, DP., Andersen, I. & Lundqvist, GR. 1979. The effects of moderate heat stress on mental performance. Scan J Work Environment & Health, 5, 352-361

Yamaji, R. 1973. The effect of the ultraviolet ray on the eye. J Illum Eng Instit Japan, 57, 218-221

Ying, CY. et al. 1974. Additive erythemogenic effects of middle (280-320nm) and long (320-400 nm) wave ultraviolet light. J Invest Dermatol, 63, 273-278

Yoshiki, S. et al. 1974. The role of vitamin D in the mineralization of dentin in rats made rachitic by a diet low in calcium and deficient in vitamin D. Calcified Tissue Research, 15(4), 295-302

Youtz, RP. 1963. Aphotic digital color sensitivity. Paper read at Psychonomic Society, Bryn Mawr, Pa

Youtz, RP. 1964. Aphotic digital color sensing: A progress report. Paper read at meeting of Eastern Psychological Association, Philadelphia, Pa

Youtz, RP. 1964. The case for skin sensitivity to color, with a testable explanatory hypothesis. Paper read at Psychonomic Society, Niagara Falls, NY

Youtz, RP. 1965. Letter to the editor. Scientific American, 212, 8-9

Youtz, RP. 1966. Dermo-optical perception. Sience, 152, 1108

Youtz, RP. 1966. Tactile color sensing under three intensities of illumination. Paper read at Eastern Psychological Association, New York City

Youtz, RP. 1967. Can fingers see color? Psychology today. 1, 37-41

Zabludovskaya, ED. 1959. Features of the development of UV erythema in young children. Pediatr, 37, 43-46

Zamirova (ed). 1965. Problems of dermo-optic sensitivity, Sverdlovsk, USSR, State Pedagogical Inst (A collection of 7 papers, in Russian)

Zelickson, AS. et al. 1970. The effect of sunlight on human epidermis. A quantitative electron microscopic study of dendritic cells. Arch Dermatol, 101, 312-315

Zilov, JUD. 1971. The prophylactic irradiation of children and adolescents living in different climatic zones in the Soviet Union. In: Ultraviolet radiation, Moscow, Medicina, 237-241 (in Russian)

Zotterman, Y. 1959. Thermal sensations. In. Field, J., Magoun, HW. & Hall, VE. (eds). Handbook of physiology: Neuro-physiology. Vol 1. American Physiological Society, Washington DC, 431-458

Zubin, J. 1965. Dermooptical perception: A cautionary report. Science, 147, 985

Anonymous. 1951. Committe on ultraviolet radiation. Secretariat report (Netherlands' Committee). In: Halbertsma, NA. & Jansen, J. (eds). Commission Internationale de l'Eclairage, Volume I. Rapports des Comités Secrétariats, Bureau Central de la CIE, New York, 41.1-12

———— 1959. Ultraviolet radiation and its hygienic significance. Collected Papers. Leningrad

———— 1964. State Standards. Recommendations for the prevention of ultraviolet deficiency, Moscow, Nauka (in Russian)

———— 1967. Effect and use of ultraviolet radiation - USSR. US Dept Commerce. Joint Publications Research Service, 41, 315

———— 1967. Effects of solar radiation on mean facial skin temperature. Aerospace Med, 38, 161-163

———— 1970. Full spectrum lamps mean fewer cavities. Electrical Worlds, 173, 60

———— 1973. Ultraviolet radiation and the work environment. US Dept Health, Ed & Welf Natl Institut Occupat Safety & Health

SECTION 2

PHYSIOLOGICAL EFFECTS OF DAYLIGHT AND ARTIFICIAL ILLUMINATION ENTERING THE EYE

The pineal/hypothalamus system

Life on earth evolved under the influence of solar radiation with its characteristic spectral composition and the typical variations in intensity depending on the rotation of our planet. Certainly this influence was modified by a number of ecological factors like the atmosphere, the green forest, the sea, but still solar radiation played the dominant role. The most conspicuous relationship between daylight and man is the diurnal rhythm, relating the light and dark cycle of day and night to complex physiological and biochemical variations of wakefulness and sleep. Most mammals, including man, are active during the day, moving about, collecting food and avoiding predators, thus being highly dependent on daylight. During the dark hours of the night when the animals are standing close together in shelter or reclining in well isolated hideouts body temperature and metabolism generally go down. Other mammals, however, are nocturnal which means their peak of activity is not during day but during night.

The timing of diurnal and nocturnal rhythms and the functional variations related to them depends on internal processes usually referred to as the biological clock. Such a clock would not be very useful if it did not keep time with sunrise and sunset, and in order to do this there must be some kind of synchronizer. It seems that the synthesis of melatonin in the pineal gland holds a central position in mediating the effects of occular light. Wurtman and his associates have put forth the so called melatonin-theory of pineal function, which holds that the pineal body acts as a neuro-endocrine transducer converting a neural input to hormonal output. The rate of melatonin synthesis is thought to be controlled by environmental illumination. Recently they have discovered a pronounced daily rhythm in the rate at which humans excrete melatonin. Results from subsequent studies have implicated melatonin in the functional activities of numerous organs including the brain, pituitary, thyroid, adrenal and smooth muscles (77, 84, 129, 131, 133, 140, 141, 152, 176, 177).

Interestingly enough, there is also some evidence relating melatonin to psychiatric disorders. Wetterberg, in 1978, found that patients with schizophrenia and mental depression exhibited certain disturbances in their melatonin metabolism (170). However, a note of caution might be needed here. It is not clear

to what extent the light-dark cycle actually generates different biological variations or merely serves as a synchronizer of inbuilt biological clocks. Furthermore, in humans, psycho-social factors are probably of equal importance as the light-dark cycle in generating or synchronizing biological rhythms (62).

Another group of studies deal with seasonal variations like annual rhythms in sexual activity, and in animals' hibernation and migratory behavior. Wurtman mentions, for example, that sheep ovulate and can be fertilized only in the fall, thus anticipating the spring by many months, when food will be available to the mother for nursing the newborn (174). This is an example of the kind of secondary effects the pineal causes, in this case, the regulation of the estrous cycle. The effect on the human ovary has also been studied and there might be stimulating or inhibiting effects on the ovarian activity in women. This might account for the fact that blindness in human females is associated with an age of menarche which is earlier than normal (128, 151, 161, 171, 175, 179).

Even if the evidence in favour of daylight as a synchronizer is substantial we do not know exactly what the characteristics of light are that control the process of ovulation. Is it the total amount of light that is decisive, or the spectral composition which differs slightly between summer and winter, or perhaps the variations occuring in the length of the day? For each one of these alternatives there seems to be some support. There is little doubt the excretion of melatonin by the pineal is a mediator also where long term variations are concerned. In experimental animals melatonin induces sleep, inhibits ovulation and modifies the secretion of other hormones. There might however be alternative factors at work and we must not hasten to explain all recurrent events solely in terms of daylight variations. Actually, seasonal rhythms associated with changes in daylight have not yet been unequivocally demonstrated in human physiology. They are, however, so well known in other animals that to quote Wurtman: "It would be surprising if they were absent in man" (174).

The amount and quality of light entering the eye will influence food and water consumption, body temperature, hormone secretion, ovulation and a variety of other basic functions of the human organism. Results obtained by Hollwich and co-workers might illustrate this. In comparative studies on blind and temporarily blind persons due to a cataract in both eyes, these authors found significantly lower levels of ACTH and cortisol. The levels normalized after cataract extraction. According to Hollwich, 1979, these and similar effects of light might be accounted for in terms of the energetic portion of the visual pathway. "Light stimuli entering the eye induce biological functions in the animal and human organism. For this purpose they use separate pathways independent of the visual process. Thus, as a working hypothesis, it seemed practical to distinguish an energetic portion of the visual pathway in contrast to the optic portion. This energetic portion represents the link between retina and hypothalamus". (97, 98, 99, 100, 102, 103, 140, 141, 149, 159, 172)

Mayron and co-workers, in 1974, were able to demonstrate that illumination simulating daylight decreased the hyperactive behaviour of students as compared to standard cool white fluorescent lighting (127). Others have focused on the influence of daylight versus artificial light, or incandescent versus fluorescent lamps. Hollwich and co-workers state: "Increasing the intensity of artificial light with fluorescent tubes leads to 'light stress' proved by increased hormone production - especially the stress hormone cortisol. The belief that artificial light is the same as natural light and that it can fully replace it, is inappropriate in the medical view and needs correction" (100).

There seems to have been a great interest amongst researchers for comparing "red and green surroundings". Effects of various kinds have been found like an influence on EEG and galvanic skin response, on time estimation and reaction time, on posture, and many more. This has lead some authors to suggest the use of background colour to increase performance, but also for developmental and therapeutic purposes. During 1980, for instance, articles appeared referring to "the tranquilizing effect of pink" (144). Many of the studies are badly controlled. Sometimes physical radiation is confused with subjectively experienced colour or light. Still, there remains an impressive amount of significant evidence showing that the illumination and colour of architectural space have a profound influence on the physiology and behaviour of man. Some of the results might be related to the flickering nature of fluorescent illumination. A discussion of this hypothesis will be found below (61, 65, 66, 74, 76, 79, 88, 100, 103, 104, 108, 109, 110, 111, 116, 120, 126, 127, 135, 137, 139, 144, 146, 148, 152, 156, 158, 162, 163, 236).

One plausible mechanism for the differential effects of various wavelengths has been proposed by Wurtman, 1975. He writes: "We found that green light is the most potent in changing the phase of the temperature cycle and that ultraviolet and red wavelengths are the least potent. The action spectrum plotted from these results closely follows the absorption spectrum for rhodopsin, the photosensitive pigment in the rods of the retina. In separate studies a similar action spectrum, peaking in the green, was found for the wavelengths of light that are most effective in inhibiting the function of the pineal gland of rats" (73, 77, 174).

We may safely conclude that daylight entering the eye controls or affects many of the highly complex endocrine and autonomic processes taking place in the human body. The isolation of melatonin and its use in experimental research has provided considerable support for the now widely accepted melatonin-theory of pineal function. It is beyond doubt that the hypothalamus is playing a major part in mediating the effects of light on man mentioned so far.

An account of early work in the field can be found in an article by Hollwich, 1955, entitled Auge und Zwischenhirn. For a more recent account the reader is referred to the following general

overviews: Giese 1964 (86), Goromozov 1968, Wurtman 1975 in Annual Review of Psychology (173), Tibbs 1979 (166), and Hollwich 1979 (97). A popular account is given by Wurtman, 1975, in Scientific American (174). Studies focusing on the pineal gland are summarized by Minneman and Wurtman 1975 (131). Also refer to the extensive and up-to-date list of references compiled by Thorington et al, 1978 (165), and the photochemical and photobiological reviews edited by Smith from 1976 and onwards.

The ascending reticular activation system, ARAS

It was in 1949 that Moruzzi and Magoun published physiological observations that would prove to be of importance to the understanding of man's general reactions to stimulation (134). They found that every impulse, which via afferent nerves reached the central nervous system's higher centres, first activated part of the brain stem, the reticular formation, which in turn activated the entire nervous system. In addition to activation there might also be inhibition; together these will determine the arousal level of the nervous system including cortex. The functional unit identified by Moruzzi and Magoun is known today as the ascending reticular activation system, ARAS.

Since then numerous investigators have studied the effect of visual stimulation upon the ARAS. This if often done by means of the reaction of the electroencephalogram called alfa-attenuation, which is known to be one of the best indicators of cortical activation. Examples of other types of measurement are reaction time, muscle strength, galvanic skin response, and subjective estimation. Several studies contrasting light dominated by short and long wavelengths respectively, or blue/green versus red surroundings, have been carried out. In the classic paper from 1942, Goldstein published his observations concerning the influence of colours on the function of the organism. Based on the study of patients suffering from Parkinson's disease, Goldstein stated that red colours tend to worsen the patients' pathological conditions, while green colours on the other hand seem to improve them. Goldstein also pointed out certain normal effects of colours on motor behaviour (88).

Attempts at replicating Goldstein's findings have been partly successful (135). Nourse and Welch, in 1971, exposed subjects to 'violet' and 'green' light for 60-second intervals, assessing arousal by means of the galvanic skin response technique. Arousal was greater to violet than to green (137). Using the same technique while their subjects were looking at coloured patches, Jacobs and Hustmyer, in 1974, could demonstrate that red was more arousing than green and green more arousing than blue or yellow (104). Employing EEG-analysis, Ali, in 1972, found that the cortical habituation response became more delayed when the subjects were made to look into a 'red' light than into a 'blue' light (61). Also this result may be interpreted in terms of greater arousal following the stimulation with 'red'. Taken together the results seem to show that light or colours richer in long wavelengths are more arousing than those of short wavelengths. However, inconsistent results are not altogether lacking (61, 69, 74, 83, 88, 103, 104, 108, 111, 126, 135, 137, 144, 146, 148, 156, 158, 162, 163, 188, 236).

Other factors bound to influence the ARAS are the intensity of light and glare caused by the light-source. Stone et al, 1974, found an increase in pulse rate which occured as soon as the high intensity lighting was switched on and remained for the whole period. They also found an increased sense of fatigue as well as a decrease in feelings of social affection and thermal comfort. As the authors themselves point out, the problem of most laboratory studies on high intensity lighting is the disturbing fact that the intensity of natural daylight is even higher. Thus it can hardly be the high level per se that gives rise to the negative effects, or to put it in the words of these authors: "The results might indicate that glarefree high intensity lighting is unlikely to evoke stress responses, but when the lighting has a discomfort factor added ..... then possible stress mechanisms will come into operation" (100, 101, 105, 110, 122, 124, 126, 148, 159, 172, 268).

In other studies the focus of interest has been the relationship between illumination on one hand and learning or performance on the other. Ramage, in 1976, was able to demonstrate a small but consistent improvement in the performance of routine tasks under the influence of a scanning light source which swept over a work area with sharply focused bands of light. (76, 114, 116, 146, 150, 160, 180). Naturally this kind of experimental result must never be directly applied in practice. Sometimes, the increase in performance may be a sign of a true improvement of the environment while, at other times, it may occur at the cost of discomfort and physiological stress.

By its nature, arousal can be divided into a phasic and a tonic component. The phasic component is the immediate response to stimulation, while the tonic component is the arousal level averaged over a prolonged period of time. Depending on the occurance of phasic reactions, tonic arousal level will gradually be altered either upwards or downwards. Through participation of the reticular system the arousal level is normally maintained and attuned to the task at hand. But it might also malfunction, as has been demonstrated in experiments on sensory deprivation and in stress research.

In the 1950's, a group of researchers in Montreal began to study sensory deprivation, and their lead was soon followed by others. By means of elaborate arrangements like enveloping a person in wadding and covering his eyes and ears or placing him in a dark, soundproof room, the experimenters were able to register very marked changes. After a period of sleep or boredom isolated persons generally show symptoms of excessive emotional response. They become irritated, have difficulty in thinking clearly, and lose their power of concentration. They become increasingly susceptible to propaganda, they suffer reduced precision in locomotion and dexterity, disturbed colour vision, show alterations of brain wave frequency, odd sensations of their bodies and in certain cases hallucinations.

One of the normal procedures in most of these studies is to keep the subject in darkness (sensory deprivation) or to rob him of the structure and meaning usually signifying the visual field (perceptual deprivation). In addition to this he is usually deprived of other kinds of stimulation as well: auditive and tactile cues being reduced to a minimum. In a few cases the effects have been directly tied to the illuminous situation, like the study by Davis, 1959, who found a reduction of somatic activity during deprivation of light and sound, or the study by Stern, 1964, on the effects on gastrointestinal motility caused by variations in visual and auditory stimulation (80, 85, 122, 153, 155, 157)

In addition to light and colour, visual patterns will have an influence on the ARAS. Visual patterns standing out against the background not only serve to attract the attention but may also cause a considerable change in arousal level. A number of studies have been carried out in order to assess the arousing quality of visual patterns employing factors like size, shape, brightness, hue, contrast, complexity, novelty and information content. Berlyne and McDonnell, for instance, found that more complex or incongruous visual patterns evoke longer alpha-attenuation of the EEG. This may be interpreted in terms of an increase in phasic arousal level (63, 68, 77, 119, 185, 224).

Küller, in 1976, demonstrated that the colour and pattern of the visual environment not only had a profoud effect on the EEG but also on pulse rate and on the subjective emotional feelings experienced by the subjects (111). This may be taken as a corroboration of the fact that the ARAS affects not only cortex but the entire autonomic nervous system. Also Matulionis, in 1978, was able to show that certain changes in the visual surroundings significantly modify human physiology. Heart and respiration rate as well as muscle characteristics of visual motor tasks were affected by the visual environments employed in his study (126).

Of special interest are a few recent studies relating illumination level to various aspects of social behavior. Sanders et al, in 1974, varied the level of illumination in a natural setting and measured the amount of noise produced by groups of people gathering in the area. There was a significant reduction in noise level under the low-illumination conditions. A study by Page and Moss, 1976, indicates there might be a relationship between illumination level and aggressive behaviour. (82, 87, 143, 154)

Whereas many kinds of variation in light and the visual field will have an effect on the ARAS it is important to realize that light is only part of the total stimulation constantly impinging upon man. The ARAS might be regarded as a clearing station for all kinds of stimulation ranging from sensory deprivation on one extreme to sensory overload on the other. Therefore, light must always be considered together with the other sources of stimulation at hand. Actually, a certain light, a certain sound, or a certain smell, may hold exactly the same arousing potential. There may also be an interaction between the different senses,

often referred to as intermodal facilitation or competition. For instance, Thomas, in 1941, presented his subjects with a sound located between a steady light and a light flickering with the same rhythm as the sound. A lateralization effect was found such that the subjects were inclined to localize the sound in the direction of the flickering light source (164). Gregg and Brogden, in 1952, found that a change in illumination level might have an influence on the auditory threshold (90). Taken together the results indicate that the requirements on illumination must be determined not only by the task at hand but by the total situation including factors like temperature and noise (26, 27, 50, 64, 69, 78, 81, 91, 92, 105, 106, 117, 121, 125, 231, 236).

A few studies have been carried out where the response of the nervous system under different lighting conditions is related to the subject's personality. Examples of this type of research are the study by Hocking and Robertson, 1969, using verbal scales of sensation-seeking as a predictor of need for stimulation, and the study by Markle, 1976, relating the physical characteristic of eye colour to responses of physiological arousal (96, 123, 145, 180).

In order to understand the function of the ARAS we might think of light as a complex set of signals. In nature light signals are employed in various ways. Daylight is used by animals and birds as a means of getting information about the major directions of north and south, east and west, up and down. In the thick forest a shade or a highlight might mean a route of escape, while a red glare might mean the danger of forest fire. Fishes and birds, who have well developed colour vision, including cones as well as rods in their retina, employ colour and pattern in a most vivid way in order to defend their territory or to attract a partner of the opposite sex. Some insects and frogs employ colour and pattern in an even more sophisticated way. Their way of protecting themselves is to be poisonous or bad tasting but in order to avoid getting hurt their bad taste or poison must be advertized well in advance, and this is often done by means of strong colour and pattern. Mammals generally do not have a well developed colour vision, a fact that is related to their nocturnal history. However, when mammals climbed up the trees and developed a way of jumping from one branch to the other, the demands on visual acuity and depth perception greatly increased and they also developed a refined colour vision. Monkeys are amongst the most colourful of all mammals. They use their coloured parts to show off or threaten and also to advertize their species and sex.

Any good system of signals, however, must work over a distance. Therefore the impact described here can not be explained in terms of the pineal/hypothalamus system. The occurrence of a red spot in the visual field, however intriguing it might look, will not cause any significant change in the radiation impinging on the retina, as would be demanded by the melatonin-theory of pineal function. Yet the reaction on

behalf of the animal may well be noticeable even if the object is far away. The active use of colour to catch attention must depend on a well developed colour vision, not always on behalf of the individual sending the signals, but always on the one receiving them. Actually, flowers, mushrooms, fruits and berries also employ colour in order to advertize their existence. On the other hand, the effect of light radiation on the pineal organ does not seem to be dependent on colour vision but more likely on the activity of the rods. In many studies of the impact of light and colour this basic difference seems to have been overlooked. Thus, we must realize that physiological effects which at first glance might look similar, may have to be accounted for by means of different functional systems in the brain.

The ARAS of man will react to light and colour signals with responses put down in the biological heritage over the milennia. These reactions will be similar from one individual to the other and they are highly resistant to change.

A review of various electrophysiological reactions to light stimulation was presented by Childers and Perry in 1971 (75). Reviews of general interest concerning the effects of light and colour on human behaviour will be found in Hayward, 1972, Plack and Shick, 1974 (147), and Birenbaum and Hayward (70). For a review of the effects of sensory and perceptual deprivation refer to Zubek 1973. A bibliography on intermodal phenomena is given in Cohen and Christensen, 1966 (78). A thorough discussion of visual patterns and arousal will be found in Berlyne's book from 1971, Aesthetics and Psychobiology. Concerning human factors in lighting, refer to Boyce 1981. Also refer to the list of general references by Thorington et al, 1978 (165).

The descending reticular activation system, DRAS

When we consider light as a part of the visual field, there is always a context and content. Thus, light will be the carrier of all kinds of visual information, some of which might be far more important at the moment than the quality of light itself. A great part of this information will be highly complex and must therefore be analyzed on the mental level in order to be properly dealt with. This will involve the highest of all the non-visual systems, the descending reticular activation system, DRAS.

It is now well established that reticular activation occurs not only by means of external stimulation but also through impulses coming from the highest nervous centres, thus descending from the cortex on the reticular formation. The consequence of this process is to place the cognitive mechanisms in charge of arousal regulation. Thus, light might either influence the arousal level via the ARAS, already before the impulse has reached the cortex, or via the DRAS, after the cortex has had the time

to make a more elaborate analysis. If the light is of high intensity, monochromatic, glaring, and contrasting against the background, or moving and flickering, it is likely to cause an increase in arousal directly via the ARAS. The more complicated information inherent in the visual field, on the other hand, will affect arousal via the DRAS, only after an analysis has been made on the cortical level. Some visual patterns might be biologically programmed and result in direct activation, while others, being complicated or perhaps culturally determined, might influence activation indirectly.

Employing emotionally loaded pictures as means of visual stimulation, Libby, Lacey and Lacey, in 1973, were able to demonstrate effects on pupil size and heart rate. Pupillary dilatation and cardiac slowing were correlated to the interest value and unpleasantness of the pictures. It is conceivable that these kinds of arousal effects are dependent on mental processes in the cortex itself (68, 115).

In order to separate the two reticular activation systems it might be useful to distinguish between "light as signal" and "light as symbol". While the ARAS seems concerned mainly with light as signal, I will put forth the hypothesis that the DRAS concerns itself with light as symbol. Unlike other functional systems concerned with the non-visual effects of light, the DRAS is depending on cognitive mechanisms including thinking on the conscious level. Personal experiences aquired through learning and stored in the long-term memory will play a decisive part in this process. Here we are caught with the idiosyncrasies, preferences and dislikes, specific to the individual. Here we will also find all the diverse cultural meanings assigned to light. Each culture or subculture seems to have its own light-tradition which is conveyed to its members through the mechanism of repetition. By using the same light, colour or pattern over and over again in a specific context every single member of the group will get to value it the same way, while other groups may value it differently or not at all. This pertains also to the use of daylight in modern society. We will find different daylight habits in different parts of the world, and this will have influenced architecture as well, including the important transition zone that windows represent.

Thus, in the DRAS, light has taken the role of symbol, the meaning of which might change over time and from one individual to the other. Allegedly, symbols might turn into signals by means of the mechanism of automation; once we have learnt to react in a certain way, we do not need to think about it any longer, meaning that the ARAS has taken over the control. This does not alter the fundamental role of the DRAS, however, it only sets it free to carry out new tasks, many of which will be related to the complex visual world, bringing us into the realm of psychology.

Numerous examples of effects mediated by the DRAS will be found in the last section of this paper. For a discussion of the relationship betweeen the ARAS, the DRAS, and other physiological systems mediating the effects of light and colour, refer to Hayward and Birenbaum, 1980 (93), and Küller, 1980 (112).

Generalized reactions to flickering light sources

In a letter to a British journal, Garrett, 1972, points out the possible damage which can be caused by stroboscopic light sources, frequently used in discotheques, art galleries and exhibitions. He cites several instances from his experience of such usage where no precautions were taken to protect visitors or staff. In his reply to this letter, Tate, a lighting engineer, states he has never come across any ill effects from the type of stroboscopic flicker used in industries operating at 100 cycles per second upwards, but also mentions that flicker employed in discotheques usually is about 25 cycles per second or less. Discussions such as these point to the need for better definitions of what is meant by flicker and also to the fact that many different physiological as well as psychological mechanisms might be involved in a typical flicker situation.

It seems clear that flickering light does have a general effect on the central and autonomic nervous system often resulting in fatigue, headaches, and other stress symptoms. It might also influence the basic electrical activity of the brain itself. Montagu, 1967, has shown that the size of the EEG response varies with the intensity and frequency of the photic stimulation (132). Also, the so called stroboscopic effect caused by a flickering light source might give rise to the impression that things do not move the way they acutally do, but backwards, at another speed or in small jerking movements. This might be very disturbing and actually cause inadequate behaviour, for instance in a working or traffic situation (67, 71, 83, 169).

Flicker sensitivity depends on the characteristics of the luminous field. The improving levels of illumination that occur in many working places today mean that flicker will become increasingly important. Research shows another key factor is the total area of the visual field which is flickering, with a person's sensitivity increasing with larger fields. Sensitivity is also dependent upon age. For some frequencies there is an increase up to 20 years and then a slow decline. The principal factor for this seems to be a reduction of retinal illumination caused by the thickening of the lens and the reduction of pupil diameter, which accompany age, but there are also central nervous factors affecting sensitivity to flicker. Actually, there is a large variability in sensitivity between people, and it is possible for some persons to find a given level of light modulation intolerable while others can not see it (71, 81, 107, 121, 138).

Reactions of individuals to photic stimulation have been used for many years as means of psychiatric and medical diagnosis. A typical study was made by Ulett et al, 1953. They studied subjects by means of psychological tests and psychiatric interviews and also recorded EEG during intermittent photic stimulation. By means of electronic brain wave analysis it was

possible to show the existence of a significant correlation between proneness to developing anxiety under stress on one hand and the pattern of so called driving response on the other, i.e. the displacement of the alpha-rhythm of the EEG by means of repetitive photic (or other) stimulation (167). Thus, it is well established that cortical reactions to flicker are related to personality and it also seems to be the case that mood states will influence flicker sensitivity. In addition to this wide variability between people, there is also a small diurnal rhythm in flicker sensitivity which in some individuals is related to the oral temperature cycle. And in this connection there are also some studies indicating that the rhythmicity might have an effect on temporal experience. Critical flicker fusion frequency has been used to study reactions to toxic components, for instance, in some recent studies by Hellberg, where it was used as a diagnostic instrument of methyl mercury poisoning. (71, 89, 94, 130, 136, 168)

The fact that flickering light can be transmitted so strongly to the cortex that it might influence the brain's basic rhythms has been used in several studies in an attempt to distinguish between incandescent and fluorescent lighting. Zaccaria and Bitterman, in 1952, compared the effect upon visual fatigue of fluorescent lamps operated with direct and alternating current. Only 25 per cent of the subjects detected a difference between the two conditions, but those who did uniformly expressed a preference for the DC condition (178). Thiry, 1951, recorded EEG activity synchronous to light flashes at frequencies up to 70cps, which was well beyond the fusion frequency of approximately 50 cps. Cortical responses to flicker at rates over 100 cps have actually been found in some cases.

To assess whether flicker sensitivity in terms of EEG response could be related to complaints of eye strain and headaches in offices, tests were conducted by Brundrett, 1974, on ten subjects who had experienced at least a few months' work under fluorescent lighting. One group of five reported headache or eye strain and the control group of five were content with their situation. Headache and eye strain sufferers tended to have a low rate of evoked signal attenuation, while the evoked potentials of the control group tended to show rapid decline with increasing frequency (71). Colman and co-workers, 1976, observed the repetitive behaviours of six autistic children under two conditions of background illumination - fluorescent and incandescent. Subjects spent significantly more time engaged in repetitive behaviour under fluorescent conditions. The authors suggest these findings might be related to the flickering nature of fluorescent illumination (79). There have also been some studies comparing ordinary fluorescent lamps to high frequency lighting. (71, 72, 116)

Flickering light is likely to involve those areas of the brain where the basic brain wave patterns are set up and moderated. However, at present very little is known about these mechanisms.

By 1949 a model for the description of non-visual effects of flicker was set up by Walter and Walter and this model might be worth looking at even today (169). A review of electro-physiological responses to photic stimulation is given by Childers and Perry, 1971 (75). An extensive overview of flicker fusion is given by Pieron, 1965. A more recent review of human sensitivity to flicker is given by Brundrett 1974 (71). References will also be found in Thorington et al, 1978 (165). The study of flicker induced seizures is not included in this bibliography. Readers are referred to Hess et al, 1974, for further information on this topic (95).

SECTION 2: SUMMARIES 61 - 180

61 Ali, MR. 1972. Pattern of EEG recovery under photic stimulation by light of different colors. Electroenceph. clin Neurophysiol, 33, 332-335 (8 references)

Cortical habituation response (CHR) to constant stimuli has been investigated. The amount of alpha recovery after the onset of the stimulus is taken to be a quantitative measure of the response habituation of the central nervous system. The present study was designed to investigate whether the CHR is affected by the variation of the stimulus wave length, specifically, whether CHR is delayed more under red light than under blue light. The subjects were ten normal, male adults. Their ages ranged from 22 to 30 years. The colored stimulus (red or blue light) was thrown directly on the eyes of the subject through a projector. The maximal duration of the stimulus presentation was 600 sec. EEG were recorded throughout the period of stimulation following a 1 min record under resting condition. The EEG data (from electromagnetic tapes) were quantified by passing them through a Muirhead low frequency analyzer to a low-inertia motor-driven counter. The data were analyzed in terms of the percentage of alpha gain during the period under the two colored lights: t for related measure was computed. The percentage difference in alpha gain under the two conditions was found significant. The results of this study show that there is a greater recovery in the alpha wave under red than under blue light. This finding indicates that CHR under red light is delayed more than under blue light and the results is interpreted in terms of a greater cortical arousal following the presentation of red light.

62 Aschoff, J., Fatranska, M., Giedke, H., Doerr, P., Stamm, D. & Wisser, H. 1971. Human circadian rhythms in continuous darkness: Entrainment by social cues. Science, 171, 213-215 (14 references)

Three groups of two subjects each were kept in underground chambers, first for 4 days in an artificial light-dark cycle, and thereafter for 4 days in complete darkness. They lived on a rigorous time schedule. Physiological as well as psychological functions were measured at 3 hour intervals. There were no differences in the results between the two sections of the experiment. Social cues are sufficient to entrain human circadian rhythms, and absence of light has no immediate effect on the functions measured.

63 Baker, G. & Franken, R. 1967. Effects of stimulus size, brightness and complexity upon EEG desynchronization. Psychonomic Science, 7(9), 289-290 (6 references)

Measures of duration of EEG desynchronization were taken while Ss were exposed to a series of slides varying in complexity as well as size and brightness. There was a positive relation between duration

of EEG desynchronization and level of complexity but no effect due to size or brightness. Significant habituation to temporal as well as spatial aspects of complexity were observed.

64 Baker, RA., Ware, J. & Sipowicz, RR. 1962. Vigilance: A comparison in auditory, visual and combined auditory-visual tasks. Canadian Journal of Psychology, 16, 192-198

Subjects monitored brief interruptions of a continuously presented (i) source of sound, (ii) source of light, or (iii) both, for a three hour period. The differences between group (iii) i.e. those given simultaneous auditory and visual signals and the two control groups were not significant, There was no evidence of intersensory interaction or arousal effects.

65 Ballowitz, L., Heller, R., Natzschka, J. & Ott, M. 1970. The effect of blue light on infant gunn rats. Birth Defects: Original Article Series, 6(2), 106-113 (21 references)

From the fourth through the 12th day of life homozygous (jaundiced) and heterozygous infant Gunn rats were exposed directly to blue and to white light for six to ten hours per day. The infant rats treated with blue light showed more stunting than those treated with white light, as compared to nonilluminated littermates. The retardation was more pronounced in female than in male homozygous Gunn rats. Mortality was increased in homozygous animals exposed to blue light.

66 Bartholomew, R. 1975. Lighting in the classroom. Building Research and Practice, 3(1), 32-38 (5 references)

A seminar room was equipped with two independent fluorescent light sources, only one of which was "on" in any given seminar hour. The first, Vita-Lite, was a full-spectrum light closely approximating to natural sunlight. The second was the standard cool-white fluorescent light commonly used in institutional settings. The physical structures of the lamps are identical, but they are distinctly different in the colour of the light they emit. The conclusion is that while there was a negligible differential effect on mood, classroom performance, and classroom interaction from the lighting conditions, there is a clear difference in the qualitative characteristics of the conditions when direct observations and appraisals are made. While this does not leave the designer with positive data for lighting design decisions, it does provide a methodology for additional studies and illustrates the need to evaluate the lighting behaviour issue further.

67 Bartley, SH. & Nelson, TM. 1963. Some relations between sensory end results and neural activity in the optic pathway. Journal of Psychology, 55, 121-143 (56 references)

It is costumary to move step by step from the periphery to the central nervous system in tracing what happens in the optic pathway. This procedure

is not always the most appropriate, if we want to know as soon as possible something about what takes place in the neural structures that immediately underly sensory end results. Since the work in the thirties, considerable improvement and increased use of the microelectrode technique has taken place. Since it is now common to record from single neurons, it has become quite customary to think in terms of the fine detail that this technique provides. Nevertheless it is thinkable that use of this technique alone, simply moving single-unit analysis from periphery to center, would not yet have disclosed the broad over-all patterning of activity we now know to exist in the pathway. Since we now possess a broad outline regarding the relation of the receptivity of the cortex to peripheral inputs, we should now be better able to evaluate and utilize microelectrode findings. The present paper has indicated a number of facts about temporal features of response in the retina, optic nerve, lateral geniculate body, and in the cortex which seem to support the theory that sensory end result produced by photic input to the eye depends upon various features of timing. A theory based upon these facts and certain interpretations, called the alternation of response theory was restated. This provides an understanding of the neurophysiological basis for brightness, particularly brightness enhancement, and of several other features of vision. A number of predictions which stem from the theory in regard to brightness and brightness enhancement have been confirmed. In fact, in no instance in which any test has been made has negation resulted. The final section of the paper pointed out that individual channels in the pathways serving addition, touch, and kinesthesis manifest a form of alternation of response akin to that theorized for the optic pathway.

68 Berlyne, DE. & McDonnell, P. 1965. Effects of stimulus complexity and incongruity on duration of EEG desynchronization. Electroencephalography and Clinical Neurophysiology, 18, 156-161 (14 references)

Human subjects were exposed to a sequence of visual patterns, each shown twice consecutively. Exposures lasted 3 sec and were separated by intervals of 15 sec. The patterns belonged to eight categories, representing various complexity and incongruity variables. More complex or incongruous patterns evoked, on the average, longer desynchronization than less complex of incongruous patterns (6.3 sec as compared with 5.8 sec). The difference was found to be statistically significant when the data for all eight categories were examined together and when the data for four of the categories (representing Irregularity of Arrangement, Amount of Material, Incongruity and Random Redistribution) were examined separately. No significant difference appeared between first and second presentations of the same patterns or between subjects who were intrinsically motivated (told to attend carefully for the sake of a later recognition test) and not extrinsically motivated, and none of the interactions was significant. There was, however, a significant tendency for desynchronization to grow shorter as the session continued. The findings are discussed in relation to theoretical and experimental work on motivational aspects of exploratory behavior and related phenomena.

69 Berry, PC. 1961. Effect of colored illumination upon perceived temperature. Journal of Applied Psychology, 45(4), 248-250 (3 references)

There is an almost universal tendency to speak of green or blue as "cool" colors, and of red or orange as "warm". The study set out to answer the following questions. Can a person's judgment of the temperature of the air around him be biased by the hue of his surroundings? Can this conventional association between colors and temperature be used to improve the comfort of individuals? It may be concluded that: Subjects did not show any change in the levels of heat they would tolerate as a function of the colors of illumination, and Subjects nevertheless persisted in the conventional belief that green and blue are "cool" colors when asked to rank the colors that they had experience.

70 Birenbaum, L. & Hayward, DG. (undated). Lighting and Behavior: A conceptual framework and bibliography. University of Massachusetts, Amherst (14 pages, 73 references inclusive of 1977)

The purpose of this bibliography is twofold. First, it provides a starting point for people who are interested in references for research about how lighting influences behavior. Second, it organizes the research into a framework which helps to elucidate the different ways in which lighting affects behavior as well as points to areas which lack reaerch but may prove to be vital in understanding how people are influenced by their environment. Because the organization is general, the bibliography includes some categories for which there are no references. The categories which describe howlighting influences behavior are as follows: I. Behaviors Associated with Lighting for Visual Tasks: A. Specific Legibility Tasks: 1: Learning and Academic Performance; 2. Other. B. General Task Performance. C. Specific Behavioral Response while Involved in a Task. II. Behaviors Associated with Lighting for Room Ambiance: A. Social Interaction; 1. Interpersonal distancing; 2. Noise levels; 3. Counceling interaction; 4. Length of stay: behavioral duration; 5. Cues for appropriate social behaviors. B. Individual (non-interactive) behavior; 1. Orientation/circulation; 2. Emotion/ anxiety/arousal; 3. Attitude/well-being; 5. Sensory deprivation. III. Interaction between I. and II. Finally, it should be noted that these categories are not mutually exclusive or exhaustive but describe most clearly the relationships between lighting and behavior.

71 Brundrett, GW. 1974. Human sensitivity to flicker. Lighting Research and Technology, 6(3), 127-143 (63 references)

The factors influencing flicker sensitivity are reviewed. Sensitivity is increasing because of improving lighting standards and personal peak sensitivity occurs for people approximately 20 years old. There is wide variability between people and the effect of flicker is related to the individual threshold. Office surveys reveal that significant numbers of people see flicker and that this feature is associated with the "unsatisfactory" ratings of the lighting. Some headaches and eyestrain are related to seeing flicker. Light modulation from fluorescent lamps at 50 and 100 Hz has been measured and the growth in the 50 Hz component with time has been studied. The 50 Hz component is the one which is

normally seen. The lamp characteristics show this 50 Hz modulation to remain at a low value for the first 7-8000 hours operation and thereafter to rise more rapidly with operation. Planned lamp replacement is now essential.

72 Brundrett, GW., Griffiths, ID. & Boyce, PR. 1973. Subjective response to a.c. and d.c. fluorescent lighting. Lighting Research and Technology, 5(3), 160-162 (4 references)

There has been criticism of fluorescent lighting ever since its introduction for commercial and industrial interiors. The purpose of the experiment described here was to examine one possible cause of these complaints, i.e. the flicker modulation that is characteristic of all fluorescent lamps when operated on an a.c. supply. The conclusion for the study is that when care is taken to remove all visible flicker there is no preference for either a.c. or d.c. fluorescent lighting. Both are said to provide reasonable conditions.

73 Cardinali, DP., Larin, F. & Wurtman, RJ. 1972. Action spectra for effects of light on Hydroxyindole-O-Methyl transferases in rat pineal, retina and harderian gland. Endocrinology, 91, 877-886 (31 references)

The relations between the spectrum emitted by a particular light source and the modifications in pineal, retina and harderian gland hydroxyindole-O-methyl transferases (HIOMT) were examined by exposing rats previously maintained for 7 days in darkness to each of 7 different light environments for 0 to 96 hours. Exposure to green, blue or yellow bulbs caused time-related decreases in pineal HIOMT activity; green light was most effective. No significant changes in pineal HIOMT were observed among rats exposed to red light; UV produced a transient stimulation of the pineal enzyme. Common fluorescent light (cool-white) was more effective than a light source that simulates natural sunlight (Vita-Lite) in decreasing pineal HIOMT. Retinal HIOMT was significantly inhibited in rats exposed to green, cool-white, and Vita-Lite bulbs for up to 96 hours, blue light produced a bi-phasic effect, i.e. inhibition for the first 48 hours and stimulation afterwards. Harderian gland HIOMT activity was not modified by any of the light sources. The exposure of rats to continuous green light for 17 days resulted in almost total loss of pineal HIOMT and in significant stimulation of the retinal enzyme; harderian gland HIOMT was not modified. When similar rats were subsequently placed in darkness for 7 days, retinal HIOMT activity remained stimulated and pineal HIOMT rose significantly. A second period of exposure to green light again depressed pineal HIOMT. These results indicate that the action spectrum for the photic control of rat pineal is similar to the absorption spectrum of rhodopsin, and that the "neureoendocrine" photoreceptor cells in the rat retina continue to function even after animals are consinuously exposed for 17 days to green light.

74 Chatterjea, R. & Rakshit, P. 1966. Estimation of temporal interval. Perceptual and Motor Skills, 22, 176 (2 references)

In several studies on the estimation of temporal intervals investigators have used either white light or white noise to mark the stimulus times. The purpose of the present study was to probe into the effect of colored light, white light and sound in the estimation of short intervals. The hypothesis was that preference of an individual for a color affects his estimations of time considerably. Colored light, however, did not have appreciable effect on individual estimation. The sound data followed the same trend, although the indifference interval was between 0.6 and 0.8 sec.

75 Childers, DG. & Perry, NW. 1971. Alpha-like activity in vision. Brain Research, 25, 1-20 (101 references)

Alpha rhythm and alpha-like activity are discussed with regard to empirical findings in psychophysics, brightness enhancement, flicker-fusion, EEG, ERG, VER, late receptor potential, ganglion cell responses, lateral geniculate body and cortical responses for photic stimulation. Various models and theoretical considerations advanced in the literature to explain these finds are considered.

76 Churchman, AT. 1971. Physiological effects of high light levels. Electronics and Power, January, 4-7 (no references)

An important but little-considered condition of work is that of illumination. For any given task, there is an optimum level of illumination which will help to increase efficiency and reduce fatigue. Such advantages are in the interest of both the employer and the employee.

77 Cohen, DB. & Nelson, WH. 1966. Effect of differently colored incidental stimuli on cued discrimination. Perceptual and Motor Skills, 22, 143-146 (6 references)

The effect on choices of geometric forms of using differently colored, similar, geometric forms as incidental cues was investigated. For this task there was a significant difference in frequency of choice of cued form associated with sex, but none associated with the 5 different colours for the 18 male and 22 female Ss tested. The use of colored incidental cues did not result in significantly more frequent choice of cued form than did the use of non-colored incidental cues.

78 Cohen, J. & Christensen, I. 1966. A note on intermodal phenomena, with an annotated bibliography. Estratta dalla Rivista IKON, Suppl. al. N. 56, Gennaio-Marzo, Milano (53 pages, 14 additional references)

The bibliography consists of 80 items in three categories viz, general interest, facilitiation and competition respectively. Items 1-6 report matters of general interest. Items 7-52 report facilitation of one mode by another, as follows: Auditory by visual, auditory by gustatory, Visual by auditory, Visual by

gustatory, Visual by olfactory, Visual by vestibular, Visual by thermal, Visual by motor and postural activity, Visual by cutaneous, Visual by algesic, Tactile by visual, Cutaneous by visual. Items 53-80 report intermodal competition, as follows: Auditory by visual, Auditory by gustatory, Auditory by olfactory, Auditory by cutaneous, Visual by auditory, Visual by gustatory Visual by olfactory, Visual by vestibular, Visual by thermal, Visual by postural, Visual by interoceptive, Tactile by visual, Cutaneous by auditory, Algesic by thermal.

79 Colman, RS., Frankel, F., Ritvo, E. & Freeman, BJ. 1976. The effects of fluorescent and incandescent illumination upon repetitive behaviors in autistic children. Journal of Autism and Childhood Schizophrenia, 6(2), 157-162 (17 references)

Repetitive behaviors of six autistic children were observed under two conditions of background illumination. During two sessions, the room was illuminated by fluorescent light and during two other sessions, by equal intensity incandescent light. Subjects spent significantly more time engaged in repetitive behavior under fluorescent light. Previous research suggested that these findings were related to the flickering nature of fluorescent illumination. Practical and theoretical implications were discussed. Further experimentation was suggested to assess relationships between flickering illumination and arousal.

80 Davis, RC. 1959. Somatic activity under reduced stimulation. Journal of Comparative and Physiological Psychology, 52, 309-314 (10 references)

To determine the condition of somatic variables under low levels of stimulation, two groups of Ss were compared. One group lay on a cot in a dark, soundproofed room for about 40 min. The other after 5 min. was given continuous moderate light and sound. Muscle potentials from three locations, circulatory and respiratory variables, were recorded, and the changes over the period in the two groups compared. In general, the reduced-stimulus group showed increased muscular and circulatory activity and discreased respiration, a pattern which may be characteristic of "anticipation". A hypothesis of increased sensitization may explain these and other results of "sensory deprivation".

81 Dobriakova, OA. 1944. The influence of gustatory, warm and cold, olfactory and aural stimuli on the critical flicker frequency of monochromatic lights. Probl fiziol Optiki, 2, 81-84

The author claims reduction in C.F.F. for green-blue illuminations and increase in orange-red, under secondary olfactory stimulation (odours of bergamot oil and geraniol). No effects were noted for yellow, or for extreme spectral red or violet. On cessation of secondary stimulation C.F.F. returned to normal and frequently went beyond in the reverse direction to that shown under secondary stimulation. Similar effects were found with gustatory and thermal secondary stimulation.

82 Dumont, F. & Lecomte, C. 1975. The effects of lighting and interpersonal distance on counseling interactions. Canadian Counsellor, 9(1), 9-19 (25 references)

This study investigated the effect of intensity of lighting and interpersonal distance in an analog counseling situation on an array of counseling variables; e.g. communication of empathy, duration of silence, duration of speech, number of interactions. Excerpts from initial sessions were randomly selected, rated, and analyzed. Results showed a significant interactive effect of lighting and distance on the communication of empathy. Both singificant and non-significant results were discussed.

83 Erwin, CW., Lerner, M., Wilson, NJ. & Wilson, WP. 1961. Some further observations on the photically elicited arousal response. Electroencephalography and Clinical Neurophysiology, 13, 391-394 (4 references)

Observations on the effects of intensity and wave length of light on EEG arousal responses have been studied. In addition arousal response durations of the left and right hemispheres of left and right-handed individuals have been investigated. Results of studies related to hemispheric dominance indicate that although there was a tendency for the right cerebral hemisphere to show a longer response, statistical analysis of the data revealed no significant difference between the sides. There is a significant decrease in arousal duration if an individual is stimulated with serially decreasing stimuli intensities. If the stimuli are serially increasing in intensity, the duration of the response is the same as if the intensity remained constant. Responses obtained were not significantly different from those obtained in the initial period with the lowest intensity. Variations in response to light of different wave lengths cannot be explained using the present data. Further studies using stimuli of varying wave lengths, but of equal intensity, are required to investigate more adequately the relationship.

84 Fiske, VM., Bryant, GK. & Putnam, J. 1960. Effect of light on the weight of the pineal in the rat. Endocrinology, 66, 489-491 (12 references)

Twenty-two day old male and female rats were places in continuous light, almost continuous darkness or under usual day-night conditions, for six to twenty-five weeks. At autopsy it was found that the pineals of the animals housed under continuous light were significantly smaller than the pineals of either the laboratory controls or the rats kept in darkness. This suggests that the pineal may play a role in the changes in reproductive activity seen in rats exposed to continuous light.

85 Fuerst, K. & Zubek, JP. 1968. Effects of sensory and perceptual deprivation on a battery of open-ended cognitive tasks. Canadian Journal of Psychology, 22(2), 122-130 (24 references)

Two experiments were conducted to test the hypothesis, advanced by several investigators, that performance on open-ended congitive tests will be impaired by exposure to an impoverished sensory environment. The Guildford battery of creative thinking (10 tests) was administered before and at the end of three days of either sensory deprivation (darkness and silence) or perceptual deprivation (unpatterned light and white noise). In both experiments, no significant differences were found between the isolated and control Ss on any of the ten cognitive tests. However, when the data of the two experiments were combined, the isolated Ss performed significantly worse than did the controls on a test of ideational fluency. In a further analysis of the data, it was observed that the pre-experimental scores of a group of six isolation quitters were consistently lower, relative to those of the successful isolation endurers and control Ss, on all ten tests of the Guildford battery. Although none of the differences were statistically significant, probably because of the small sample of quitters, the results suggest that low pre-experimental scores on open-ended cognitive tests may be indicative of isolation intolerance.

86 Giese, AC. 1964. Historical introduction. In: Giese, AC. (ed). Photophysiology. Volume I. Academic Press, London, New York, 1-18 (66 references)

Historical introduction: The development of photochemistry, Photosensitization in biological systems, Photosynthesis, Phototaxis, Vision, Photoperiodism, Diurnal rhythms and visible light, Medical uses of ultraviolet light, Effects of ultraviolet radiation upon cells, Bioluminescence, Reference books on photobiology.

87 Giesen, M. & Hendrick, C. 1974. Effects of seating distance and room illumination on the affective outcomes of small group interaction. Social Behavior and Personality, 2(1), 87-96 (9 references)

Three experiments explored the effects of variation in room illumination and in seating distance between members of a small group on moods, evaluations, attraction, and opinion expression. Groups of three subjects and a moderator discussed a socially relevant issue and then made several ratings. During the discussion, group members sat either very close to each other or far apart. In the first two studies room illumination ranged from normal lighting to darkness, and in the third study the room was either red or blue in hue. Check questions indicated sucessful manipulation of the variables. However, across the three experiments there were only slight effects for the several measures of affective response. The results indicate that, contrary to expectation, interaction distance is not per se a very powerful variable. Very likely, pleasant or unpleasant effect will depend on distance only under relatively circumscribed boundary conditions, which are, as yet, undetermined.

88 Goldstein, K. 1942. Some experimental observations concerning the influence of colors on the function of the organism. Occupational Therapy and Rehabilitation, 21, 147-151 (2 references)

In human life the various colors are related to various emotional conditions. The influence of colors is increased in neurotics and psychotics. If you stretch out your arms in front of you and distract your attention from them, then your arms deviate a little outwardly without your intention and your will. After they have deviated to a certain point, they cease to move, if you do not interfere. It seems that red produces a removal of the arm from the center of the body; green brings the arm nearer to it. The different colors effect the organism in such a way that some increase the pathological deviation; others decrease it; or, in other words, some bring the pathological behavior nearer to normality - others increase the abnormality. The contrary effects of green and red - the one improving the pathological condition, the other increasing it - are to be observed not only as disturbances of position, Experiments show that the movements which are executed with the same intention by the patient are performed more exactly as to extent and correctness in green light than in red. Red is not always disturbing; in normal life it often stimulates to activity. The similarity of the descriptions of sensitive normal persons and our patients shows that we have to deal with normal phenomena which probably occur in every individual. All the factors mentioned ask for special attention in relation to our problem of color therapy. Some conditions in Parkinsonism can at times be diminished in severity if the individuals are protected against red or yellow colors, if they wear, for instance, spectacles with green lenses.

89 Goldstone, S. 1955. Flicker fusion measurements and anxiety level. Journal of Experimental Psychology, 49(3), 200-202 (5 references)

This study involved 33 high-anxiety patients, 18 low-anxiety patients, 2 high-anxiety normals, and 21 low-anxiety normals. A flicker fusion test was administered to all Ss and the following reliable differences were found: 1. Those groups designated high anxiety had a lower FFT than those groups designated low anxiety, suggesting reduced sensitivity to flicker associated with high anxiety. 2. Those groups designated high anxiety had a greater intraindividual variability of judgments than those groups designated low anxiety. 3. Those groups designated high anxiety had a greater decline in sensitivity to flicker (FFT) associated with continued exposure to the flicker test than those groups designated low anxiety.

90 Gregg, LW. & Brogden, WJ. 1952. The effect of simultaneous visual stimulation on absolute auditory sensitivity. Journal of Experimental Psychology, 43, 179-186

Auditory thresholds were measured under three conditions of auxiliary illumination (2.050, 2.065, 2.105 millilamberts). Experimental subjects were asked to report on the presence or absence of the light as well as that of the tone. The control subjects reported on the presence or absence of the

tone only. The results for the former group showed a significant tencency for the auditory threshold to rise with increase in illumination. Results for the latter group showed a significant lowering of the auditory thresholds as the brightness increased.

91 Gregson, RAM. 1964. Modification of perceived relative intensities of acid tastes by ambient illumination changes. Australian Journal of Psychology, 16(3), 190-199 (19 references)

The measurement of intersensory facilitation, arising when ambient light modifies the subjective stimation of gustatory intensity differences, was attempted. Artificial light at two intensities and citric acid at concentrations of .00115, .00100, and .00085 gm/ml in tap water were used with 24 Ss, mean age 20.9 years. Mean relative intensity ratings fitted a linear trace decay model almost exactly, leaving very small superimposed intersensory effect. Examination of significant heteroscedasity ($p<.00001$) in results related to changes in illumination showed large intersubject differences: some Ss showed consistent facilitation and others a consistent opposite effect with increased illumination. The intersensory effect is probably multiplicative on perceived intensities, and not consistent with a simple absolute threshold shift effect.

92 Gulick, WL. & Smith, FL. 1959. The effect of intensity of visual stimulation upon auditory acuity. Psychological Record, 9, 29-32

Intensity of irrelevant visual stimulation on auditory discrimination was investigated. Twelve adult subjects with normal hearing listened to tape recordings of 36 pitch and 36 timbre discrimination tasks under three conditions of illumination. No evidence was obtained to indicate that visual stimulation from a homogeneous field affects auditory acuity.

93 Hayward, DG. & Birenbaum, L. 1980. Lighting and human behavior. In: Proceedings of the 19th CIE Congress. Kyoto 1979. Commission Internationale de l'Eclairage, Paris, 283-286 (14 references)

This paper presents a conceptual framework for lighting-behavior relationships which incorporates physical parameters of lighting, a person's internal states and dispositions, perceptual and cognitive appraisal of environmental conditions, a range of potential behavioral outcomes, and a person's ongoing evaluation of such behaviors. This proposed conceptual framework is used as a context for a more thorough examination of behaviors which affect and are affected by lighting conditions: the principal categories of behavior are task performance, social behavior, spatial behavior, and adaptive behaviors. An agenda for further lighting-behavior research is presented, followed by a discussion of the implications of a behavioral perspective for a generalized design process.

94 Hellberg, J. 1978. The influence of fatigue and different light wavelengths on critical flicker fusion intensity in scotopic vision. Psychological Research Bulletin, 18(2), Lund University, Sweden (10 pages, 6 references)

Measured cffi in scotopic vision and the level of dark adaptation by using a modified, automatic adaptometer. Flicker was held constant at 10 cps. Light on two different wavelengths (5650 A and 5900 A) was used. The subjects (22 males and 27 females) were mainly university students that volunteered for the test. Cffi for the two wavelengths was compared to an earlier investigation where 5650 A had been used. The results showed that time of the day did not influence cffi. A significant increase of cffi occured when the wavelength was changed from 5650 A to 5900 A. An extrapolation was made that pointed to a 72%-gain in sensitivity of the apparatus if one could use a light source which emits the wavelengths 5000 A. This was considered important since the apparatus is meant to be used as a diagnostic instrument in epidemiological investigations of populations exposed to methyl mercury (MeHg).

95 Hess, RF., Harding, GFA. & Drasdo, N. 1974. Seizures induced by flickering light. Am J Optom & Physiol Optics, 51(7), 517-529 (73 references)

Intermittent photic stimulation can induce epileptic seizures in some patients. These seizures may take various forms which are characterized by overt phenomena or atypical EEG signals. Many adventitious stimuli in the environment have been found to be capable of producing these attacks. The neurophysiological mechanisms underlying this condition are only partially understood, and are the subject of considerable research effort at the present time. Various therapies have been proposed including some involving spectacle devices.

96 Hocking, J. & Robertson, M. 1969. Sensation seeking scale as a predictor of need for stimulation during sensory restriction. Journal of Consulting and Clinical Psychology, 33(3), 367-369 (13 references)

The study tested the hypothesis that the Zuckerman Sensation Seeking Scale (SSS) predicts strength of need for stimulation under conditions of sensory restriction. During a 3-hour isolation period, 15 high- and 15 low-SSS scorers were free to button press for visual, auditory, and kinesthetic stimulation. Except for visual stimulation high-SSS scorers button pressed at a higher rate than low-SSS scorers, but the differences were not significant. Low-SSS scorers showed a significantly greater need for visual stimulation than high-SSS scorers. High-SSS scorers showed a significant preference for kinesthetic stimulation, while low-SSS scorers had a singificant preference for visual stimulation. Results were discussed in the light of future research strategy.

97 Hollwich, F. 1979. The influence of occular light perception on metabolism in man and in animal. Springer Verlag, New York (129 pages, 634 references)

The following topics are discussed. The energetic portion of the optic nerve. Light and the pineal gland. Light and growth. Light and the body temperature. Light and kidney function. Light and blood count. Light and metabolic functions. Light and thyroid function. Light and sexual function. Ligth and adrenal and pituitary functions. Natural sunlight and artificial fluorescent light. Light pollution. The importance of light in metabolism in man and animal. Summary.

98 Hollwich, F. & Dieckhues, B. 1980. The effect of natural and artificial light via the eye on the hormonal and metabolic balance of animal and man. Ophthalmologica, 180(4), 188-197 (31 references)

Color change of the plaice and frog, and development of the testes in duck are induced by light stimuli via the eye. Eliminating experiences on the frog (Hollwich) and on the duck (Benoit) showed that these stimuli - besides vision - use a separate way, the so-called "energetic portion" of the visual pathway (Hollwich). In compared studies on blind and on temporarily blind patients involved by cataract in both eyes, we found significant low levels of ACTH and cortisol. The levels normalized after cataract extraction. - Furthermore. we studied the influence of strong artifical illumination (3.500 and 3.200 lx) on healthy persons with considerable and, on the other hand, with minimal difference of their spectral composition to daylight. We found stress-like levels of ACTH and cortisol in the first group. These findings explain the agitated mental and physical behavior of children staying the whole day in school under artificial illumination with strong spectral deviation from daylight. Therefore, to avoid mental and physical alterations, the spectrum of artificial illumination should be largely similar to that of natural light.

99 Hollwich, F., Dieckhues, B. & Meiners, CO. 1975. Die physiologische Bedeutung des Lichtes für den Menschen. Lichttechnik 27(10), 388-394 (40 references)

Over the many thousand of years of its development the human eye has completely adapted itself to natural daylight. Artificial lighting, however, to which many of us are exposed for the major part of the day, differs from natural daylight as regards spectral composition, intensity and monotony. The paper discusses the physiological effects of artificial lighting on man on the basis of experimental and clinical investigations on humans and animals.

100 Hollwich, F., Dieckhues, B. & Schrameyer, B. 1977. Die Wirkung des natürlichen und künstlichen Lichtes über das Auge auf den Hormon- und Stoffwechselhaushalt des Menschen. Klin Mbl Augenheilk, 171, 98-104 (11 references)

Examinations of hormone levels in blind persons compared with almost blind and people with normal vision and hormone evaluation with increased artificial light exposure show a definite stimulating effect of light on the human hormonal balance. The effect of light is mediated by an intact perception of light by the eye over an "energetic part" of the visual pathway - hypothalamus - hypophysis - periphal endocrine gland (Hollwich 1948). Increasing the intensity of artificial light with fluorescent tubes leads to "light stress" proved by increased hormone production - especially the stress hormone cortisol. The belief that artificial light is the same as natural light and that it can fully replace it, is inappropriate in the medical view and needs correction.

101 Ilyanok, VA. & Samsonova, VG. 1971. Effect of brightness distribution in the visual field of the observer on the functional state of different human brain regions. In: Commission Internationale de l'Eclairage, 17 Session, Barcelone, Bureau Central de la Commission, Paris, p 71.29 (16 pages, 5 references)

A direct effect (unrelated to object discrimination) has been found of the brightness distribution in the visual field on the magnitude of rhythmic evoked potentials at higher levels of the human brain.

102 Ishisu, T. 1962. The effects of exposure to light on the body. Part 1. Effects on the body under light and dark conditions. Mie Medical Journal, 11(3), 509-521 (39 references)

Under both the light and dark conditions the author performed experiments on 6 subjects on the amount of urine, the amount of urinary 17-ketosteroids and its steroid pattern, and uropepsin, serum Na and K, and cholesterol, blood sugar, lactic acid, pyruvic acid, and cholinesterase. The significant effects upon the body are, under the light conditions, the increase in the amount of urinary 17-ketosteroids, and the increase of the gonodal steroid, the gluco-steroid, and cortical male hormone groups. The value of uropepsin and the concentration of serum K and pyruvic acid in blood also showed an increase. As to the adrenal cortex of rabbits bred under the light conditions, many fuchsinophil granules appeared in the shallow layer of the zona fasciculata by Zinsser's stain, and the PAS positive substances were present in a large number in the deep layer of the zona fasciculata.

103 Ishisu, T. 1965. The effect of exposure to light on the body. Part 2. Effects of exposure to colored light on the body. Mie Medical Journal, 15(2), 121-128 (9 references)

The effect of blue- and red-lights on living body was observed in healthy male students ranging from 21 to 23 years old. The maximum peaks in blue- and red-lights were 470 mμ and 650 mμ respectively, and their illuminations were 700 lux. The amount of urinary 17-KS

and its fractional pattern, that of uropepsin, volume of urine, specific gravity of urine, K and Na in the serum, blood sugar, lactic and pyruvic acids in the blood, ChE in the blood and cell plasma, cholesterol in the blood, thiamine content in the blood and urine were measured with the following results. The amount of urinary 17-KS increased in either colored light exposure. The increase was more significant in the red-light exposure. The increase in uropepsin was not significant at the colored light exposure. No effect of colored light on K and Na in the serum was found. Volume of urine increased significantly in both lights and showed the tendency to excrete hypotonic urine. Thiamine in the blood slightly increased at the beginning of exposure, while its excretion increased during exposure. ChE in the plasma showed the tendency to increase in the blue-light exposure. No change was observed in K and Na concentrations in the blood under the colored light exposure.

104 Jacobs, KW. & Hustmyer, FE. 1974. Effects of four psychological primary colors on GSR, heart rate and respiration rate. Perceptual and Motor Skills, 38, 763-766 (8 references)

Judges selected from ISCC-NBS patches those colors which were most representative of red, yellow, green, and blue. These colors were presented for 1 min. each with GSR, heart rate, and respiration being recorded. There was a significant color effect on GSR but not on the other measures. Red was significantly more arousing than blue or yellow and green more than blue.

105 Kallman, WM. & Isaac, W. 1977. Altering arousal in humans by varying ambient sensory conditions. Perceptual and Motor Skills, 44(1), 19-22 (13 references)

Reaction times of 6 male and 6 female college students were used as a measure of arousal under different levels of ambient sensory stimulation. Subjects were tested under conditions of light-quiet, light-noise, dark-quiet and dark-ncise with a non-signalled reaction-time task using a tactile stimulus. All sensory conditions were presented to each subject in a counterbalanced order and replicated in a second session 3 to 8 wk. later. Significant main effects were noise and replication. Improvement in performance across replications was related to the sex of the subject. White noise and level of illumination interacted to produce the typical U-shaped function. Results are discussed in terms of their relevance for research using behavioral and physiological measures of arousal.

106 Kearney, GE. 1966. Hue preferences as a function of ambient temperatures. Australian Journal of Psychology, 18(3), 271-275 (8 references)

Preferences for hues at three different temperature levels and three levels of brightness were determined using the method of paired comparisons. Three groups each of 34 Ss took part. Preferences were influenced by hue and not by brightness. Preferences at low temperatures were positively correlated with the wavelength of light, and at high temperatures were inversely related to wavelength. Intermediate temperatures showed no significant relationship.

107 King, V. 1972. Discomfort glare from flashing sources. Journal of the American Optometric Association, 43(1), 53-56 (3 references)

An attempt was made to relate certain aspects of the pupillary light response to intermittent stimuli which also produced a sensation of discomfort. The glaring stimuli were presented to the left eye and the consensual pupillary reflex of the right eye was made of: 1/ the effects of various sizes of circular glare sources 2) the effects of different background luminances and 3) the effects of immobilizing the pupil with a drug. The results indicate that the pupillary responses are related to the threshold sensation of discomfort. This relationship is not the simple one of a certain amount of constriction always occurring at the threshold nor is it one of the threshold being determined by the pupil constricting to a critical diameter. It may be that the rapid stretching of the iris to an amount that is dependent on the initial size of the pupil produces impulses in the fifth nerve branches terminating in the iris which lead to the unpleasant or painful sensation that is known as discomfort glare.

108 Kingma, A., Backers, G. & Boekhoudt, M. 1978. De invloed van de kleur van een ruimte op de uitvoering van een aandachtstaak. Heymans Bulletins Psychologische Instituten, R.U. Groningen, Nr SW HB-79-430 EX, Haren (44 pages, 9 references)

The influence of the color of a room on the execution of an attention-task was examined in an experimental situation. There were two experimental conditions: a red-painted and a green-painted room. Red and green had been chosen, assuming those colours have an opposite and maximum effect; respectively "expansive, arousal generating" (red) and "contractive, slowing down" (green). The 32 female Ss (students) passed all through both experimental conditions. In both rooms the Ss performed the same task. This task was a derivation of the so-called "Stroop" experiments. The Ss had to react to the colour of a visual stimulus, being a colour-printed word, and to neglect the meaning of the word. We did not find any evidence for an influence of the color of a room on the attention-task; neither for error-rate nor for reaction-time.

109 Kleiber, DA., Musick, PL., Jayson, JK., Maas, JB. & Bartholomew, RP. 1974. Lamps - their effect on social interaction and fatigue. Lighting Design and Application, 4(1), 51-53 (no references)

Two experiments were conducted to determine the relative effects of different lighting conditions on the quality of classroom seminars and the resistance to fatigue. In the first experiment, using videotape and questionnaires to provide data, it was determined that there were no differences between the two light sources in terms of actual classroom behavior. In the second experiment, students did not report greater or lesser fatigue under each lighting condition, but physiological measures indicated that they showed less fatigue under Vita-Lite whether they were aware of it or not, suggesting that this is the more stimulating of the two light sources.

110 Krtilova, A. & Matousek, J. 1980. The importance of daylight for human organismus and its function in integrated lighting system. In: Krochmann, J.(ed). Proceedings of the symposium on Daylight. Physical, psychological and architectural aspects. Commission Internationale de l'Eclairage, Institut für Lichttechnik, TU Berlin, 226-237 (13 references)

The daylight has big importance for human organismus 1) from biological point of view - the influence on circadian rhythms and on the levels of hormones etc. 2) from physiological point of view - the influence of various psychological functions, expecially on visual functions (visus, visual performance, colour perception etc), 3) from psychological point of view - the variability of daylight and its glare non-uniformity has big influence on psychological condition of man. The experiments in laboratory with integrated lighting 500 lx and relation of daylight component: artificial light component 1:1, 1:2, 1:3 and 1:5 have shown the best results for human organismus from biological, psychological and physiological point of view in relation 1:1 and 1:2.

111 Küller, R. 1976. The use of space - some physiological and philosophical aspects. In: Korosec-Serfaty, P. (ed). Appropriation of space. Proceedings of the Strasbourg Conference, CIACO, Louvain-la-Neuve, 154-163 (16 references, also available in French)

The research subjects, six men and six women, were placed in two rooms in balanced order for a period of three hours. The one room was grey and sterile, the other colourful and diversified. The two rooms differed in visual complexity and visual unity but not in pleasantness. Measurements taken during the first, second and third hour showed that the subjects generally experienced a lack of emotional control in the colourful room. The chaotic visual impact made them feel silent and subdued. Also, the alpha-component of the EEG was considerably lower in the colourful room than in the grey one as long as the subjects' eyes were open, This difference disappeared more or less when the subjects closed their eyes. The difference in alpha level between the subjects in the two rooms can be explained in terms of cortical arousal. Stress reactions were more noticeable in men than in women. The men also become more bored in the grey room. In contrast to the women they might not have been able to relax mentally although there was little to look at. This assumption is supported by a general clinical experience, namely that stress and tension diseases occur more often and more seriously in men than in women. Subjects' EKG (heart rate) was slower in the colourful room than in the grey one, which is in agreement with a hypothesis of Lacey, Kagan, Lacey and Moss, 1963, i.e. intense attention might be accompanied by cardiac deceleration. Thus, it was demonstrated that colouring and visual patterning of the interior space might have a profound physiological and psychological effect and this effect might vary between different groups of subjects.

112 Küller, R. 1980. Non-visual effects of daylight. In: Krochmann, J. (ed). Proceedings of the symposium on Daylight. Physical, psychological and architectural aspects. Commission Internationale de l'Eclairage, Institut für Lichttechnik, TU Berlin, 172-181 (18 references)

Daylight will influence man along various routes and on many different functional levels. We must realize at least five

major functional systems and probably several minor ones (not mentioned here). Two of the systems act through radiation of the skin, while the other three act through light entering the eye. They are likely to interact in a rather complicated way that it will take great experimental skill to break down into its basic components. The synthesis of vitamin D in response to ultraviolet radiation of the skin is likely to have a general physiological effect on the organism, amongst others influencing the individual's health status. Infrared radiation will influence the metabolic state of the organism by means of the hypothalamic function of heat regulation. Daylight reaching the eye will affect the endocrine and autonomic systems of the entire organism. Together these three will set the stage for the reticular activation system by means of which the visual world may be decoded in terms of signals ascending from the environment or symbols descending from cortex, as a result of a cognitive analysis of the visual field.

113 Köhler, W. 1969. Dynamische Beleuchtung. AIC Color 69, Stockholm L4:1142-1148 (no references)

Biological basis of lighting - The inseparable duality of light and colour - Biogenetic consideration - Space as perception - Architecture as art of light - Illumination level and biological well-being - Teleological planning of colour conditions as a task of the art of illumination - An appeal to bibliography and new research.

114 La Giusa, FF. & Perney, LR. 1974. Further studies on the effects of brightness variations on attention span in a learning environment. Journal of Illuminating Engineering Society, 3, 249-252 (3 references)

This study is focused on the visual environment; on a method by which lighting can be used as a direct aid to the learning process by manipulating brightness variations within the visual environment. The study's findingsaffirm the hypothesis that attention reaction to visual aids can be enhanced by reinforcing brightness patterns. It further demonstrates that such manipulative lighting techniques can be an effective means of improving pupil attention while in long term use in an actual classroom.

115 Libby, WL., Lacey, BC. & Lacey, JI. 1973. Pupillary and cardiac activity during visual attention. Psychophysiology, 10(3), 270-294 (56 references)

Thirty pictures, rated on 22 scales, were shown to 34 males, while pupillary diameters and heart rates were recorded, to test the prediction that attention to the environment leads to sympathetic-like dilutation and parasympathetic-like cardiac slowing, and to study the relationships of the responses to stimulus-attributes. The prediction was satisfied, demonstrating directional fractionation and situational stereotypy. Tonic levels changed significantly during the experiment and also showed directional fractionation. A few individuals and stimuli, however, yielded reliable pupillary constriction, demonstrating

intra-stressor sterotypy. Four factors characterized the ratings, two of which were associated with the autonomic responses. Pupillary dilatation and cardiac slowing increased as the Attention-interest value increased. Pupillary dilatation was greatest to pictures midway on the Pleasantness-Evaluation factor, and greater to unpleasant than to pleasant stimuli. Cardiac slowing was linearly related to pleasantness, with unpleasant stimuli provoking the greatest slowing. The two responses were correlated less than measurement reliability would have allowed, demonstrating quantitative dissociation. When base-corrected scores were used the correlations again were low and highly variable among subjects and stimuli, even in direction.

116 Lion, JS. 1964. The performance of manipulative and inspection tasks under tungsten and fluorescent lighting. Ergonomics, 7, 51-61 (8 references)

The influence of different lighting systems giving the same level of illumination upon performance of manipulative and inspection tasks was studied. Fifty-three students were given a battery of four tasks, once under tungsten light and once under fluorescent light. Three manipulative tasks consisted of size-grading ball-bearings, needle threading and measuring steel rods. The fourth task, a clerical one, involved reading columns of paired numbers. Results showed that on the three manipulative tasks subjects worked significantly more quickly under fluorescent light than under tungsten light but did not make significantly more errors. The type of lighting appeared to have no effect on performance of the clerical task. It is suggested that working under a tungsten light (filament) may produce more fatigue due to increased glare. Differences in performance by males and females, and the effect of practice are also shown. Future experiments on this subject are outlined.

117 Lishman, JR. & Lee, DN. 1973. The autonomy of visual kinaesthesis. Perception, 2, 287-294 (7 references)

Kinaesthesis, the sensing of body movement, which is essential for controlling activity, depends on registering the changes which accompany body movement. While there are two basic types of change - mechanical (articular, cutaneous, and vestibular) and visual - and so two potential sources of kinaesthetic information, the mechanical changes have traditionally been considered the basis of kinaesthesis, vision being considered a purely exteroceptive sense. JJ. Gibson, on the other hand, has argued that vision is a powerful kinaesthetic sense. To test this idea visual-mechanical kinaesthetic conflicts were created by moving the visible surroundings linearly forward and backward around a passively or actively moving subject. In most cases vision dominated. Therefore vision is not a purely exteroceptive sense, nor is visual kinaesthesis simply an adjunct to mechanical kinaesthesis. Vision is an autonomous kinaesthetic sense.

118 Logan, HL. 1976. Light and the benign indoor environment. In: Commission Internationale de l'Eclairage, Compte Rendu, 18e Session, Londres 1975, Bureau Central de la CIE, Paris, 795-803 (15 references)

The introduction of artificial electrical fields has upset the balance between people and their environment. There is more to "light" than can be seen by the naked eye. This paper discusses the need to redress the balance in the indoor environments. It explains how man escaped from his ecological niche, and why he can now only survive artificially, protected by his inventions; and is now, and must, increasingly work, learn and live indoors. It explains that the basic "substance" of his environment is energy - sealevel solar radiation and its accompanying electrostatic-ionic and other energy fields, and what profound effect they have on human health. It gives the principal elements in designing the optimum indoor environment, which are summed up in a "Design Clock". In concludes that lighting equipment of the future will provide every service required to deliver the optimum indoor climate, being based on satisfying the vital needs of the body as well as the eyes. It ends with the hope that the CIE will widen its purview to include all the effects on people of sea-level solar radiation and its artificial substitutes, and includes an Appendix listing the main established effects from 250 to 2800 nanometers.

119 Lukins, NM. & Sherman, IC. 1941. The effect of color on the output of work of psychotic patients in occupational therapy. Occupational Therapy and Rehabilitation, 20, 121-125 (1 reference)

The color of the materials used had no effect on the output of work of psychotic patients when weaving on the Todd loom or performing rake knitting, utilizing red, black or white materials.

120 Maas, JB., Jayson, JK. & Kleiber, DA. 1974. Effects of spectral differences in illumination on fatigue. Journal of Applied Psychology, 59(4), 524-526 (4 references)

An experiment was conducted to determine the effects of different spectra of environmental illumination on fatigue after a period of studying. No significant differences in the subjects' self-reported states were identified. However, objective measures revealed less perceptual fatigue and better visual acuity under lighting which closely approximated the spectral quality of natural sunlight than under traditional cool-white lighting.

121 Maier, B., Behar, I. & Bevan, W. 1961. The effect of auditory stimulation upon the critical flicker frequency for different regions of the visible spectrum. American Journal of Psychology, 74, 67-73

The authors report that an increase in the loudness of a tone is associated with a decrease in the C.F.F. of an orange light; that a similar increase has no effect with a green light, but raises the C.F.F. of blue lights. Pitch, they claim, has no influence on C.F.F., but in conjunction with loudness and colour, seems to have a significant effect.

122 Marjerrison, G. & Keogh, RP. 1967. Electroencephalographic changes during brief periods of perceptual deprivation. Perceptual and Motor Skills, 24, 611-615 (14 references)

16 schizophrenic Ss, exposed to a bright structureless visual field in a perceptual deprivation situation, showed mean decreases of 0.25 cycles/second ($p < .05$) in alpha frequencies measured from occipital EEGs. The mean decreases in alpha frequency occurred during both sessions in a drug-placebo test and retest, without the amount of the mean change significantly differing between drugs vs placebo, or first vs second testing. The decreases correlated with a measure of perceptual field-dependency but not with ratings of symptomatology or of the amount and quality of visual imagery reported by Ss. Such frequency decreases, comparable to those measured by other investigators over 7-day periods of perceptual deprivation, are suggested to depend upon conditions of high input levels of unpatterned optic stimulation.

123 Markle, A. 1976. Eye color and responsiveness to arousing stimuli. Perceptual and Motor Skills, 43, 127-133 (14 references)

The hypothesis was advanced that dark-eyed subjects are more responsive to arousing stimuli than light-eyed subjects. 40 subjects listened to neutral and arousing auditory stimuli and viewed scenes which were neutral, violent, or sexual in nature. The dependent measure of arousal was a score derived from a combination of physiological responses recorded on a polygraph. Scores were significantly higher for dark-eyed that light-eyed subjects. Significant sex differences were also found, females having higher scores than males. Implications for further research and application were discussed.

124 Marmolin, H. & Lisper, HO. (undated). Reaction time as a measure of night vision ability. Report 158. Department of Psychology, University of Uppsala, Sweden (18 pages, 7 references)

The hypothesis tested was that the amount of increase in reaction time (RT) due to decreased light intensity could be used as a measure of the light sensitivity of S. The results supported this hypothesis. A considerable interindividual correlation between the threshold for light and the amount of increase in RT was obtained. The relation between RT and light intensity could be described by an equation that allowed prediction of the threshold from the amount of increase in RT.

125 Maruyama, K. 1961. "Contralateral relationship" between the ears and the halves of the visual field in the sensory interaction. Tohoku psychol Folia, 19, 81-92

To test the assumption of intersensory "contralateral relationship" five experimental series were used, of which four were concerned with the effect of tone on visual sensitivity, and the other with the effect of light on auditory sensitivity. The tone delivered to one ear influenced the opposite half of the visual field and illumination of the right periphery of vision facilitated the sensitivity of the left ear.

126 Matulionis, RC. 1978. Effects of achromatic luminance intensities and contrasts on human performance. Man-Environment Systems, 8(4), 159-166 (21 references)

The aim of the study was to investigate whether and to what extent luminous conditions as found in an everyday environment affect human performance. The effects of varied luminance levels were investigated in six subjects in six different visual environments. The sequence of the visual conditions presented to the subjects were vertical surfaces of gray, white, black, black-white, white-black, and gray, combined with work plan of gray, white, black and gray. Four activities were performed by each subject in each of the visual activities consisting of closing and opening the eyes, drawing of squares, viewing a projected image of a triangle, and attempting at its reproduction. The responses of the subjects performing these activities were investigated for each environmental condition by monitoring visual motor performance, postural orientation, and physiologic events. The events monitored consisted of thirty-six dependent variables, twelve of which were investigated in conjunction with the performance of the visual motor tasks. The results of the experiment show that certain changes in the visual surrounds significantly modify human behavior. Heart and respiration rate as well as muscle characteristics of the visual motor tasks are affected by the stimuli of the visual environment. These implications are highly pertinent to the design of human environment.

127 Mayron, LW., Ott, JN., Nations, R. & Mayron, EL. 1974. Light, radiation, and academic behavior. Initial studies on the effects of full-spectrum lighting and radiation shielding on behavior and academic performance of school children. Academic Therapy, 10(1), 33-47 (6 references)

It has been demonstrated that the use of full-spectrum fluorescent lighting and radiation shielding decreased the hyper-active behavior of students in two first-grade rooms as compared to the students in two control rooms with standard cool white fluorescent lighting ($p<0.0005$).

128 McDonald, RL. 1966. Lunar and seasonal variations in obstetric factors. Journal of Genetic Psychology, 108, 81-87 (18 references)

This study was designed to assess lunar and seasonal variations in obstetric factors such as birth rates, birth weights, and incidence of prematurity. Subjects for the study were 1909 full-term Negro deliveries occuring over a six-year period at a southern community hospital. Births via Caesarean section or induction were excluded. Significant findings were as follows: (a) more births occur during the new-moon and full-moon phases than during the quarter phases; (b) monthly variations are observed in female birth rates, highest rates occuring in August and September; (c) there is a spring birth through (March, April, May) for female births; (d) mean male birth weights are reliably larger than mean female birth weights; and (e) mean male birth weights for fall months (September, October, November) are larger than those for spring months (March, April, May). These findings are discussed and related to previous results.

129 Miles, LEM., Raynal, DM. & Wilson, MA. 1977. Blind man living in normal society has circadian rhythms of 24.9 hours. Science, 198, 421-423 (18 references)

A psychologically normal blind man, living and working in normal society, suffered from a severe cyclic sleep-wake disorder. Investigations showed that he had circadian rhythms of body temperature, alertness, performance, cortisol secretion, and urinary electrolyte excretion which were desynchronized from the 24-hour societal schedule. These rhythms all had periods which were longer than 24 hours and indistinguishable from the period of the lunar day.

130 Miller, AR., Frauchiger, RA. & Kiker, VL. 1967. Temperoal experiences as a function of sensory stimulation and motor activity. Perceptual and Motor Skills, 25, 997-1000 (8 references)

This study was concerned with establishing quantifiable continua of phenomenal temporal judgments. Using 6 levels of sensory input and 3 levels of motor behavior, a linear relationship was found between sensory input and temporal estimations for a 90-sec. interval. Both sensory input and motor behavior had significant effects, but not the interaction. It was postulated that the so-called unfilled interval could be better understood if it could be related to various levels of information input.

131 Minneman, KP. & Wurtman, RJ. 1975. Effects of pineal compounds on mammals. Life Sciences, 17(8), 1189-1199 (149 references)

It has been suspected for many years the the mammalian pineal body secretes biologically active compounds. As early as 1938, investigators demonstrated that minute quantities of an extract of bovine pineal organs could delay sexual maturation in immature female mice. In 1958 the modern era of pineal research was initiated by isolating from bovine pineals the substance, melatonin, that aggregates the pigment granules in amphibian melanophores, and identifying is structure. Within a few years this compound was shown to be physiologically active in mammals: it surpressed ovarian growth in female rats. Subsequent studies have implicated melatonin in the funtional activities of numerous additional organs, including brain, pituitary, thyroid, adrenal, and smooth muscle. The isolation of melatonin and its use in experimental research has provided considerable support for the now widely accepted "melatonin theory of pineal function". This theory holds that the pineal body acts as a neuroendocrine transducer, converting a neural input to a hormonal output (melatonin); moreover, the rate of melatonin synthesis is thought to be controlled by environmental illumination. This paper briefly summarizes the literature concerning the effects of melatonin and other pineal compounds on mammals.

132 Montagu, JD. 1967. The relationship between the intensity of repetitive photic stimulation and the cerebral response. Electroencephalography and Clinical Neurophysiology, 23, 152-161 (12 references)

Sixteen healthy subjects were subjected to flicker at four intensities (modulation depths) of square wave stimuli from an electro-luminescent source. Each subject was stimulated at eight flash rates ranging from 6 to 30 c/sec at each of the four intensities and the whole procedure was performed twice in one session. Recordings were taken from a single pair of electrodes on the occiput and vertex. The cerebral rhythms were analysed by means of a frequency analyser. The principal results were as follows: (1) During stimulation at the lowest rate (6 c/sec) and at the higher rates (16-30 c/sec) the fundamental response increased with each increase in intensity. The relationship was approximately linear when the log response was plotted against intensity on a linear scale. (2) During stimulation at the intermediate rates (8-12 c/sec) the fundamental response increased with the intensity only up to a certain point. A further increase in intensity resulted in a decrease in response. (3) During stimulation at 8-12 c/sec the second harmonic response showed a similar trend with intensity to that of the fundamental response. The relationship between the pattern of response to stimulation and the frequency spectrum of the spontaneous rhythms was examined between subjects.

133 Moore, RY., Heller, A., Wurtman, RJ. & Axelrod, J. 1967. Visual pathway mediating pineal response to environmental light. Science, 155, 220-223 (14 references)

Activity of the melatonin-forming enzyme, hydroxyindole-O-methyltransferase in rat pineal is increased when the animal is exposed to continuous darkness, and it is decreased by exposure to continuous light. Response to environmental light is initiated in the retina and transmitted to the pineal by way of the central nervous system and the cervical sympathetics. The central visual pathway essential for mediation of this response is the inferior accesory optic tract. Visual pathways to thalamus and tectum do not participate in this response.

134 Moruzzi, G. & Magoun, HW. 1949. Brain stem reticular formation and activation of the EEG. Electroencephalography and Clinical Neurophysiology, 1, 455-473 (42 references)

Transitions from sleep to wakefulness, or from the less extreme states of relaxation and drowsiness to alertness and attention are all characterized by an apparent breaking up of the synchronization of discharge of elements of the cerebral cortex, an alteration marked in the EEG by the replacement of high-voltage slow waves with low-voltage fast activity. The magnitude of the electrical change parallels the degree of transition, and that most commonly observed in clinical electroencephalography is a minimal one, consisting of an alpha-wave blockade during attention to visual stimulation. Such activation of the EEG may be produced by any type of afferent stimulus that arouses the subject to alertness, or it may be centrally generated, but the basic processes underlying it, like those involved in waking from sleep, have remained obscure. Experiments on cats have identified a

cephalically directed brain stem system, the stimulation of which desynchronizes and activates the EEG, replacing high-voltage slow waves with low-voltage fast activity. This system is distributed through the central core of the brain stem and appears to comprise a series of reticular relays ascending to the basal diencephalon. Its effects are exerted generally upon the cortex and are mediated, in part, at least, by the diffuse thalamic projection system. Possible implications of this system in the arousal reaction to afferent stimulation and in the maintenance of wakefulness is discussed.

135 Nakshian, JS. 1964. The effects of red and green surroundings on behavior. Journal of General Psychology, 70, 143-161 (19 references)

Three hypotheses derived from Goldstein's theory concerning the differential effects of red and green "environments" on behavior were tested as to their validity for a normal population. Hypothesis I stated that efficiency of performance on tasks requiring relatively fine psychomotor coordination will be greater under green than under achromatic, and greater under achromatic than under red. Hypothesis II made the same statement in regard to the accuracy of psychophysical judgments. Hypothesis III stated that red, as compared to achromatic, will have an expansive effect, and green, as compared to achromatic, will have a contractive effect on the performance of arm movements made laterally both away from and toward the vertical midline of the body. The Ss were surrounded on three sides by colored surfaces. The results indicated some support for Hypothesis I, but no support for Hypothesis II and III. The overall results gave very limited support to Goldstein's theory and to widely held assumptions about the effects of colored surroundings on psychomotor and intellectual functions. The effects found were limited to two tasks, Hand Tremor and Motor Inhibition, which appear to share a common factor of measuring inhibitory control over motor expression.

136 Nelson, TM., Bartley, SH. & Jordan, JF. 1963. Experimental evidence for the involvement of a neurophysiological mechanism in the discrimination of duration. Journal of Psychology, 55, 371-385 (20 references)

In three experiments, naive subjects discriminated the duration of intervals filled with intermittent photic stimuli. The photic presentations selected were such as to vary amplitude and synchrony of optic pathway activity. The results indicate that (a) amplitude and synchrony of optic pathway activity do have an effect although this effect perhaps interacts with autochthonous cortical activity; and (b) the continuum of duration discrimination is linear but not precisely parallel to the time continuum, the indifference point depending upon adaptation level and the specific nature of interval filling. There is some evidence indicating that self-produced standards are used when the experimental design makes this possible and are likely an important variable in discrimination of longer intervals. A methodology was devised to eliminate this practice.

137 Nourse, JC. & Welch, RB. 1971. Emotional attitudes of color: A comparison of violet and green. Perceptual and Motor Skills, 32, 403-406 (4 references)

14 human Ss were exposed for 60-sec intervals to violet light and to green light, in alternating order, for a total period of 6 min. Electrical skin conductance was monitored throughout the session. The crucial measure was the galvanic skin response (GSR) occurring in the first 12 sec of exposure to a given color. As predicted, GSR was greater to violet than to green.

138 Nyström, M., Bogren Hansson, M. & Marklund, K. 1975. Infant preference of intermittent light. Psychological Research Bulletin 15(4), Lund University, Sweden (11 pages, 19 referencesI

Obtained systematic fixation behaviour for five frequencies of intermittent light presented in pair combinations to two groups of infants aged 4-8 and 8-12 weeks respectively. The fusion frequency 100 Hz induced less visual fixation than the other four frequencies, 1, 5, 10 and 20 Hz, among which a higher one generally evoked longer fixations. The results support the assumption that the same type of proximal stimulation underlies infant preference for complexity, moving objects and intermittent light. Furthermore, the data are in line with a developmental frame of reference in which preference for spatial as well as temporal complexity is governed by a principle of age-related optimal stimulation.

139 O'Leary, KD., Rosenbaum, A., Brook, S. & Hughes, PC. (undated). Fluorescent lighting: A purported source of hyperactive behavior. Accepted for publication in the Journal of Abnormal Child Psychology, April 1977 (19 pages, 15 references)

Seven first grade children with conduct disorders and/or hyperactivity attended full day sessions at a laboratory school classroom. During an eight week period, the classroom lighting conditions alternated at the end of each week. During odd numbered weeks, the classroom was illuminated by a standard cool white fluorescent system. On even numbered weeks illumination was a daylight simulating fluorescent system of equal foot candles with controls for purported soft x-rays and radio frequency (RF). There were no effects of lighting conditions on hyperactive behavior as assessed by (a) independent observations of task orientation or (b) ratings of activity level. A Critical Flicker Fusion measure, a reported indicator of visual-sensory fatigue, indicated that the daylight simulating condition was associated with a decreasing CFF across weeks.

140 Orth, DN. & Island, DP. 1969. Light synchronization of the circadian rhythm in plasma cortisol (17-OHCS) concentration in man. Journal of Clinical Endocrinology, 29, 479-486 (18 references)

In order to determine whether the pituitary-adrenal cycle of normal man is synchronized by the dark-light cycle or by some other phenomenon associated with the sleep-wake cycle, normal subjects

underwent experimental alteration of their dark-light schedules in such a way that partial dissociation of the dark-light schedules from the sleep-wake schedule was achieved. In addition, 3 blind subjects were studied. The normal subjects were allowed several days to become adapted to a given schedule prior to sampling of blood for plasma 17-hydroxycorticosteroid (17-OHCS) determinations. Hourly blood specimens were obtained through indwelling venous catheters in such a manner as to avoid disturbing sleep or exposing the subject to light during dark periods. Each subject slept 8 hours each day from 10 pm to 6 am, and the schedule of meals and activity was identical for all studies; only the dark-light schedules were altered. When the hours of darkness were scheduled in the middle of the waking day, from 10 am until 6 pm, normal subjects exhibited, in addition to the usual 17-OHCS peak at the time of awakening, a second peak in plasma 17-OHCS at the time of illumination. When darkness began at 10 pm but was prolonged until 10 am, 4 hours after awakening, the peak in plasma 17-OHCS occured only when the lights were turned on, not when the subjects awakened. When normal subjects were kept in total darkness except for 1 hour of light from 6 to 7 pm, the peak usually seen at the time of awakening was delayed and diminished and a second major peak was observed during the brief period of illumination. Two of the 3 blind subjects were found to have plasma 17-OHCS rhythms that were not normally synchronized with sleep. One blind subject, studied on 2 occasions, appeared to have a shift in the timing of the 17-OHCS cycle, suggesting that he had a fre-running circadian rhythm. It is concluded that the dark-light cycle may be an important synchronizer of the pituitary-adrenal cycle in man.

141 Osterman, PO. 1974. Light synchronization of the circadian rhythm of plasma 11-hydroxocorticosteroids in man. Acta Endocrinologica, 77, 128-134 (15 references)

The levels of plasma 11-hydrocorticosteroids were studied in 4 healthy subjects with a constant sleep-waking cycle and a constant activity schedule before and after experimental alteration of the dark-light cycle. The subjects slept in the dark from 10.30 pm to 6.30 am. During a control period of 10 days the subjects stayed in rooms which were well lighted after 6.30 am. During the following 10 days darkness was prolonged by 4 h until 10.30 am. Hourly blood samples were obtained from 2.30 to 11.30 am on days 9 and 10 of each period. Following the period of prolonged darkness there was a shift in the rhythm of the plasma 11-hydroxycorticosteroids. The secretion period in the morning started later than during the control period. Present data indicate that in man the dark-light transition is important for the synchronization of the circadian plasma cortisol rhythm in the morning.

142 Ott, JN. 1976. Health and light. The effects of natural and artificial light on man and other living things. Pocket Books, New York (222 pages, 91 references)

The light side of health - How it began - The electromagnetic spectrum - Reluctant apples and timid tiger lilies - Light and the endocrine

system - I break my glasses - An experiment with phototherapy on human cancer patients - Chloroplasts and light filters - Animal response to light - Bilogical effects of tinted lenses - Effects of radiation on biological clocks - The TV radiation story - Trace amounts of radiation and full-spectrum lighting - Photobiology comes of age - Routine opposition to new ideas as standard procedure.

143 Page, RA. & Moss, MK. 1976. Environmental influences on aggression: The effects of darkness and proximity of victim. Journal of Applied Psychology, 6(2), 126-133 (14 references)

It was hypothesized that darkness acts as a disinhibitor, and that subjects would deliver higher intensity shocks to a victim in a dimly lit setting than in a brightly lit setting. It was also predicted that this effect would be greater when subject and victim were in close proximity than when they were isolated from each other. The results supported these predictions. It was suggested that lighting may have important effects on social behaviors, and that further research on the influences of lighting on human behavior is needed.

144 Pelligrini, RJ. & Schauss, AG. 1980. Muscle strength as a function of exposure to hue differences in visual stimuli: An experimental test of the kinesoid hypothesis. Orthomolecular Psychiatry, 9(2), 144-147 (19 references)

The study was conducted to test experimentally the kinesoid hypothesis that visual stimuli of different hues may differentially affect muscle strength. Thus, the maximum squeze strength of N = 72 subjects (36 males, 36 females) was measured using a hand dynomometer, as Ss stared at blue or pink cardboard plate. The results of 2(sex) x 2(plate colour) mixed design factorial ANOVA indicated significantly higher squeeze strength scores: (a) for males than for females; and (b) in response to the blue as compared with the pink plate. In view of the limited magnitude of the plate color effect, however, the results were interpreted as providing only partial support for the kinesoid hypothesis.

145 Philipp, RL. & Wilde, GJS. 1970. Stimulation seeking behavior and extraversion. Acta Psychologica, 32, 269-280 (41 references)

According to Eysenck, extraverts require more external stimulation than introverts in order to maintain optimal arousal levels. Manipulation of stimulation was attempted, by markedly reducing sensory input without the S's prior expectancy, thereby minimizing the possible occurrence of differential demand characteristics. Seven measures of extraversion were used to select the final S samples. A lever-pulling task was reinforced with light and music. Extraverts had significantly higher initial and overall response rates than introverts. Predicted performance decrements and reminiscence were not manifested. Findings concerning extraverts' higher need for stimulation were discussed in terms of Eysenck's theory, hedonic value of reinforcement, differential drives and "time-out" from positive reinforcement.

146 Pierce, DH. & Weinland, JD. 1934. The effect of color on workmen. Personality Journal, 13, 34-38 (no references)

The experiment described here was undertaken to examine the effect of color upon men working at the Bogardus factory test machine. Various colored lights were used, one by one, in a room painted white. The men were paid wages and employed for regular working days. Output was measured and introspective reports of bodily feeling were taken every fifteen minutes. The findings favored white and indicated that nervous excitation resulted when the colors deviated from white. Introspective feeling reactions were marked but not consistent. Green for instance did not appear to be characteristically stimulating nor blue soothing. There was no evidence supporting the view that red is warm and green is cool. The results indicate that feeling responses to color are due to association of color with objects rather than to any inherent feeling response to color itself.

147 Plack, JJ. & Shick, J. 1974. The effects of color on human behavior. Journal of the Association for the Study of Perception, 9(1), 4-16 (75 references)

The purpose of this article was to review selected color research and relate it to motor performance. The color research was classified according to physical variables, perceptual variables, color preferences and moods. Following the review, the writers discussed implications of the research for motor performance and advanced hypotheses which may be productive to pursue. It is hoped that the reader will be motivated to adapt and/or extend the hypotheses to the individual's educational disciplines.

148 Pressey, SL. 1921. The influence of color upon mental and motor efficiency. American Journal of Psychology, 32, 326-356 (40 references)

First to be considered are possible differences among the hues, in their effects upon mental and physical activity. The writer feels that there is no adequate evidence in previous work to show any such differences. He has found no such differences in the present experimentation. The common notion that certain hues have a marked influence upon emotional tone and mental work is the result, he believes, of such subtle and pervasive influences, arising from figures of speech, custom, artistic and social convention, and everyday association of certain hues to other sensations of a strong affective toning. The misconception may also be due in part to a failure to differentiate the influence of brightness from the influence of hue. If there is an effect of illumination upon mental work, it would appear, then, that brightness must be the important factor. Certain of the experimental results obtained by the writer have suggested a slowing of mental work under dim light and a stimulation under bright light. Such an effect is at least not incompatible with what little previous work has been done in this field; and the hypothesis of a stimulating or dynamogenic influence of brightness upon mental work and neuro-muscular tone seems by no means unreasonable. It need hardly be added that, if there is such an influence it is a matter of great general importance, from a practical point of view.

149 Radnot, M. 1964. Die Wirkung der Beleuchtung auf die vegetativen Funktionen des Menschen. In: Commission Internationale de l'Eclairage Compte Rendu, Quinzieme Session, Vienne 1963, Volume C, Bureau Central de la Commission, Paris, 530-533 (no references)

Light, more precisely visible light, does not only enact a psychological action but also has a stimulating effect upon the human organism. The effect manifests itself in the human body by the neuroendocrine system. In weak daylight or insufficient illumination, the stimulus of light is missing. The effect of light can be registered by the change in the number of eosinophil cells of the blood. The light can only perform such effect if the eye, or better to say the corresponding part of the retina, is intact, and if an adequate quantity of light reaches the retina. Accordingly, for the physiological function of human organism a sufficient amount of light is wanted.

150 Ramage, WW. 1976. Task performance under stimulating light. In: Commission Internationale de l'Eclairage Compte Rendu, 18e Session, Londres 1975, Bureau Central de la Commission, Paris, 261-267 (14 references)

An experimental "scanning" light source which cyclically swept a work area with sharply focused bands of light was evaluated as a stimulating light source. It was hypothesized that the moving edges of the light bands, although above fusion threshold, would help maintain arousal and performance by creating activity on the visual pathways and in the activating centers of the brain. Performance under the experimental light was compared against performance under conventional incandescent light. Three tasks of a routine nature were used to measure performance changes. These were a vigilance task, a typing task, and a simulated driving task. The measure of performance was basically rate: typing speed or reaction time. The mean of this measure for each subject under the two light sources was compared for significant differences. The experimental results show a small but consistent improvement in task performance under the scanning light source. During two hour sessions, the reaction time performance in the vigilance and driving tasks were significantly better with the scanning light as compared to the incandescent light. In the typing task, the typing speed was maintained better with the scanning light source. These results are preliminary in that the experiments were primarily exploratory. The scanning light parameters were chosen arbitrarily and no attempt was made to optimize them. It is expected that even greater performance gains can be obtained by studies which lead to the enhancement of the relevant physiological effects.

151 Reinberg, A. 1967. Eclairement et cycle menstruel de la femme (Lighting and the human menstrual cycle). In: La photoregulation de le reproduction chez les oiseaux et les mumiferes. Rapport au Collegue Inter du CNRS, Montpellier, 529-548 (40 references)

This problem can be discussed in the light of indirect evidence only. 1) Descriptive statistical studies on human population suggest that a) menarche occurs predominantly during the winter in the northern hemisphere; b) later at 600 m altitude than at lower levels; and

c) earlier in blind girls than in girls with normal vision.
2) Least square spectral analysis of rectal temperature series of a woman of 26 years age before, during and after 80 days of isolation under-ground without known synchronizer and with light on a self-selected schedule during isolation (intensity not exceeding 50 lux at 1 meter from source) revealed that several spectral components persist during isolation: the period of the circadian rhythm lengthens during isolation from 24 to 24.5 hours, whereas a circatrigintan spectral component of about 29 days shortens during isolation to 25.9 days on the average; menstrual cycle length undergoes changes comparable to those of the circatrigintan component of body temperature. Such various descriptive statistical (1) and physiological approaches (2) yield indirect tentative evidence suggesting that the environmental lighting regimen, (among others environmental factors) which is known to affect gonodal function in small mammals, also influence the ovary of women, although one can not differentiate between a possible stimulating effect of darkness and/or an inhibition of ovarian activity by light.

152 Saltarelli, CG. & Coppola, CP. 1979. Influence of visible light on organ weights of mice. Laboratory Animal Science, 29(3), 319-322 (10 references)

Hau:ICR mice separated by sex, were reared for 30 days under various fluorescent lamps; pink, blue, black UV, cool white and full spectrum. Body weights and absolute organ weights were compared. After light exposure, female body weights were not significantly different between any groups; however, a difference in male body weights was observed. Light affected the weights of the pituitary, adrenals, kidneys and prostate in male mice and the adrenals, thyroid and pineal glands in females. The weight of adrenal glands of both males and females were most sensitive to changes in lighting.

153 Salzarulo, P., Lairy, GC. & Bancaud, J. 1976. Striate cortex potentials related to eye movements in the light and in darknes in the waking human. Perception, 5, 303-308 (17 references)

Potentials in relation to eye movements were studied by means of direct recording of the striate cortex in a waking man. In a lighted environment, the usual evoked potential - lambda response was obtained and was clearly visible after each eye movement. In complete darkness no individual potential was observable by means of visual analysis after each eye movement, but a slow potential of low amplitude could be obtained by superimposition and averaging of the cortical striate activity time-locked to the start of a series of eye-movements. This eye-movement potential showed a longer latency and a lower amplitude than the lambda response. These data are discussed in reference to those obtained in the cat and the monkey; the significance of this eye-movement potential in darkness as a "corollary discharge" is considered.

154 Sanders, M., Gustanski, J. & Lawton, M. 1974. Effect of ambient illumination on noise level of groups. Journal of Applied Psychology, 59(4), 527-528 (13 references)

The ambient illumination level was varied in a natural setting. Unobtrusive measures of the noise produced by groups of people gathering in the area revealed a significant ($p<.001$) reduction in noise under the low-illumination conditions. Suggestions for future research are presented.

155 Saunders, MG. & Zubek, JP. 1967. EEG changes in perceptual and sensory deprivation. Electroencephalography and Clinical Neurophysiology, Suppl 25, 246-257 (28 references)

Observations on changes in the EEG produced by 7-14 days sensory and perceptual deprivation in healthy young adults have been explored and attempts made to correlate the EEG changes with other factors. Continuous exposure to unpatterned light and noise produces the greatest effect on the occipital EEG activity. Absence of stimuli produces a lesser effect. Kinesthetic deprivation in the presence of otherwise normal backgrounds of stimulation also produces EEG changes whilst increase in kinesthetic stimulation during perceptual deprivation decreases EEG changes. Prior knowledge of the duration of deprivation appears to modify the rate of change in the EEG activity. There appears to be no clear evidence as to the cause of the EEG changes but deprivation appears to have marked effects on the individual both in the psyche and the soma.

156 Smets, G. 1969. Time expression of red and blue. Perceptual and Motor Skills. 29, 511-514 (8 references)

The present investigation was designed to test the hypothesis that an observer perceives the time interval spent before a red colour stimulus as shorter than objectively the same time interval spent watching a blue colour stimulus. The hypothesis was supported.

157 Stern, RM. 1964. Effects of variation in visual and auditory stimulation on gastrointestinal motility. Psychological Reports, 14, 799-802 (6 references)

The purpose of this experiment was to investigate the effects of three different stimulus conditions on gastrointestinal motility as measured by electrodes on the surface of the abdomen. The 16 Ss were each run for two 40-min. sessions, during which they were instructed to lie quietly on a cot. Amplitude differentiated between a group that recieved diffuse stimulation and groups that received normal stimulation and no stimulation, with the former showing greater activity throughout the session. The increase in gastrointestinal activity for Ss in the diffuse stimulus group is attributed to the novelty and ambiguity of the stimulus situation.

158 Stolper, JH. 1977. Color induced physiological response. Man-Environment Systems, 7, 101-108 (20 references)

Color theory has produced the concept of "warm", or advancing, and "cool", or receding colors. It describes the psychological effects upon a subject viewing colors at opposite ends of the visible spectrum. The purpose of this study was to determine if advancing and receding colors in the bakground of a reading task could induce adverse stress in a subject. Twenty subjects performed a reading task under six experimental conditions while the investigator recorded changes in the accomodation of the lens of the eye, changes in retinal color, and shifts in the face plane. The results showed that accomodation of the lens was increased with a red bakground and decreased for a blue bakground. Retinal color changed in the subject performing a reading task against either a red or blue background. A shift in face plane was measured in 90 percent of the observation. Accomodation and face plane shift were used as indicators of the presence of adverse stress in a subject. Conclusions drawn from the investigation lend support to the theory that advancing or receding color in the background of a visual task induces differential responses in a subject. Response to colors was predictable, and blue, of the specifications used in this study, in the background of a close visual task could induce adverse stress in a subject.

159 Stone, PT., Harker, SDP., Coley, WZ., Ruff, HR. & Jones, G. 1974. Light, endocrine mechanisms and stress. In: Stone, PT. et al. Human reactions to high intensity lighting. LUTERG Report No 156, Section 2, Department of Human Sciences, Loughborough, 9-100 (47 references)

Six males aged 23 to 47 years were subjected to two levels of illumination for 4 hours during two consecutive mornings. The illumination consisted of 51 fluorescent tubes along the ceiling of the experiment room giving a diffuse light of 1.000 lux on one occasion and 11.000 lux on the other. The methods employed to study the effects of the different illumination levels included, besides two questionnaires of room and mood assessment, pulse rate as well as biochemical analyses of urinary steroid excretion, plasma growth hormone and plasma cortisol. The most clearcut result was an increase in pulse rate which occurred as soon as the high intensity lighting was switched on and remained for the whole period. Also, according to the verbal response the higher lighting level gave rise to an increased sense of fatigue, decreased social affection, and thermal comfort. The result is interpreted on a neuroendocrine basis suggesting a model where light, via the retina regulates the activity of the sympathetic nerves to the pineal. The results might indicate that glarefree high intensity lighting is unlikely to evoke stress responses, but when the lighting has a discomfort factor added, i.e. an affective component, then possible stress mechanisms will come into operation. The article includes an overview of studies on biological effects of lights.

160 Sucov, EW. & Taylor, LH. 1976. Behaviors affected by non-uniform light distributions. In: Commission Internationale de l'Eclairage, Compte Rendu, 18e Session, Londres 1975, Bureau Central de la CIE, Paris, 737-743 (10 references)

Two experiments were performed. The first demonstrated that, under equal illumination at left and right side, 67% of the people chose the right side. When the illumination ratio was 100 to 1, 100% of the subjects chose the right side when it was brightest and 75% chose the left side when it was brightest. The second experiment showed that performance, as measured by two simultaneous visual-mental tasks, was best under non-uniform illumination as compared with uniform or psychedelic illumination.

161 Tasso, J. & Miller, E. 1976. The effects of the full moon on human behavior. Journal of Psychology, 93, 81-83 (3 references)

Data were gathered in a large metropolitan area over a period of one year as to nine categories of 34.318 criminal offenses committed during the phases of the full moon and non full moon. It was found that the eight categories of rape, robbery and assault, burglary, larceny and theft, auto theft, offenses against family and children, drunkenness, and disorderly conduct, occurred significantly more frequently during the full moon phase than at other times of the year. Only the category of homicide did not occur more frequently during the full moon phase. The results support further exploration and research related to cosmic influences on man's behavior.

162 Terstenjak, A. 1962. Motorische Reaktionswerte einzelner Farbtöne und ihre statistische Erheblichkeit. Die Farbe II, Nr 1/6, 147-152 (2 references)

By two series of experiments the reaction times have been determined for the hues blue (two shades), green, yellow, red (four shades) and white. The values of the reaction time have been found to be inversely proportional to the respective wave-lengths. Among 36 differences, 19 have been found of statistical significance.

163 Terstenjak, A. 1967. Zur Frage der "langweiligen" Farben. Die Farbe, 16, Nr 1/6, 131-138 (no references)

The question under examination is whether a scientific foundation can be found for the popular distinction between colors that are found "boring" and those that are not, in other words, whether or not the exclusive influence of a given color causes the viewing time to be overestimated as against other colors. An experiment with 84 observers showed that the duration of viewing was underestimated only with yellow and brown; for the other colors it was overestimated. In a second series of experiments under the same conditions individual sympathy for different colors was tested. Analysis of variance showed that there is considerable statistical correlation between a given color and the degree of sympathy evinced, but the degree of sympathy among the subjects tested showed insignificant variance. Therefore in order to meet "functional color" demands it is not absolutely essential to take into account differences in the subjective taste for colors.

164 Thomas, GJ. 1941. An experimental study of the influence of vision on sound localisation. Journal of Experimental Psychology, 26, 143

Subjects were presented with sounds located between a steady light and a light flickering with the same rhythm as the sound. A lateralization effect was found such that the subjects were inclined to localise the sounds in the direction of the flickering light.

165 Thorington, L. (ed). 1978. Actinic effects of optical radiation. Bibliography and keyword index. First Draft. CIE TC 1.7, Duro-Test Corporation, 2321 Kennedy Boulevard, North Bergen, New Jersey, 07047, USA (840 pages of references)

The references have been accumulated and the keywords have evolved over a period of more than ten years. Listing 1.400 keywords and more than 800 pages of references this is probably the most extensive bibliography in the field. For the most part the bibliography deals with the effects of optical radiation on animate life although some peripheral related items are included.

166 Tibbs, BC. 1979. Light and Man's health. BC. Tibbs. 13 Wyatt Road, London N5 2JU (46 pages, 143 references)

Introduction. Light and light absorption. Photobiology: Photosynthesis. Vision. Non-visual light responses in man. The non-visual role of the eye. Responses to wavelength and colour: Colour effects in animals; Colour effects in man; White light effects; Near ultraviolet; Full spectrum light; Mediating mechanisms. Phototechnology. Conclusion. Bibliography.

167 Ulett, GA., Gleser, G., Winokur, G. & Lawler, A. 1953. The EEG and reaction to photic stimulation as an index of anxiety-proneness. Electroencephalography and Clinical Neurophysiology, 5, 23-32 (23 references)

One hundred and ninety subjects (patients and controls) were utilized in an attempt to develop an EEG measure for selecting anxiety-prone individuals. All were carefully studied by psychological tests and psychiatric interviews and rated for their proneness to develop anxiety under stress. EEGs were taken under resting conditions and during intermittent photic stimulation. An electronic brain wave analyser was used. There was a significant correlation between the criteria of anxiety-proneness and the following: 1. per cent of fast, slow and low alpha activity in the electronically analysed resting EEG. 2. Pattern of fundamental driving response. 3. Amount of harmonic driving response particularly in the 20-30 c/sec. range to stimulation with flicker frequencies 1/2 or 1/4 this rate. Amount of subjective dysphoria produced by intermittent photic stimulation. A check list of EEG anxiety indicators derived from the above correlated 0.51 with the validating criterion of anxiety-proneness.

168 Walsh, JF. & Misiak, H. 1966. Diurnal variation of critical flicker frequency. Journal of General Psychology, 75, 167-175 (10 references)

The effect of hour-to-hour variability upon critical flicker frequency (CFF) thresholds of 60 college resident students, 30 males and 30 females, was investigated. Monocular thresholds were obtained by the method of constant stimuli from 8 a.m. to 8 p.m. in five sessions spaced three hours apart. A diurnal effect was found in which there is an inverse relationship between CFF thresholds and time of day ($p < .05$). The highest values for CFF were obtained at 8 p.m. and 11 a.m., indicating a non-linear relationship was also present ($p < .05$). In addition, three patterns of response were detected: (a) positive slope - indicating an increase in CFF values with time of day; (b) negative slope - showing a decrease in CFF with time of day; and (c) zero slope - reflecting no basic change in threshold values over time. The validity of the three patterns of responding needs to be explored systematically in CFF as well as in other perceptual and cognitive areas. Such patterns would be strong evidence against using averaged data in making evaluations of a function or an agent.

169 Walter, VJ. & Walter, WG. 1949. The central effects of rhythmic sensory stimulation. Electroencephalography and Clinical Neurophysiology, 1, 57-86 (58 references)

Records obtained during photic stimulation may be described in terms of the following components, any or all of which may be present at any time, or from time to time. A. A series of descrete elementary evoked responses, B. Fusion of evoked responses giving an accidental appearance of rhythmicity, C. Instrumental summation of evoked response and spontaneous rhythms, D. True augmentation or "driving" of local rhythms at the frequency of the stimulus, E. Augmentation of harmonically related rhythms in other areas. Differences between individuals are attributable in some cases to anatomical variations and correlate also to some extent with the character of their spontaneous activity, with age and with differences in personality. Alterations in the response in given individuals are produced by somatic, mental and emotional changes whether spontaneous, voluntary or induced. Somatic, mental and emotional changes can be induced in the subject by stimulation at appropriate frequences. The above effects can interact with one another in both regenerative and degenerative fashion. Subjective visual effects are attributed to interference between rhythmic evoked responses and spontaneous rhythms at cortical and possibly thalamic levels. Anomalous (non-visual) effects in normal and abnormal subjects are attributed to interaction between the evoked activity and harmonically related spontaneous rhythms in other circuits at a thalamic level. Evocation of activity in non-visual circuits can be used to study their physiology and as an aid to diagnosis of some pathological conditions. Some theoretical implications of these findings are speculatively discussed.

170 Wetterberg, L. 1978. Melatonin in humans. Physiological and clinical studies. Journal of Neural Transmission, Suppl 13, 289-310 (26 references)

Studies are reported of the variation of melatonin in serum, plasma urine and cerebrospinal fluid in normal subjects and in patients

with various diseases. The diurnal variation of plasma and urine melatonin found in healthy controls on a regular dark-sleep pattern persisted when the subjects slept in light. The effect of sleep deprivation and of rapid light exposure at night is reported. There was a correlation between melatonin in morning urine and plasma at 2 a.m. Four hours of extended darkness in the morning as well as a 9-hour shift of sleep and activity cycles following travel affected the melatonin rhythm. The night increase in plasma melatonin preceeded both the cortisol and prolactin rise. A single oral dose of 4.3×10^5 nmol of melatonin given to a 44-year healthy male gave a peak plasma value of 624 nmol/l after 30 min. Plasma melatonin was not affected by electro-convulsive therapy, TRH-injection, L-Dopa or bromoergocryptine orally. Patients with alcoholism, migraine, postoperative pinealoma, panhypopituitarism, hereditary dystonia and schizophrenics on propranolol exhibited a dicreased amplitude of their diurnal rhythm of melatonin. Two patients with pituitary tumors had occasional high levels of plasma melatonin. The change in melatonin secretion in human is apparently controlled by a mechanism which is at least partly influenced by environmental lighting conditions, drugs and different disease states.

171 Wetterberg, L., Arendt, J., Paunier, L., Sizonenko, PC., van Donselaar, W. & Heyden, T. 1976. Human serum melatonin changes during the menstrual cycle. Journal Clin Endocrin Metab, 42, 185-188 (9 references)

Serum melatonin concentration in early morning during the menstrual cycle, studied in five healthy women, showed that melatonin was elevated at the time of menstrual bleeding and had its nadir at the time of ovulation. It is possible that melatonin is involved in the regulation of the menstrual cycle in humans.

172 Worthington, CS. 1972. Sensory input and circadian effects upon cage activity in two species of cebid monkey. Psychonomic Science, 28(3), 165-166 (5 references)

Day and night measures of cage activity in the duirnal squirrel monkey and the nocturnal owl monkey were obtained under various sensory input conditions. Significant activity differences were obtained between the species, due to the circadian factor and due to illumination and sound factors. The circadian and illumination variables produced opposite effects from one species to the other. The overall species effect was not significant.

173 Wurtman, RJ. 1975. The effect of light on man and other mammals. Annual Review of Psychology, 37, 467-483 (62 references)

Introduction: Light as an environmental constituent. Characteristics of natural lighting; Spectral composition, Intensity. Responses of humans and other mammals to light; Direct and indirect effects of light, Photoreceptors, Effects of light on the skin and subcutaneous tissues; Cellular injury, Protective responses, Vitamin D and light, Light and plasma bilirubin concentrations, Photosensitizing foods and drugs. Effects of light mediated via retinal photoreceptors; Light and biological rhythms, Light and the mammalian pineal organ, Light and mammalian gonodal function.

174 Wurtman, RJ. 1975. The effects of light on the human body. Scientific American, 233(1), 68-77 (4 references)

Sunlight tans skin, stimulates the formation of vitamin D and sets biological rhythms. Light is also used in the treatment of disease. Such effects now raise questions about the role of artificial light. Some direct and indirect effects of light on the human body are outlined. Indirect effects include the production or entrainment (synchronization) of biological rhythms. Such effects are evidently mediated by photoreceptors in the eye and involve the brain and neuroendocrine organs. For example, excretion of melatonin, a hormone produced by the pineal organ, follows a daily rhythm. In animals melatonin synthesis is regulated by light. The hormone acting on the pituitary, plays a role in the maturation and the cyclic activity of the sex glands. Ultraviolet radiation acts on the skin to synthesize vitamin D. Erythema, or reddening of the skin, is caused by ultraviolet wavelengths between 290 and 320 nanometers. In response melanocytes increase their synthesis of melanin, a pigment that darkens the skin. Simultaneously the epidermis thickens, offering further protection. In some people the interaction of light with photosensitizers circulating in the blood causes a rash. Light can be used to treat psoriasis and other skins disorders. In infants with neonatal jaundice light is also used therapeutically to lower the amount of bilirubin circulating in the blood until infant's liver mature enough to excrete the substance. The therapy prevents the bilirubin from concentrating in the brain and destroying brain tissue.

175 Wurtman, RJ., Axelrod, J., Chu, EW. & Fischer, JR. 1964. Mediation of some effects of illumination on the rat estrous cycle by the sympathetic nervous system. Endocrinology, 75, 266-272 (33 references)

When mature rats are placed in continuous illumination, their "incidence of estrus" is enhanced; darkness has the opposite effect. Removal of the eyes or of both superior cervical ganglia blocks this effect of light. These procedures also eliminate the light-induced hypertrophy of the ovaries and the uterus and prevent the associated decreases in pineal weight and melatonin-synthesizing ability. These findings demonstrate that the autonomic nervous system plays a role in the regulation of the rat estrous cycle, and suggest that this role may involve control of melatonin synthesis in the pineal gland.

176 Wurtman, RJ., Axelrod, J. & Fischer, JE. 1964. Melatonin synthesis in the pineal gland: Effect of light mediated by the sympathetic nervous system. Science, 143, 1328-1329 (12 references)

Exposure to light reduces the ability of the rat pineal gland to synthesize melatonin and decreases the weight of the gland. When the sympathetic nerves to the pineal gland are cut, light no longer has an effect on melatonin synthesis or pineal weight. The response of the gland does not require that the gonads or the pitiuary gland be present.

177 Wurtman, RJ., Axelrod, J. & Phillips, LS. 1963. Melatonin synthesis in the pineal gland: Control by light. Science, 142, 1071-1073 (15 references)

In rats placed in continuous darkness for 6 days, there is a striking increase in the activity of melatonin-synthesizing-enzyme in the pineal gland, but no change in the activity of monoamine oxidase. Since melatonin appears to have a hormonal role in mammals, and its synthesis is confined to the pineal gland, the inhibition of hydroxyindole-O-methyl transferase by light may constitute a mechanism of neuroendocrine regulation.

178 Zaccaria, A. & Bitterman, ME. 1952. The effect of fluorescent flicker on visual efficiency. Journal of Applied Psychology, 36, 413-416 (20 references)

The experiment here reported was designed to study the effects of fluorescent lamp flicker upon visual fatigue. Performance of a standardized visual task was measured for two 30-minute periods under 20 foot-candles of fluorescent daylight illumination. During one of the periods the lamps were operated with direct current, while during the other period they were operated with alternating current. In this way spectral characteristics, brightness level, and distribution were constant, with flicker being the only variable. Performance did not differ significantly under the two conditions, but the AC condition produced a significantly greater drop in critical fusion frequency than did the DC. Only 25 per cent of the subjects detected a difference between the two conditions of illumination, but those that did uniformly expressed a preference for the DC condition. It may be concluded that single-lamp, or in-phase, multiple-lamp fluorescent installations are undesirable. Further experimentation is needed for the evaluation of out-of-phase installations.

179 Zacharias, L. & Wurtman, RJ. 1964. Blindness: Its relation to age of menarche. Science. 144, 1154-1155 (31 references)

Blindness in human females is associated with an age of menarche which is earlier than normal. When blindness is accompanied by a total loss of light perception, menarche is even earlier. It is well known that emotional factors can influence ovulation in humans. It might be conjectured that the relation between blindness and human ovary function is nonspecific, and a consequence of the emotional stress and behavioral adaptations associated with blindness. This hypothesis seems unlikely; although there are many instances of nonspecific inhibition or delay of human gonad function, few if any are known in which acceleration occurs without some specific disturbance in neuroendocrine function. It seems more probable that stimulation of the retina by environmental lighting produces a specific effect on the human ovary.

180 Östberg, O., Stone, PT. & Benson, RA. 1975. Free magnitude estimation of discomfort glare and working task difficulty. Göteborg Psychological Reports, 5(15), University of Göteborg, Sweden (18 pages, 30 references)

The first part of this investigation required 32 subjects to develop their own magnitude scales of discomfort glare. Then in part two, they employed their individual scales to assess degrees of working task difficulty and glare discomfort. The task consisted of four different levels of difficulty in compensatory tracking. The glare originated from a bright light source set to give four different levels of discomfort to the subjects. Each subject was scored on the dimensions of augmenting/reducing (Petrie), category width (Pettigres), and extraversion/introversion and neuroticism (Eysenck) and all were given a visual screening test. Only the test of neuroticism correlated significantly with glare variance. The subjects were very skilful and consistent in using their individual scales. By transforming each subject's ratings into a common score scale, it was found that the subjective ratings were highly correlated to the corresponding objective Glare Indices. Of particular interest was the finding that increased task difficulty meant increased discomfort glare, and vice versa. It is concluded that future studies of discomfort glare aspects of lighting could profitably employ the free magnitude estimation technique in order to allow for individual differences in scaling behavior.

SECTION 2: ADDITIONAL REFERENCES

Adrian, W. 1969. Pupil size and wavelength of light of equivalent luminance. AIC Color 69, Stockholm, B4:181-187

Alföldy, A., Fehér, M. & Nemcsics, A. 1976. The role of colored environment in diagnostics and therapy. AIC Color Dynamics 76, Budapest, paper 18.4, 522-526

Ali, MA. 1972. Action spectra of retinomotor and pupillary responses. Vision Research, 12(6), 1199

Allen, F. & Schwartz, M. 1940. The effect of stimulation of the senses of vision, hearing, taste, and smell upon the sensibility of the organs of vision. Journal of General Physiology, 24, 105-121

Allphin, W. 1954. School lighting and posture. Illuminating Engineering, April

Aschoff, J. 1969. Phasenlage der Tagesperiodik in Abhängigkeit von Jahreszeit und Breitengrad. Oecologia (Berlin), 3, 125-165

Aschoff, J., Pöppel, E. & Wever, R. 1969. Circadiane Periodik des Menschen unter dem Einfluss von Licht-Dunkel-Wechseln unterschiedlicher Periode. Pflügers Arch, 306, 58-70

Aschoff, J. et al. 1970. Circadian rhythms in men as influenced by artificial light-dark cylces of various periods. J Interdiscip Cycle Research, 1(1), 105-107

Assenmacher, I. 1966. Influence de la lumière sur certains rythmes physiologiques. Lux, 505

Assenmacher, I. & Boissin, J. 1972. Photoperiodism and physiologic circadian rhythmes. Lux, 69 (in French)

Avery, DL. 1974. The relationship of light-dark reversal transients and free-running rhythms. In. J Chronobiol. 2, 223-232

Baierl, F. 1952. Licht und Farbe zur Leistungssteigerung. Industrie-Organis, 21(1)

Ballowitz, L. 1971. Effects of blue and white light on infant (Gunn) rats and on lactating mother rats. Biology of the Neonate, 19, 409-425

Barlow, JS. 1960. Rhythmic activity induced by photic stimulation in relation to intrinsic alpha activity of the brain in man. Electroencephalography and Clinical Neurophysiology, 12, 317-326

Barlow, JS. 1962. The relationship among "photic driving" responses to single flashes, and the resting EEG. Quart Progr Rep No 64, Res Lab of Electronics, MIT Cambridge, Massachusetts, 274-283

Barlow, JS. 1963. Some statistical characteristics of electrocortical activity in relation to visual-oculomotor tracking in man. Bol Inst Estud méd biol (Mex), 21, 497-517

Barlow, JS. 1964. Rhythmic afterdischarge to flashes. Quart Progr Rep No 75, Res Lab of Electronics, MIT, Cambridge, Massachusetts, 149-155

Bartlett, NR. & Macleod, S. 1954. Effect of flash and field luminance upon human reaction time. Journal of the Optical Society of America, 44, 306-311

Bartley, SH. 1939. Some effects of intermittent photic stimulation. Journal of Experimental Psychology, 25, 462-480

Bartley, SH. 1940. The relation between cortical response to visual stimulation and changes in the alpha rhythm. Journal of Experimental Psychology, 27, 624-639

Bartley, SH. 1942. A factor in visual fatigue. Psychosomatic Medicine, 4, 369-375

Bartley, SH. 1951. Intermittent photic stimulation at marginal intensity levels. Journal of Psychology, 32, 217-223

Bauer, SF. & Hornick, EJ. 1968. Lunar effect of mental illness. American Journal of Psychiatry, 125, 696-697

Baumgardt, E. 1959. La Psychophysiologie de la Couleur. Couleurs, 28, 47

Baumgardt, E. & Le Grand, Y. 1956. On visual fatigue. Cahier du Centre Scientifique et Technique du Batiment, No 27, Note 230

Becher, H., Eichner, D., Frey, E., Hollwich, F., Leopold-Messer, G., Mrodzinsky, K., Rohen, J. & Thiel, R. (eds). 1955. Auge und Zwichen-Hirn. Verdinand Enke Verlag, Stuttgart & 23 Beih Klin Mbl Augenheilk, 5

Beck, J. 1969. Lightness and orientation. American Journal of Psychology, 82, 359-366

Behar, I. & Bevan, W. 1961. The perceived duration of auditory and visual intervals: Cross-modal comparison and interaction. American Journal of Psychology, 74, 17-26

Benoit, J. 1972. Quantitative and qualitative study of the action of visible light on genital, endocrine and other vegetative functions of vertebrates. Lux, 69, October (in French)

Berlyne, DE. 1958. The influence of the albedo and complexity of stimuli on visual fixation in the human infant. British Journal of Psychology, 49, 315-318

Berlyne, DE. 1958. The influence of complexity and novelty in visual figures on orienting responses. Journal of Experimental Psychology, 55, 289-296

Berlyne, DE. 1958. Supplementary report: Complexity and orienting responses with longer exposures. Journal of Experimental Psychology, 56, 183

Berlyne, DE. 1971. Aesthetics and psychobiology. Appleton Century Crofts, New York

Berlyne, DE. 1974. Verbal and exploratory responses to visual patterns varying in uncertainty and in redundancy. In: Berlyne, DE. (ed). Studies in new experimental aesthetics. Steps toward an objective psychology of aesthetic appreciation. John Wiley & Sons, New York, 121-158

Berlyne, DE., Robbins, MC. & Thompson, R. 1974. A cross-cultural study of exploratory and verbal responses to visual patterns varying in complexity. In: Berlyne, DE. (ed). Studies in new experimental aesthetics. Steps toward an objective psychology of aesthetic appreciation. John Wiley & Sons, New York, 259-278

Bevan, W. & Pritchard, JF. 1964. The effects of visual intensities upon the judgement of loudness. American Journal of Psychology, 77, 93-98

Birenbaum, L. 1979. The behavioral correlates of alternative lighting designs. Master's Thesis (Psychology), University of Massachusetts, Amherst

Birkner, FE. 1970. Photic influences on primate reproduction. Laboratory Animal Care, 20(2), 181-185

Birmbaum, R. 1978. Health hazards of visual display units. London School of Hygiene and Tropical Medicine

Bissonnette, TH. 1936. Sexual photoperiodicity. Quart Rev Biology, 11, 371-386

Björn, LO. 1973. Ljus och Liv. Aldus, Stockholm (in Swedish)

Blackenmore, C. & Cooper, GF. 1970. Development of the brain depends on the visual environment. Nature (London), 228, 477-478

Blackman, S. & Catalina, D. 1973. The moon and the emergency room. Perceptual and Motor Skills, 37(2), 624-626

Blum, H. 1941. Photodynamic action and diseases caused by light. Reinhold, New York

Blum, RH. 1956. Photic stimulation, imagery and alpha rhythm. Journal ment Sci, 102, 160-167

Bondy, SC. et al. 1972. Reversible responses of the cerebral circulation to visual deprivation. Brain Research, 43, 606

Borst, JE. 1975. The effects of artificial light and radiation on plants, animals and human beings with particular emphasis on school children. Unpublished master's thesis, Western Connecticut State College

Bousfield, WA., Esterbrook, J. & Whitmarch, GA. 1957. The effect of concomitant colored and uncolored pictorial representations on the learning of stimulus words. Journal of Applied Psychology, 41, 165-168

Bowen, EJ. (ed). 1965. Recent progress in photobiology. Academic Press, Blackwell

Boyce, PR. 1970. The influence of illumination level on prolonged work performance. Lighting Research and Technology, 2(2), 74-94

Boyce, PR. 1981. Human factors in lighting. Applied Science Publishers, London

Brazier, MAB. 1964. A study of the variability of response to flicker: the influence of other sensory stimuli. Docum Ophthal (Den Haag), 18, 221-237

Brazier, MAB. & Casby, JU. 1951. A study of the EEG in normal subjects during intermittent photic stimulation. Electroencephalography and Clinical Neurophysiology, 3, 380-381

Brown, FA. 1976. Biological clocks: Endogenous cycles synchronized by subtle geophysical rhythms. BioSystems, 8, 67-81

Brown, FA., Fingerman, M. & Hines, MN. 1954. A study of the mechanisms involved in shifting of the phases of the endogenous daily rhythm by light stimuli. Biol Bulletin, 106, 308-317

Brown, FA., Hastings, JW. & Palmer, JD. 1970. The biological clock: Two views. Academic Press, New York

Brown, FA. & Park, YH. 1967. Association-formation between photic and subtle geophysical stimulus patterns - a new biological concept. Biol Bulletin, 132, 311-319

Brown, LT. & Gregory, LP. 1968. Attentional response of humans and squirrel monkeys to visual patterns. Final studies and résumé. Perceptual and Motor Skills, 27, 787-814

Brundrett, GW. 1971. Flicker and personality. In: Proceedings of an international symposium on the perception and application of flashing lights. Adam Hilger, London, 391-395

Bünning, E. 1973. The physiological clock (3rd edition). Springer Verlag, New York

Buswell, GT. 1935. The effect of color. In: Buswell, GT. How people look at pictures. A study of the psychology of perception in art. University of Chicago Press, Chicago Illinois, 93-97

Butler, RA. 1957. The effect of deprivation of visual incentives on visual exploration in monkeys. J comp physiol Psychology, 50, 177-179

Campbell, DE. 1977. Phases of the moon and human behavior. Man-Environment Systems, 7(4), 217-218

Caron, RF. & Caron, AJ. 1968. The effects of repeated exposure and stimulus complexity on visual fixation in infants, Psychonomic Science, 10, 207-208

Caron, RF. & Caron, AJ. 1969. Degree of stimulus complexity and habituation of visual fixation in infants. Psychonomic Science, 14, 78-79

Carr, SJ. & Dabbs, JM. 1974. The effects of lighting, distance and intimacy of topic on verbal and visual behavior. Sociometry, 37(4), 592-600

Carterette, EC. & Symmes, D. 1952. Color as an exceptional variable in photic stimulation. Electroencephalography and Clinical Neurophysiology, 4, 289-296

Cavalloni, L. & Macaluso, V. 1970. Artificial lighting in the regulation of the working environment. Occupational Safety and Health Series, 21, 261-262

Cavonius, CR. et al. 1974. Local suppression of alpha activity by pattern in half the visual field. Nature, 251, 412-413

Cernilovskaja, FM. 1964. Health significance of fluorescent lighting in industry. Medicina, Leningrad (in Russian)

Champness, BG., Hyland, ME. & Lynes, JA. 1976. Effects of colour rendering properties of light sources on aspects of social behavior. Paper read at: Electricity Research Council & British Psychological Society Conference, Capenhurst

Champness, B., Hyland, M. & Olver, K. 1978. Effects of fluorescent lighting on social behaviour and judgements. Architectural Psychology Newsletter, 8(1), 2-3, Kingston Polytechnic, Kingston upon Thames

Chance, RE. 1978. The effects of environmental light on human performance and fitness. Thesis for Florida Technological University

Cheng, MF. 1976. Interaction of light and other environmental variables on activity in the hypothalamic hypophyseal gonodal system, Nature, 263, 148-149

Chernilovskii, FM. 1968. The lighting of industrial factories and the efficiency of the worker. Ministry of Health, Leningrad's Scientific Research Inst of Hygiene, Health & Occupational Diseases, Leningrad

Child, IL. & Wendt, GR. 1938. The temporal course of the influence of visual stimulation upon the auditory threshold. Journal of Experimental Psychology, 23, 108-127

Christensen, BC. & Buchmann, B. (eds). 1961. Progress in photobiology. Proceedings of the third international congress on photobiology, Copenhagen 1960, Elsevier Publishing Company, London, New York

Chruikshank, RM. 1937. Human occipital brain potentials as affected by intensity - duration variables of visual stimulation. Journal of Experimental Psychology, 21, 625-641

Cigánek, L. 1966. Evoked potentials in man: Interaction of sound and light. Electroencephalography and Clinical Neurophysiology, 21, 28-33

Cohen, LB. 1969. Observing responses, visual preferences and habituation to visual stimuli in infants. Journal exp Child Psychol, 419-443

Coley, WZ. 1972. Internal effects of light, including ultraviolet, on man. LUTERG Report No 84, Department of Human Sciences, Loughborough

Collins, JB. & Hopkinson, RG. 1954. Flicker discomfort in relation to lighting of buildings. Trans Illum Eng Soc, 19(5), 135

Conroy, RTWL. & Mills, JN. 1970. Human circadian rhythms. J&A Churchill, London

Craig, RS. 1978. Information processing overload and television. A study of the effects of color, program difficulty and sex. Dissertation Abstr International, 38(9-A), 5108

Critchlow, V. 1963. The role of light in the neuroendocrine system. In: Nalbandov, AV. (ed). Recent Advances in Neuroendocrinology, 377-402, University of Illinois Press, Urbana Illinois

Crouch, CL. 1965. Effect of light on the human organism. Conference Proceedings, Electromagnetic Radiation in Agriculture, Roanoka, Va. p. 2

Crozier, WJ., Wolf, E. & Zerrahn-Wolf, G. 1938. Temperature and the critical intensity for response to visual flicker. Proc Natl Acad Sci US, 24, 216

Dantsig, NM. 1963. Illumination of dwellings and communal buildings In: Guide to communal hygiene, Moscow, Medgiz, 3, 123 (in Russian)

Dantsig, NM. & Belikova, VK. 1949. Some health problems of fluorescent lighting. Part 1. Gig i Sanit, 10, 28 (in Russian)

Darakis, L. 1976-77. Influence of five stimulus colors on GSR. Bulletin de Psychologie, 30(14-16), 760-766 (in French)

Davis, JM., McCourt, WF. & Solomon, P. 1960. The effect of visual stimulation on hallucinations and other mental experiences during sensory deprivation. American Journal of Psychiatry, 116, 889-892

Davis, RC., Lundervold, A. & Miller, JD. 1957. The pattern of somatic responses during a repetitive motor task and its modification by visual stimuli. Journal of Comparative and Physiological Psychology, 50, 53-60

Day, H. 1966. Looking time as a function of stimulus variables and individual differences. Perceptual and Motor Skills, 22, 423-428

Day, H. 1968. Some determinants of looking time under different instructional sets. Perception and Psychophysics, 4, 279-281

Déjardin, G. & Falgon, R. 1956. Sur le "papillotement" des lampes a fluorescence. In: Proeccedings of the first international photobiological congress, Amsterdam 1954, Veenman & Zonen, Wageningen, 414-416

De Lange, H. 1958. Research into the dynamic nature of the human fovea-cortex systems with intermittent and modulated light. I. Attenuation characteristics with white and colored light. J Opt Soc Amer, 48, 777-784

Delay, ER., Smith, ES. & Isaak, W. 1978. Effects of illumination and auditory threshold. Physiology and Behavior. 20(2), 201-202

Deutsch, F. 1937. Psycho-physical reactions of the vascular system to the influence of light and to impression gained through light. Folica Clinica Orientalia, 1, 3-4

DeValois, RL., Jacobs, GH. & Jones, AE. 1962. Effects of increments and decrements of light on neural discharge rates. Science, 136, 986-987

Dewan, EM. 1967. On the possibility of a perfect rhythm method of birth control by periodic light stimulation. American Journal of Obstetrics and Gynecology, 99(7), 1016-1019

Dewan, EM. 1969. Rhythms. Science and Technology, January, 20-28

Dieckhues, B. 1974. Der Einfluss des Augenlichtes auf Organ- und Stoffwechselfunktionen bei Mensch und Tier. Hippokrates, 45, 433-449

Dorfman, DD. & Miller, R. 1966. Some effects of light on sound intensity generalization as a function of number of training trials. Perceptual and Motor Skills, 23(1), 291

Dubrov, A. 1972. Heliobiology. Soviet Life, January

Duda, P. & Zubek, JP. 1965. Auditory sensitivity after prolonged visual deprivation. Psychonomic Science, 3, 359-360

Durham, RL., Nunnally, JC. & Lemond, LC. 1971. The effects of levels of information conflict on visual selection. Perception and Psychophysics, 10, 93-96

Eastman, AA. & Campbell, JH. 1952. Stroboscopic and flicker effects from fluorescent lamps. Illuminating Engineering, January, 27-35

Ellingson, RJ. 1960. Cortical electrical responses to visual stimulation in the human infant. Electroencephalography and Clinical Neurophysiology, 12, 663-677

Engel, R. 1964. Electroencephalographic responses to photic stimulation and their correlation with maturation. Annuals of the New York Academy of Sciences, 117, 407-414

Epel, BL. 1973. Inhibition of growth and respiration by visible and near visible light. Photophysiology, 8, 209-229

Evans, DR. & Day, HI. 1971. The factorial structure of responses to perceptual complexity. Psychonomic Science, 22(6), 357-359

Fanger, PO. et al. 1977. Can colour and noise influence man's thermal comfort? Ergonomics, 20(1), 11-18

Fantz, RL. 1964. Visual experience in infants: Decreased attention to familiar patterns relative to novel ones. Science, 146, 668-670

Farmer, DS. 1961. Photoperiodicity. Annual Review of Physiology, 23, 71-96

Fatranska, M. 1968. Einige Bemerkungen zum Einfluss des Lichtes auf Organismus des Menschen. Z Ges Hyg, 14, 146-148

Faw, TT. & Nunnally, JC. 1967. The effects on eye movements of complexity, novelty and affective tone. Perception and Psychophysics, 2, 263-267

Faw, TT. & Nunnally, JC. 1968. The influence of stimulus complexity, novelty and affective value on children's visual fixations. Journal of Experimental Child Psychology, 6, 141-153

Feldman, S. 1964. Visual projections to the hypothalamus and preoptic area. Annals of the New York Academy of Sciences, 117, Sept 10, 53-68

Fernandez-Guardiola, A., Toro-Donoso, A., Aquino-Cias, J. & Gumadiaz, E. 1968. Peripheral and central modulation of the visual input during habituation. Prog Brain Research, 22, 388-399

Fisher, M. et al. 1972. Effect of low illumination on galvanic skin response. American Journal of Optometry, 49, 503-507

Fiske, VM. & Huppert, LC. 1968. Melatonin action on pineal varies with photoperiod. Science, 162, 279

Frankel, F., Freeman, BJ., Ritvo, E., Chikami, B. & Carr, E. 1976. Effects of frequency of photic stimulation upon autistic and retarded children. American Journal of Mental Deficiency, 81, 32-40

Fredriksen, E. (forthcoming). Stroboscopic effects in lighting installations. Licht-Forschung

Freund, L. et al. 1929. Über den Einfluss des Lichtes auf die Funktionen des Gehör und Geruchorgans. Strahlentherapie, 34, 110-116

Fry, GA. 1953. Effect of brightness distribution in the entire field of view upon the performance of a task. Engineering Experiment Station News - Ohio State University, October, 22-28

Fuchs, J. 1964. Physical alterations which occur in the blind and are illustrated on ancient Egyptian works of art. Annals of the New York Academy of Sciences, 117, 618-623

Fugate, J. 1957. Physiological basis for discomfort glare. Am J Optom & Arch Am Acad Optom, 34, 377-387

Fugate, JM. & Fry, GA. 1956. Relation of changes in pupil size to visual discomfort. Illuminating Engineering. 51(7), 537-549

Fuller, CA., Sulzman, FM. & Moore-Ede, MC. 1978. Thermoregulation is impaired in an environment without circadian time cues. Science, 199, 794-796

Gadomska, H. 1965. The influence of colours on men at work. Prace Centralnego Instytutu, Ochrony Pracy, Warsaw, 15, 47, 233

Gale, A., Christie, B. & Penfold, V. 1971. Stimulus complexity and the occipital EEG. British Journal of Psychology, 62(4), 527-531

Gale, A., Dunkin, A. & Coles, M. 1969. Variation in visual input and the occipital EEG. Psychonomic Science, 14, 262-263

Gallardo, R., Armengol, V. & Palestini, M. 1962. Importancia de los factores oculares periféricos en la habituacion fotica cortical. Acta Neurol Latinoam, 8, 5-14

Ganong, WF., Shepherd, MD., Wall, JR., Van Brunt, TEE. & Clegg, MT. 1963. Penetration of light into the brain of mammals. Endocrinology, 72, 962-963

Garrett, A. 1976. On the effects of flashing white and coloured light on humans. Leonardo, 9, 213-214

Garrett, A. & Tate, RLC. 1972. Star correspondence. Federation of British Artists Quarterly, 1(2), 17-19

Gary, AL. & Glover, J. 1975. Eye color and social behavior. Paper presented at the meeting of the Southeastern Psychological Association, Atlanta, March

Gastaut, H. 1949. Effect des stimulations physiques sur l'EEG de l'homme. Electroencephalography and Clin Neurophysiology, 2 Suppl 69, 82

Gebert, F. 1977. Psychologische und physiologische Wirkungen von Umgebungsfarben. Doctoral dissertation. Physiologischen Institut der Universität Marburg/Lahn

Geller, I. 1971. Ethanol preference in the rat as a function of photoperiod. Science, 173, 456-458

Gendreau, PE., Freedman, N., Wilde, GJS. & Scott, GD. 1968. The effect of 7 days perceptual deprivation on the visual evoked potential and EEG frequency, Canad Psychologist, 9, 278

George, WZ. 1972. An investigation into a possible physiological effect of high levels of illumination. Department of Human Sciences, Loughborough

Gerard, RM. 1958. Differential effects of colored lights on psychophysiological functions. Doctoral dissertation, University of California, Los Angeles

Gerard, RM. 1958. Color and emotional arousal. American Psychologist, 13, 340

Gergen, JA. & MacLean, PD. 1964. The limbic system: Photic activation of limbic cortical areas in the Squirrel Monkey. Annals of the New York Academy of Sciences, 117, 69-87

Gergen, KJ., Gergen, MM. & Barton, W. 1973. Deviance in the dark. Psychology today, 7, 129-130

Gerritzen, F. 1966. Influence of light on human circadian rhythms. Aerospace Medicine, 37, 66-70

Gibson, JJ. 1952. The relation between visual and postural determinants of the phenomenal vertical. Psychol Rev, 59, 370-375

Giese, AC. (ed). 1964-73. Photophysiology. Volume 1-8. Academic Press, New York, London

Giessmann, HG. & Lindner, H. 1974. Influence of the level of lighting on concentration. Arbeitsmed. Fragen in der Opthalmologie, 4, 108-114

Goff, MLR. & Finger, FW. 1966. Activity rhythms and diurnal light-dark control. Science, 154, 1346-1348

Goldman, G., Segal, J. & Segalis, M. 1938. L'action d'une excitation intermittente sur le rythme de Berger. C R Soc Biol, 127, 1217-1220

Goldstein, K. 1939. The organism. American Book, New York

Goldstein, K. & Rosenthal, O. 1930. Zum Problem der Wirkung der Farben auf den Organismus. Schweiz Arch Neurol Psychiatr, 26, 3-26

Goodfellow, RAH. & Smith, PC. 1973. Effects of environmental color on two psychomotor tasks. Perceptual and Motor Skills, 37, 296-298

Goromosov, MS. 1968. The physiological basis of health standards for dwellings. Public Health Papers 33, World Health Organization, Geneva

Gould, JD. & Peeples, DR. 1970. Eye movements during visual search and discrimination of meaningless symbol and object patterns. Journal of Experimental Psychology, 85(1), 51-55

Gradina, C. et al. 1966. Electroencephalographic studies of persons experimentally exposed to flickering and non-flickering incandescent and fluorescent lighting. Fiozio Normala, 12(4), 317-325

Gray, JS. & Prevetta, P. 1950. Fluorescent light versus daylight. Journal of Applied Psychology, 34, 235-236

Gurtovoj, GK. & Kravkov, SV. 1951. Der Einfluss der Farbigkeit der Belichtung des einen Auges auf die Reaktionsfähigkeit des anderen. Dol Akad Nau SSSR, NS 78, 391-392

Guth, SK. 1973. Some observations on the biological effects of light. Lighting Design and Application, 3(11), 24-29

Güthenke, R. 1959. Die biologische Bedeutung des Lichtes und der Farben. Mensch und Farbe, 3/4, 99-138

Görsdorf, K. 1953. Über die tatsächliche Wirkung von Farben. Mensch und Arbeit, 2

Hafez, ESE. 1956. Requirements, responses, mechanisms and application of photoperiodicity. In: Proceedings of the First International Photobiological Congress (4th International Light Congress), Amsterdam, 1954, Comité International de Photobiologie, 101-102

Hagino, N. 1971. Influence of constant light on the hypothalamic regulation of pituitary function in the baboon. Endocrinology, 89, 1322-1324

Halberg, F., Halberg, E., Barnum, CP. & Bittner, JJ. 1959. Physiologic 24-hour periodicity in human beings and mice, the lighting regimen and daily routine. In: Withrow, RB. (ed). Photoperiodism and related phenomena in plants and animals. Publication of the American Association for the Advancement of Science, 55, 803-878, Washington DC

Halpern, L. 1956. Additional contributions to the sensorimotor induction syndrome in unilateral disequilibrium with special reference to the effect of colours. J Nerv Ment Dis, 123, 334-350

Halpern, L. (undated). Farberlebnis und Statokinetik. Schweiz Archiv f Neurologie und Psychiatrie, Band 80(1-2)

Halpern, L. & Feinmesser, M. 1956. The variability of threshold of acoustic discomfort in sensorimotor induction syndrome with special reference to the effect of colours. Confin Neurol (Basel), 75, 309-320

Halpern, L. & Kugelmass, S. 1956. The variability of reaction time in the sensorimotor induction syndrome with special reference to the effect of colors. Journal of Psychology, 41, 225-269

Halstead, WC., Knox, GW. & Walker, AE. 1942. Modification of cortical activity by means of intermittent photic stimulation in the monkey. Journal of Neurophysiology, 5, 349-356

Halstead, WC., Wolf, JI., Knox, GW. & Walker, AE. 1942. Effects of intensity and wave length on driving cortical activity in monkeys. Journal of Neurophysiology, 5, 483-486

Hammes, JA. & Wiggins, SL. 1962. Perceptual-motor steadiness, manifest anxiety, and color illumination. Perceptual and Motor Skills, 14, 59-61

Hammond, J. 1954. Light regulation of hormone secretion. Vitam u Horm, 12, 157-206

Harding, GFA. 1974. The visually evoked response. Advances in Ophthalmology, 28, 2-28, Basel

Hare, RD. 1973. Orienting and defensive responses to viual stimuli. Psychophysiology, 10, 453-464

Hare, R., Wood, K., Britain, S. & Frazelle, J. 1971. Autonomic responses to affective visual stimulation: Sex differences. Journal of Experimental Research in Personality, 5, 14-22

Hare, R., Wood, K., Britain, S. & Shadman, J. 1970. Autonomic responses to affective visual stimulation. Psychophysiology, 7, 408-417

Harmon, DB. 1945. Lighting and child development. Illuminating Engineering, 40, 199-233

Harmon, DB. 1954. School lighting and posture. Discussion of paper by Willard Allphin. Illuminating Engineering, 49, 362-366

Harris, R. 1935. The interaction of ourselves and things about us with light. Cold Spring Harbor Symposia Quant Biol 3

Hartman, GW. 1934. The facilitation effect of strong general illumination upon the discrimination of pitch and intensity differences. Journal of Experimental Psychology, 17, 813-822

Hartnoll, RG. & Miller, PJ. 1962. Twilight transitions and biological rhythmicity. Nature, 194, 1293-1295

Hassel, G. 1951. The effect of colour of light on the ability and the effort of seeing. In: Halbertsma, NA. & Jansen, J. (eds). Commission Internationale de l'Eclairage, Volume II, Communications Individuelles, Bureau Central de la CIE, New York, p: Vp 1-11

Hastings, JW. 1964. The role of light in persistent daily rhythms. In: Giese, AC. (ed). Photophysiology, Volume I. Academic Press, New York, London, 333-361

Hatayama, T., Takayama, T. & Komatsu, H. 1970. Studies on sensory overload: I. Part 2. Effects of sensory overload and sensory deprivation upon physiological functions. Tohoku Psychol Folia, 28, 73-83

Hawkes, J. 1962. Man and the sun. Random House, New York

Hayward, DG. 1972. The psychology and physiology of light and colour as an issue in the planning and managing of environment: A selected bibliography. Monticello, IL, Council of Planning Librarians, Exchange Bibliography No 288, May

Hellmann, N. 1951. Farbe und Lärm. Werkstatt und Betrieb, H. 5

Hennsge, Polster & Schob, 1945. Wirkung von Farbe und farbigem Licht auf psychiatrisch stationäre patienten. Dresden

Herbst, CH. 1968. The effect of light on workers. Elektrizitat, 11, 294-300

Heron, W., Doane, BK. & Scott, TH. 1956. Visual disturbance after prolonged perceptual isolation. Canadian Journal of Psychology, 10, 13-18

Herron, PL. & LaGiusa, FF. 1975. Brightness variations affect deaf learners' attention. Lighting Design and Application, February, 30-34

Hess, EH. & Polt, JM. 1960. Pupil size as related to interest value of visual stimuli. Science, 132, 349-350

Hillman, WS. 1973. Light, time, and the signals of the year. Bio Sci, 23(2), 81

Hirsch, IJ., Bilger, RC. & Deatherage, BH. 1956. The effect of auditory and visual background on apparent duration. American Journal of Psychology, 69, 561-574

Hoffman, K. 1971. Splitting the circadian rhythm as a function of light intensity. In: Menaker, M. (ed). Biochronometry. Proceedings of a symposium. Friday Harbor, Washington, September 1969, National Academy of Sciences, Washington DC, 134-151

Holaender, A. (ed). 1955-56. Radiation biology (3 volumes). McGraw-Hill, New York

Hollwich, F. 1955. Der Einfluss des Augenlichtes auf die Regulation des Stoffwechsels. In: Auge und Zwischenhirn. 23 Beih Klin Mbl Augenheilk, 5, 95-136. Verdinand Enke Verlag, Stuttgart

Hollwich, F. 1964. The influence of light via the eyes on animals and man. Annals of the New York Academy of Sciences, 117, 105-131

Hollwich, F. 1980. The effect of natural and artificial light via the eye on the hormonal and metabolic balance of animal and man. In: Krochmann, J. (ed). Proceedings of the symposium on Daylight. Physical, psychological and architectural aspects. Commission Internationale de l'Eclairage, Institut für Lichttechnik, TU, Berlin, 182-193

Hollwich, F. & Dieckhues, B. 1966. Der Einfluss des Lichtes auf die Eosinophilenreaktion bei sehenden und blinden Personen. Klim Mbl Augenheilk, 149, 840-847

Hollwich, F. & Dieckhues, B. 1967. Augenlicht und Nebennierenrindenfunktion. Dtsch Med Wschr, 92, 2335-2341

Hollwich, F. & Dieckhues, B. 1971. Circadian rhythm in the blind. J Interdiscipl Cycle Res, 2, 291

Hollwich, F. & Dieckhues, B. 1974. Changes in the circadian rhythm of blind people. In: Scheving et al. (eds). Chronobiology. G Thieme, Stuttgart

Hollwich, F. & Tilgner, S. 1964. Reaktionen der Eosinophilenzahl auf okulare Lichtreize. Dtsch Med Wschr, 89, 1430-1436

Holmgren, H. & Swensson, A. 1953. Der Einfluss des Lichtes auf den 24-Stunden Rhythmus der Aktivtat des Leberglykogens und der Korpertemperatur. Acta Medica Scandinavia, Suppl 278, 71-76

Holubar, J. 1960. The time sense and photic driving in man. Physiol Bohemaslov, 9, 482-487

Honju, S., Fujiwara, T., Takasaka, M., Suzuki, Y. & Imaizumi, K. 1963. Observations on the diurnal temperature variation of cynomolgus monkeys (Macaca irus) and on the effect of changes in the routine of lighting upon this variation. Japanese Journal of Medical Science and Biology, 16, 189-198

Hooke, JF., Youell, KJ. & Etkin, MW. 1975. Color preference and arousal. Perceptual and Motor Skills, 40, 710

Hopkinson, RG. 1956. Glare discomfort and pupil diameter. Journal of the Optical Society of America, 46(8), 649-656

Hopkinson, RG. & Longmore, J. 1959. Attention and distraction in the lighting of work-places. Ergonomics, 2, 321-334

Hosemann, H. 1950. Bestehen solare und lunare Einflusse auf die Nativität und den Menstruationszyklus? Z Geburtsh Gynaek, 133, 263-267

Hosemann, H. 1950. Underliegt der Menstruationszyklus der Frau und die tägliche Geburtenzahl solaren und lunaren Einflussen? Deutsch Med Wschr, 75, 815-820

Houghton, FC., Olson, HT. & Suciv, J. 1940. Sensations of warmth as affected by the color of the environment. Journal of the Illum Engineering Society, 35, 908-914

Hovde, CA., Harman, PJ., DeLuca, AM. & Haft, JS. 1961. Electrical responses in brain to photic stimulation. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress of photobiology. Elsevier Publishing Company, London, New York

Humphrey, NK. & Keeble, GR. 1975. Interactive effects of unpleasant light and unpleasant sound. Nature, 253, 346-347

Humphrey, NK. & Keeble, GR. 1977. Do monkeys' subjective clocks run faster in red light than in blue? Perception, 6, 7-14

Hutton, DW. 1973. Eye movements and physiological responses to visual stimuli, Viewpoints, Vol 49, March

Höfling, G. 1973. Kopfschmerzen durch Leuchtstofflampen? Schilling Verlag für Informationstechnik, Herne

Ibison, RA. 1952. Differential effects in the recall of textual materials associated with the inclusion of colored and uncolored illustrations. In: Indiana University studies in education. Thesis Abstract Series 1951, No 3, 51-55, Bloomington, Ind

Illnerova, H., Bäckström, M., Sääf, J., Wetterberg, L. & Vangbo, B. (undated). Melatonin in rat pineal gland and serum: Rapid parallel decline after light exposure at night. Neurosci Letters (in press 1978)

Ilyanok, VA. 1961. Effect of intensity and depth of pulsation of flickering light on the electrical activity of the human brain. Biophysics, 6, 72-82

Jacob, E. 1966. Lighting and productivity. International Lighting Review, 103-108

Jacobs, KW. & Suess, JF. 1975. Effects of four psychological colors on anxiety state. Perceptual and Motor Skills, 41, 201-210

Jafarey, NA., Khan, MY. & Jafarey, SN. 1970. Role of artificial lighting in decreasing the age of menarche. Lancet, 2, 471

Jaffe, R. 1956. The influence of visual stimulation on kinaesthetic figural after-effects. American Journal of Psychology, 69, 70-75

Jaffee, CL. 1966. Effects of visual or auditory deprivation on frequency of responding to a light or buzzer. Perceptual and Motor Skills, 22, 506

James, WT. & Domingos, WR. 1953. The effect of color shock on motor performance and tremor. Journal of General Psychology, 48, 187-193

Janssens, J. 1979. Building exteriors as informative components in the environment. Man-Environment Systems, 9(4-5), 252

Johansson, BW. 1977. Biologiska rytmer 1. Observanda Medica Ferrosan, 4(1), 27-32

Johansson, BW. 1977. Biologiska rytmer 2. Observanda Medica Ferrosan, 4(2), 56-60

Johnson, FH. (ed). 1955. The luminiscence of biological systems. Am Assoc Adv Sci, Washington DC

Johnson, HM. 1920. The dynamogenic influence of light on tactile discrimination. Psychobiology, 2, 351-374

Johnsson, A. 1977. Biologiska klockor. Natur och Kultur, Stockholm

Johnsson, A., Engelmann, W., Klemke, W. & Ekse, AT. 1979. Free-running human circadian rhythms in Svalbard. Z Naturforsch, 34, 470-473

Jores, A. 1934. Über den Einfluss des Lichtes auf die 24-Stundenperiodik des Menschen. Dtsch Arch Klin Med, 176, 544

Jöchle, W. 1964. Trends in photophysiologic concepts. Annals of the New York Academy of Sciences, 117, 88-104

Kamp, A., Sem-Jacobsen, CW., Storm van Leeuwen, W. & van der Tweel, LH. 1960. Cortical responses to modulated light in the human subject. Acta Physiol Scand, 48, 1-12

Kappers, JA. 1971. Regulation of reproductive system by the pineal gland and dependence on light. J Neuro-Visceral Relations, Suppl 10, 141

Karwoski, TF. & Odbert, HS. 1938. Color music. Psychol Monogr, 50(2)

Kelly, DE. 1962. Pineal organs: Photoreception, secretion and development. American Scientist, 50, 597-625

Kelly, DH. 1964. Sine waves and flicker fusion. Docum Ophthal (Den Haag), 18, 16-35

Kimura, A. 1976. Study of pineal regulation mechanism in genital development - influence of light and drugs on genital organs. Tokushima J Exper Med, 23, 1-7

Kish, G. & Baron, A. 1962. Motivational state underlying the light reinforcement phenomenon. J Comp Physiol Psychol, 55, 1007-1010

Kitasato, H. 1966. The relation between the photic driving of EEG and the response evoked by photic stimulation in man. Japanese Journal of Physiology, 16, 238-253

Kitasato, H. & Hatsuda, T. 1966. The cortical responses evoked by double photic stimuli in various states of man. Japanese Journal of Physiology, 16, 227-237

Kitchner, J. 1967. The effects of various levels of tactile, visual and auditory stimulation on temporal estimations, MA thesis, California State College at Los Angeles

Klein, DC. & Weller, JL. 1972. Rapid light-induced decrease in pineal serotin N-acetyltransferase activity. Science, 177(4048), 532

Klinker, L. et al. 1976. The influence of light on human regulation in relation to social factors. J Interdisc Cycle Res, 7(3), 203-214

Klorman, R., Wiesenfeld, AR. & Austin, ML. 1975. Autonomic responses to affective visual stimuli. Psychophysiology, 12(5), 543-560

Kmcatnow, VP. & Kalpina. 1972. Physiological and hygienic evluation of working conditions in low intensity coloured light. Ergonomics, 15(6), 718

Knoche, H. 1960. Ursprung, Verlauf und Endigung der retinohypothalamischen Bahn. Z Zellforsch, 51, 658

Knoerchen, R. et al. 1975. Circadian variations of visual sensitivity and vegetative responsiveness to light in man. Exper Studies of Shiftwork, Westdeutscher Verlag, Opladen, 244-253

Knox, GW. 1945. Investigations of flicker and fusion. Journal of General Psychology, 33, 121-154

Kogi, K. & Saito, SA. 1971. A factor-analytic study of phase discrimination in mental fatigue. In: Hashimoto, K., Kogi, K. & Grandjean, E. (eds). Methodology in human fatigue assessment, Taylor and Francis, London

Kohn, H. & Salisbury, I. 1967. Electroencephalographic indications of brightness enhancement. Vision Research, 7, 461-468

Kooi, KA. & Bagchi, BK. 1964. Visual evoked responses in man: Normative data. Annals of the New York Academy of Sciences, 112, 254-269

Krause-Liebscher, I. 1966. Über einige Ergebnisse farbphysiologischer Untersuchungen. Internationale Farbentagung. Interfarbe 66, Vortrag 2.3

Kravkov, SV. 1942. Color vision and autonomic nervous system. Journal of the Optical Society of America, June

Krieger, DT., Kreuzer, J. & Rizzo, FA. 1969. Constant light: Effect on circadian patterns and phase reversal of steroid and electrolyte levels in man. Journal of Clinical Endocrinology, 29, 1634-1638

Krieger, DT. & Rizzo, F. 1971. Circadian periodicity of plasma 11-hydroxycorticosteroid levels in subjects with partial and absent light perception. Neurendocrinology, 8, 165-179

Kriens, O. 1956. Untersuchungen über die absolute Eosinophilenzahl des kindlichen Blutes und ihr Verhalten nach Flickerlichtbeleuchtung beider Augen. Inaug Diss Med Fak Univ, Münster

Krtilova-Milova, A. et al. 1972. Influence of a brief light stimulus on equilibrium. Agressologie, 13, 85-89

Krugman, HE. 1947. Flicker fusion frequency as a function of anxiety reaction: An exploratory study. Psychosom Med, 9, 269-272

Kuhnt, U. & Creutzfeldt, OD. 1971. Decreased post synaptic inhibition in the visual cortex during flicker stimulation. Electroencephalography and Clinical Neurophysiology, 30, 79-82

König, H. 1970. Die Blendwirkung monochromatischen Lichtes auf das menschliche Auge. Vision Rev, 10, 875-885

La Giusa, FF. & Perney, LR. 1973. Effectsof brightness variations on attention span in a learning environment. Lighting Design and Application, 3(5), 26-30

Landau, J. & Feldman, S. 1954. Diminished endogeneous morning eosinopenia in blind subjects. Acta Endocrinol, 15, 53

Landis, C. 1951. Something about flicker fusion. Sci Mon, 73, 308-314

Landis, C. & Hamwi, V. 1954. The effect of certain physiological determinants in the flicker fusion threshold. Journal of Applied Physiology, 6, 566-571

Landis, C. & Hamwi, V. 1956. Critical flicker frequency, age, and intelligence. American Journal of Psychology, 69(3), 459-461

Laurens, H. 1929. Some of the physiological effects of radiant energy. Jour of the Opt Soc of Am and RSI, 18(3), 237

Lee, RH. 1941. Critical fusion frequency of flicker. US Public Health Serv Bull, 265, 195-208

Lefave, MK. et al. 1977. Effects of stimulus context and repeated aversive visual stimulation on the cardiac correlate of attention. Perceptual and Motor Skills, 44(1), 215-221

Le Grand, Y. 1937. Sur le rythme apparent du papillatement. CR Acad Sci, 204, 1590

Le Grand, Y. 1966. Untersuchungen der Wirkung farbiger Beleuchtung auf das vegetative Nervensystem von Tier und Mensch. Internationale Farbentagung, Interfarbe 66, Vortrag 2.1

Lehon, LH. 1976. Effects of self-selected lighting level on reading speed and comprehension of visually impaired and normally sighted children. Lighting Design and Application, 6, 32-43

Lehtonen, JB. 1974. Visual evoked cortical potentials for single flashes and flickering light in migraine. Headache, 14, 1-12

Lemond, LC., Durham, RI., Slater, GP., Wilson, WH. & Nunnally, JC. 1974. Varying degress of complexity and isolation in visual exploration. Perceptual and Motor Skills, 38, 787-794

Levine, B. 1958. Sensory interaction: The joint effects of visual and auditory stimulation on CFF. Dissertation Abstracts, 18(1), 300

Levinson, J. 1960. Fusion of complex flicker, II. Science, 131, 1438-1440

Levinson, JZ. 1968. Flicker fusion phenomena. Science, 160, 21-28

Lewis, AL. 1976. Effects of illumination and contrast on visual processes affecting comfort and performance. Lighting Design and Application, 6, 16

Lewis, PR., Lobban, MC. & Shaw, TJ. 1956. Patterns of urine flow in human subjects during a prolonged period of light on a 22 hour day. Journal of Physiology, 133, 659

Lewy, AJ., Wehr, TA., Goodwin, FK., Newsome, DA. & Markey, SP. 1980. Light suppresses melatonin secretion in humans. Science, 210, 1267-1269

Lezawa, GG. 1963. On the mechanism of development of habituation to photically evoked responses in the visual pathway (in Russian). Bull Acad Sci Georgian SSSR, 35/3, 705-711

Lichtenstein, F. 1951. Über die Bedeutung und die Funktionen der Naturfarben in der Menschlichen Nahrung. Zbl Gynäkol, 73, 9-16

Lieber, AL. 1978. Human aggression and the lunar synodic cycle. Journal of Clinical Psychiatry, 39, 385-393

Lieber, AL. 1979. The lunar effect. Corgi Books, Transworld Publishers, London

Lieber, AL. & Sherin, CR. 1972. Homicides and the lunar cycle: Toward a theory of lunar influence on human emotional disturbance, American Journal of Psychiatry, 129, 69-74

Lindner, H. 1976. Einfluss der Beleuchtung-Niveaus auf Visuell-Motorische Leistungen. Lichttechnik, 28(7), 299-305

Lindsley, DB., Wendt, RH., Lindsley, DF., Fox, SS., Howell, J. & Adey, WR. 1964. Diurnal activity, behavior and EEG responses in visually deprived monkeys. Annals of the New York Academy of Sciences, 117, 564-588

Lisk, RD. 1965. Direct effects of light on the hypothalamus. American Association for the Advancement of Science, December

Lisk, RD. & Sawyer, CH. 1966. Induction of paradoxical sleep by lights-off stimulation. Proceedings of the Society of Experimental Biology and Medicine, 123, 664-667

Llewellyn, LlJ. 1932. Light and sexual periodicity. Nature, London, 129, 868

Lobban, MC. 1965. Time, light and diurnal rhythms. In: Edholm, OG. & Bacharach, AL. (eds). The physiology of human survival. Academic Press, London, New York, 351-386

Lobban, MC. 1972. Human dialy rhythms of renal excretion in a modern arctic indian settlement during the midwinter darkness. J Interdiscipl Cycle Res, 3, 245

Lobban, MC. 1974. Seasonal variations in daily patterns of renal excretion in modern Eskimo children. J Interdiscipl Cycle Res, 5, 295

Lobban, MC. & Tredre, B. 1964. Renal diurnal rhythms in blind subjects. Journal of Physiology, 170, 29-30

Lobban, MC. & Tredre, BE. 1967. Perception of light and the maintenance of human renal diurnal rhythms. Journal of Physiology, 189, 32-33

Lodge, A., Armington, JC., Barnett, AB., Shanks, BL. & Newcomb, CN. 1969. Newborn infants' electroretinograms and evoked electroencephalographic responses to orange and white light. Child Development, 40, 267-293

Loef, C. 1974. Farbe - Musik - Form. Ihre bedeutenden Zusammehänge. Musterschmidt Göttingen, Frankfurt, Zürich

Lofts, B. 1970. Animal photoperiodism. The Institute of Biology's studies in biology, No 25, Edward Arnold Publishers

Logan, HL. 1967. The relationship of light to health. Illum Engg, 159-167

Logan, HL. 1972. Survival and sun "light". Paper presented at: I.E.E.E. 1972 Intercon, New York, Paper 6C3

Logan, HL. 1974. Light and the human environment. In: Fields within fields, Vol 12, 58-64, The World Institute Council, New York City

Lotz, RGA. 1961. Wirkung optischer Strahlung auf das vegetative Regulationssystem. In: Christensen, BC. & Buchmann, C. (eds). Progress in photobiology. Proceedings of the third international congress of photobiology. Elsevier Publishing Company, London, New York, 417-421

Luce, GG. 1970. The impact of light. In: Luce, GG. Biological rhythms in psychiatry and medicine. Public Health Service Publication 2088, National Institute of Mental Health, Washington DC, pp 120-132, 172-174

Luce, GG. 1971. Body time. Pantheon Books, Random House, New York

Luckiesh, M. 1970. Effects of classroom lighting upon educational progress and visual welfare of school children. Illuminating Engineering, 35, 915-938

Luckiesh, M. & Moss, FK. 1933. Muscular tension resulting from glare. Journal of General Psychology, 8, 455-460

Luckiesh, M. & Moss, FK. 1933. Correlation between illumination and nervous muscular tension resulting from visual effort. Journal of Experimental Psychology, 16, 540-555

Luckiesh, M. & Pacini, AJ. 1926. Light and health. Williams & Wilkins Co, Baltimore

Lynch, HJ., Wurtman, RJ., Moskowitz, MA., Archer, MC. & Ho, MH. 1975. Daily rhythm in human urinary melatonin. Sicence, 187(4172), 169-171

MacDougall, R. 1903. On the influence of varying intensities and qualities of visual stimulation upon the rapidity of reactions to auditory stimuli. American Journal of Physiology, 9, 116-121

Mackworth, NH. 1965. Visual nosie causes tunnel vision. Psychonomic Science, 3, 67-68

MacLeod, S. & Bartlett, NR. 1954. Human reaction time during dark adaptation. Journal of Optical Society of America, 44, 374-379

Magee, K, Basinska, J., Quarrington, B. & Stanger, HC. 1970. Blindness and menarche, Life Science, 9, 7-12

Maione, M. 1950. Stimoli luminosi e toneuo-vegetativo. Ann Oftalm, 76, 347-358

Makarova, LG. 1966. Changes of EEG in a healthy individual with trigger light stimulation. Bulletin of USSR, Academy of Medical Science, Institute of Neurology, Moscow, 62, 6-11

Marg, E. 1964. The accessory optic system. Annals of the New York Academy of Sciences, 117, 35-52

Markwardt, F. & Repke, K. 1954. Etude du mode d'action de la lumière, régulatrice de l'oestrus. In: Proceedings of the first international photobiological congress. Veenman & Zonen, Wageningen, 401-404

Marshall, FHA. 1932. Light as a factor in sexual reproduction. Nature, London, 129, pp 344, 361

Marx, H. 1946. Hypphysäre Insuffizienz bei Lichtmangel. Klin Wschr, 24/25, 18

Mast, SO. 1911. Light and the behavior of organisms. Wiley, New York

Mayron, LW. & Kaplan, E. 1976. Bioeffects of fluorescent lighting. Academic Therapy, 12(1), 75-90

Mayron, LW., Mayron, EL., Ott, JN. & Nations, R. 1976. Light, radiation and academic achievement: Second-year data. Academic Therapy, 11(4), 397-407

McCall, RB. & Kagan, J. 1967. Attention in the infant: Effects of complexity, contour, perimeter, and familiarity. Child Development, 38, 939-952

McCall, RB. & Melson, WH. 1970. Complexity, contour and area as determinants of attention in infants. Developmental Psychology, 3, 343-349

McCollum, M., Burch, NR. & Roessler, R. 1969. Personality and respiratory responses to sound and light. Psychophysiology, 6, 291-300

McElroy, WD. & Strehler, B. 1954. Life and light. John Hopkins Press, Baltimore, Maryland

Menaker, M. 1967. Lunar periodicity with reference to live births. American Journal of Obstetrics and Gynecology, 98(7), 1002-1004

Menaker, M. 1971. Rhythms, reproduction and photoreception. Biol Reprod, 4, 295-308

Menaker, M. (ed). 1971. Biochronometry. Proceedings of a symposium. Friday Harbor. Washington. National Academy of Sciences, Washington DC

Menju, K. 1940. Effect of the visible light upon the secretion of milk. Japanese Journal of Obstetrics and Gynecology

Menzel, DH. 1959. Our sun. Harward University Press, Cambridge, Massachusetts

Menzel, W. 1962. Menschliche Tag-Nacht-Rhythmik und Schichtarbeit. Benno Schwabe und Co Verlag, Basel, Stuttgart

Meshcheryakov, VA. 1977. Experimental neuroses in dogs cause by an increase in the intensity of (light) stimuli. Zhur vyssh Nerv Deyalel'nosti, 28(4), 755-759

Migeon, CJ., Tyler, FH., Mahoney, JP. et al. 1956. The diurnal variations of plasma levels and urinary excretion of 17-OCHS in normal subjects, night workers and blind subjects. Journal of Clinical Endocrinology, 16, 622

Mikols, RP. 1977. The effect of varying illumination levels on task performance in juvenile delinquents. Dissertation Abstracts International, 38(6-A), 3387

Miller, RL. 1967. The clinical validation of the pupillary response: The effect of chromatic and achromatic stimuli upon pupil responsitivity. Dissertation Abstracts International, 27(7-B), 2515

Mills, JN. & Thomas, S. 1957. Diurnal excretory rhythms in a subject changing from night to day work. Journal of Physiology, 137, 65

Milstein, SL. & Zubek, JP. 1971. Temporal changes in cutaneous sensitivity during prolonged visual deprivation. Canadian Journal of Psychology, 25, 336-348

Mindel, JS. et al. 1973. Photostimulation and visual physiology: Implications for behavioral studies. Behavioral Biology, 8, 325-335

Minton, HL. 1963. A replication of perceptual curiosity as a function of stimulus complexity. Journal of Experimental Psychology, 66, 522-524

Moffett, A. 1969. Stimulus complexity as a determinant of visual attention in infants. Journal of Experimental Child Psychology, 8, 173-179

Monnier, M., Boehmer, A. & Scholer, A. 1976. Early habituation, dishabituation and generalization induced in the visual centres by colour stimuli. Vision Research, 16, 1497-1504

Moon, LE. & Lodahl, TM. 1956. The reinforcing effects of changes in illumination on lever-pressing in the monkey. American Journal of Psychology, 69, 288-290

Moore, RY. 1973. Retinohypothalamic projection in mammals: A comparative study. Brain Research, 49, 403

Moore, RY., Heller, A., Brathnager, RK., Wurtman, RJ. & Axelrod, J. 1968. Central control of the pineal gland: Visual pathways. Archieves Neurology, 18, 208-218

Moore, RY. & Klein, DC. 1974. Visual pathways and the central neural control of a circadian rhythm in pineal serotonin-n-acetyltransferase activity. Brain Research, 71, 17-33

Morgan, CJ. 1967. Sunlight and its effect on human behavior and performance. CIE Conference on sunlight in buildings. Bouwcentrum, Rotterdam

Morin, G., Gastaut, H. & Corriol, J. 1948. Etude électroencéphalograpique des rythmes induits par la stimulation lumineuse intermittente rythmée chez l'homme. J Physiol (Paris), 40, 199-222

Mundy-Castle, AC. 1953. An analysis of central responses to photic stimulation in normal adults. Electroencephalography and Clinical Neurophysiology, 5, 1-22

Mundy-Castle, AC. 1955. The alpha rhythm and rate of visual perception. J Natl Inst Person Research, 6, 38

Mutzhas, MF. 1980. Photobiologie - Ein Grenzgebiet der Lichttechnik. In: Licht 80, Lichttechnische Gesellschaft, Berlin, Tagesband 1, 119-124

Nakshian, JS. 1956. An investigation of the effects of red and green surroundings on behavior. Doctoral Dissertation, University of Connecticut

Nalin, NI. 1975. Functional state of dispatcher-operators working in buildings without natural light. Gig i Sanit, 2, 27-30

Noell, WK., Delmelle, MC. & Albrecht, R. 1971. Vitamin A deficiency effect on retina: Dependence on light. Science, 172, 72-75

Novokhatskiy, AS. 1960. Hypothalamic potentials evoked by photic stimulation of the retina. In: Samsonova, VG. (ed). Problems of Physiological Optics, Vol 15, Physiology of Vision under Normal and Extremal Conditions. Academy of Sciences USSR, available as NTIS document N72-15028-604, Springfield, Va

Odbert, HS., Karwoski, TF. & Eckerson, AB. 1942. Studies in synesthetic thinking. I. Musical and verbal associations of color and mood. Journal of General Psychology, 26, 153-173

O'Hare, JJ. 1956. Intersensory effects of visual stimuli on the minimum audible threshold. Journal of General Psychology, 54, 167-170

Oksche, A. 1960. Optico-vegetative regulatory mechanisms of the diencephalon, Anat Anz, 108, 320-329

Olmedo, EL., Kirk, RE. & Suarez, EM. 1973. Effects of environmental variation on arousal during vigilance performance. Perceptual and Motor Skills, 36(3, Pt. 2), 1251-1257

Osborn, RD. 1968. The moon and the mental hospital: An investigation of one area of folklore. Journal of Psychiatric Nursing, 6, 88-93

Osterman, PO. & Wide, L. 1975. The plasma prolactin levels in man during prolongation of darkness in the morning. Acta Endocrinologica (kbh), 78, 675-682

Ott, JN. 1964. Some responses of plants and animals to variations in wavelengths of light energy. Annals of the New York Academy of Sciences, 117, 624-635

Ott, JN. 1965. Effects of wavelengths of light on physiological functions of plants and animals. Illuminating Engineering, 60(4), 254-261

Painter, M. 1976-77. Fluorescent lights and hyperactivity in children: An experiment. Academic Therapy, 12(2), 181-184

Palmer, JD. 1976. An introduction to biological rhythms. Academic Press

Pangman, CH. & Zubek, JP. 1972. Temporal changes in auditory flutter fusion frequency during prolonged visual deprivation. Perception and Psychophysics, 11, 172-174

Parkes, AS. 1968. Seasonal variation in human sexual activity. In: Thoday, JM. & Parkes, AD. (eds). Genetic and environmental influences on behavior. Oliver & Boyd, Edinburgh, 128

Pengelley, ET. et al. 1971. Annual biological clocks. Scientific American, 224(4), 72-79

Pepler, RD. 1960. Warmth, glare and a background of quiet speech: A comparison of their effects on performance. Ergonomics, 3(1), 68-73

Phelps, J. & Zubek, JP. 1969. The effects of prolonged visual deprivation on various cutaneous and auditory measures. Psychonomic Science, 14, 194-195

Piéron, H. 1965. Vision in intermittent light. Laws and mechanisms of the critical frequency for fusion. In: Neff, WD. (ed). Contribution to sensory physiology, Academic Press, New York, 179-264

Pokorny, AD. 1968. Moon phases and mental hospital admissions. Journal of Psychiatric Nursing, 6, 325-327

Pokorny, AD. & Jachimczyk, J. 1974. The questionable relationship between homicides and the lunar cycle. American Journal of Psychiatry, 131(7), 827-829

Pollack, JD. 1968. Reaction time to different wavelengths at various luminance. Perception and Psychophysics, 3, 17-24

Ponzer, JL. 1972. Lighting, people, environment, production. IEE Trans Ind Application, 8, 98-103

Raab, W. 1939. Zur Frage: Licht und Stoffwechel des Menschen. Z Ges Exp Med, 106, 154

Radnot, M. & Wallner, D. 1965. The endogenous eosinopenic reaction in different eye diseases. Acta Ophthal, 43, 164

Raitselskii, LA. 1971. The signifiance of lighting quality in improving work efficiency and in lowering production costs. Svetotekhnika (USSR), 10, 5-8

Ray, VF. 1953. Human color perception and behavioral response. Transactions of the New York Academy of Sciences, 16, 98-104

Regan, D. 1966. Some characteristics of average steady-state and transient responses evoked by modulated light. Electroencephalography and Clinical Neurophysiology, 20, 238-248

Regan, D. 1968. Chromatic adaptation and steady-evoked potentials. Vision Research, 8, 149-158

Reinberg, A. 1972. Influence of lighting on human biologic rhythms (in French), Lux, No 69

Reinberg, A., Halberg, F., Ghata, J. & Siffre, M. 1966. Spectre thermique (rythmes de la temperature rectale) d'une femme adulte saine avanta, pendant et apres son isolement souterrain de trois mois. Comptes Rendus Acad Sci, 262, 782-785

Reiter, RJ. 1974. Circannual reproductive rhythms in mammals related to photoperiod and pineal function: A review. Chronobiology, 1(4), 365-395

Reiter, RJ., Blum, K., Wallace, JE. & Merritt, JH. 1973. Effect of the pineal gland on alcohol consumption by congenitally blind male rats. Quart J Stud Alc, 34, 937-939

Rey, PP. & Rey, JP. 1963. Les effets comparés de deux éclairages fluorescents sur une täche visuelle et des tests de fatigue. Ergonomics, 6, 393-401

Rippmenn, ET. 1957. The moon and the birth rate. American Journal of Obstetric and Gynecology, 74, 148-151

Ritter, CE. 1954. A woman in the polar night. Dutton, New York

Roessler, G. 1979. Die ständige Tageslichergänzungsbeleuchtung. Eine experimentelle Untersuchung, ihre psycho-physiologischen Grundlagen. Dissertation, Technische Universität, Berlin

Ronchi, L. 1976. Human biological and performance rhythms in the frame of illuminating engineering. Trans George Ronchi Foundation, 31(3), 405-408

Rothman, S. 1923. Untersuchungen über die Physiologie der Lichtwirkungen. Ztschr f d ges exper Med, 36, 398-446

Rowan, W. 1938. Light and seasonal reproduction in animals. Biol Rev Cambridge Phil Soc, 13, 374-402

Rowan, WM. 1956. Photoperiodism in vertebrates. In: Proceedings of the first international photobiological congress (4th international light congress), Amsterdam, Comité International de Photobiologie, 46-51

Ruffer, W. 1928. Über die Beeinflussung menschlicher Leistungen durch farbiges Licht. Industr Psychotch, 5, 161-177

Ryan, TA., Cottrell, CI. & Bitterman, ME. 1950. Muscular tension as an index of effort: The effect of glare and other disturbances in visual work. American Journalof Psychology, 63(3), 317-341

Sato, K. & Kitajima, K. 1965. On the average EEG response activities in relation to the intensity of flicker stimulation. Japanese Journal of Physiology, 15, 596-622

Scharrer, E. 1937. Über ein vegetatives optisches System. Klin Wochschr, 1521-1523

Scharrer, E. 1964. Photo-neuro-endocrine systems: General concepts. Annals of the New York Academy of Sciences, 117, 13-22

Schauss, AG. 1979. Tranquilizing effect of color reduces aggressive behavior and potential violence. Orthomolecular Psychiatry, 8(4), 218-221

Schneider, L. 1963. Optimale Beleuchtungsstärken für die Arbeit Arbeitsphysiologische Betrachtungsweise. Lichttechnik,15, H. 6&7

Schnurman, AG. 1948. The effect of the moon on childbirth. Virginia Med Monthly, 76, 78

Schober, H. 1963. Die Ursachen asthenopischer Beschwerden bei Beleuchtung durch Leuchtstofflampen. Klin Mbl Augenheilk, 123, 452-474

Scott, TH., Bexton, WH., Heron, W. & Doane, BK. 1959. Cognitive effects of perceptual isolation. Canadian Journal of Psychology, 13, 200

Segal, J. 1961. Die physiologische Wirkung des Lichtes von Leuchtstoffröhren. Sowjetwissenschaft. Naturwissenschaftliche Beiträge (Berlin), 366-373

Serra, EA. 1959. Neurological contribution to action mechanisms of intermittent photic stimulation. 4 Int Congress of Electroencephalography and Clinical Neurophysiology, Pergamon Press, London, 427

Shackelford, PG. et al. 1973. Periodicity of susceptibility to pneumococcal infection: Influence of light and adrenocortical secretions. Science, 182, 285-287

Shannon, IL. & Suddick, RP. 1973. Effects of light and darkness on human parotid salivary flow rate and chemical composition. Arch Oral Biol, 18, 601-608

Shannon, IL. et al. 1974. Effects of lights of specific spectral characteristics on human resting parotid gland function. Arch Oral Biol, 19, 1077-1078

Sharp, GWG. 1960. The effect of light on diurnal leucocyte variations. Journal of Endocrinology, 21, 213

Shick, J. 1977. Relationship between personality and color in the performance of a gross motor skill. Journal of the Association for the Study of Perception, 12(1), 19-22

Shigesa, T. & Gunn, WJ. 1978. Annoyance response to recorded aircraft noise. I. Effect of intensity of illumination. Journal of Auditory Research, 18, 175-182

Shipley, T. 1964. Rod-cone duplexity and the autonomic action of light. Vision Research, 4, 155-177

Shipley, T., Jones, RW. & Fry, A. 1965. Evoked visual potentials and human color vision. Science, 150, 1162-1165

Simenhoff, ML. 1974. Influence of photic input on circadian rhythms in man. Journal of Applied Physiology, 37, 373-377

Simonson, E. & Brozek, J. 1948. Effects of illumination level on visual performance and fatigue. J Opt Soc Amer, 38, 384-397

Simonson, E. Brozek, J. 1948. The effect of spectral quality of light on visual performance and fatigue. J Opt Soc Amer, 38, 839-840

Simonson, E. & Brozek, J. 1952. Flicker fusion frequency: Background and application. Physics Review, 32, 349-378

Sinclair, JD. & Geller, I. 1972. Ethanol consumption by rats under different lighting conditions. Sciences, 175, 1143-1144

Smith, KC. (ed). 1976- . Photochemical and photobiological reviews. Vol 1 ff. Plenum Press, New York

Smith, KC. (ed). 1977. The science of photobiology. Plenum Press

Smith, RS. 1958. An investigation of the relations between physiological and cognitive measures of the affective response to color. Dissertation Abstracts, 19, 873

Smith, SW. 1976. Performance of complex tasks under different levels of illumination. 1. Needle probe task. Journal of Illuminating Engineering Society, 5(4), 235-242

Sobol, M. & Day, HI. 1967. The effect of colour on exploratory behaviour and arousal. Paper read to Canadian Psychological Association

Sommer, J. 1969. Arbeitsleistung und Beleuchtung. Arbeit und Leistung, 23, 142-158

Sommer, J. 1977. The influence of illumination on intelligence, concentration, and reaction performance. Part I. Lichttechnik, 29(8), 242-245

Sommer, J. 1977. Effect of lighting on intelligence, concentration and reaction performance. Part II. Lichttechnik, 29(9), 270-272

Sommer, J. & Herbst, CH. 1971. Einfluss der Beleuchtung auf die Arbeit an der Schreibmaschine. Lichttechnik, 23, 23-26

Spalding, JF. et al. 1969. Sex ratio of progeny from mice reared under various color lighting conditions. Lab Anim Care, 19(5), 602-604

Spandri, P. 1974. Sleep and wakefulness and light and dark in the determination of the adrenal gland rhythm of cortisol. Minerva Med, 65, 2521-2525

Srivastava, RK. & Peel, TS. 1968. Human movement as a function of color stimulation. Environmental Research Foundation, Topeka, Kansas

Steele, HD. 1972. Light as a stimulant of the central nervous system: Some theoretical considerations and implications. LUTERG Report No 60, Department of Human Sicences, Loughborough

Stenzel, AG. 1953. Einfluss von Licht, Lichtfarbe und Raumfarbe auf den arbeitenden Menschen. Lichttechnik, H 6

Stewart, TFM. 1979. Eyestrain and visual display units: A review. Displays, 1, 25-32

Stolper, JH. 1971. Differential effects of color in the background of a visual task. PhD Dissertation, University of Wisconsin, Department of Environmental Design

Stone, PT., Harker, SDP., Coley, WZ., Ruff, HR. & Jones, G. 1974. Human reactions to high intensity lighting. LUTERG Report No 156, Department of Human Sciences, Loughborough

Stone, PT., Harker, SDP., Coley, WZ., Ruff, HR. & Jones, G. 1974. An investigation of the EMG response to high intensity lighting. In: Stone, PT. et al. Human reactions to high intensity lighting. LUTERG Report No 156, Section 3, 101-136, Department of Human Sciences, Loughborough

Storm van Leeuwen, W. & Kok, L. 1953. Some ways in which EEG changes may be produced by photic stimulation. Folia Psychiat Neerl, 56, 519-524

Strobel, E. & Dorschner, H. 1956. Zur Frage der Menstruationsverhältnisse bei blinden Frauen. Geburtshilfe & Frauenheilk, 16, 1024

Struwe, G. et al. 1970. Eye ultrastructure, colour reception and behavior. Nature, 226(5248), 865-866

Sutton, PRN. 1959. Association between colour of the iris of the eye and reaction to dental pain. Nature, 184, 122

Swade, RH. 1969. Circadian rhythms in fluctuating light cycles: Toward a new model of entrainment. J Theoret Biol, 24, 227-239

Sysin, AN. et al. 1966. Physiological assessment of artificial illumination of different spectral composition. Vesta Akad Med Nauk SSSR, 21, 41-46

Tanaka, M. 1973. The anisotropic structure of personal space. Japanese Journal of Educational Psychology, 21(4), 232-233

Taylor, AN. & Wilson, RW. 1970. Electrophysiological evidence for the action of light on the pineal gland in the rat. Experientia, 26, 267-270

Taylor, LH. & Sucov, EW. 1974. Movement of people towards lights. Illuminating Engineering Society Journal, 3, 237-241

Taylor, LH. & Sucov, EW. & Shaffer, DH. 1974. Office lighting and performance. Paper presented at 1974 annual IES Conference, New Orleans, USA (Also Westinghouse Research Laboratories, Pittsburgh, USA)

Terstenjak, A. 1955. Reaktionszeiten und Ermüdungserscheinungen beim Fixieren einzelner Farbtöne. Contributi del Laboratorio Psicologia Universita Milano, 19, 467-491

Terstenjak, A. 1963. Deux recherches sur l'interaction audio-visuelle. Bulletin du CERP, 12(2), 149-159

Terstenjak, A. 1966. Motorische Reaktionswerte der Signalfarben Rot, Gelb, Grün bei Tageslicht und im Dunkeln. Internationale Farbentag. Interfarbe 66. Vortrag 2.6

Theorell, H. 1951. Light and human life. In: Halbertsma, NA. & Jansen, J. (eds). Commission Internationale de l'Eclairage, Volume II. Stockholm, Bureau Central de la CIE, New York

Thiry, S. 1951. Contribution a l'étude de l'entrainement photique. Archives Internationels de Physiologie, 59(1), 10-25

Thomas, JB. & Pizzarello, DJ. 1967. Blindness, biologic rhythms and menarche. Obstet Gynec, NY, 30, 507

Thompson, RF., Voss, JF. & Brodgen, WJ. 1958. Effects of brightness of simultaneous visual stimulation on absolute auditory sensitivity. Journal of Experimental Psychology, 55, 45-50

Thorington, L. 1973. Light, biology and people. I. Lighting Design and Application, 3(11), 19-23

Thorington, L. 1973. Light, biology and people. II. Lighting Design and Application, 3(12), 31-36

Thorington, L. 1975. Artificial lighting - what color and spectrum? Lighting Design and Application, Nov

Thorington, L., Parascandola, L. & Cunningham, L. 1971. Visual and biologic aspects of an artificial sunlight illuminant. Journal of Illuminating Engineering Society, 67, 33-41

Tikkanen, KT. 1970. Spectral eye fatigue in a school environment. Lighting Research and Technology, 11(4), 184-188

Tilgner, S. 1967. Beziehungen zwischen Licht, Auge und Nebennierenrinden-Aktivität (demonstriert am Verhalten der Eosinophilenzahl im peripheren Blut). Biol Rdsch, 5, 267-277

Timonen, S. 1968. Multiple pregnancies and photoperiodicity. Annals Chirurgiae et Gynaecologiae Feminae, 57, 135-138

Timonen, S., Franzas, B., Wichmann, K. 1964. Photosensibility of the human pituitary. Annales Chirurgiae et Gynaecologiae Feminae, 165-172

Toman, J. 1941. Flicker Potentials and the alpha rhythm in man. Journal of Neurophysiology, 4, 51-61

Travis, LE. & Hall, M. 1938. The effect of visual after-sensation upon brain potential patterning under different degrees of attention. Journal of Experimental Psychology, 22, 472-479

Travis, LE. & Knott, JR. 1937. Brain potential studies: I. Perseveration time to light. Journal of Psychology, 3, 97-100

Travis, LE. & Knott, JR. 1937. Brain potential studies: II. Perseveration time to visually presented words. Journal of Experimental Psychology, 21, 353-358

Travis, RC., Kennedy, JL., Mead, LC. & Allphin, W. 1951. Muscle action potentials as a measure of visual performance cost. Illuminating Engineering, 46, 182-187

Troupin, AS. 1966. Photic activation and experimental data concerning colored stimuli. Neurology, 16, 269-276

Tsushima, W. 1963. Diurnal variation of the critical flicker frequency. Master's Dissertation. Fordham University, New York

Tulloch, MV. 1974. The role of illumination in sensory deprivation. Dissertation Abstracts International, 34(7-A), 3718-3719

Ulett, GA. & Gleser, G. 1952. The effect of experimental stress upon the photically activated EEG. Science, 115, 678-682

Ulett, GA. & Johnsson, LC. 1958. Pattern, stability and correlates of photic-electroencephalographic activation. J Nerv Ment Dis, 126, 153-168

Valsik, JA. 1965. The seasonal rhythm of menarche. A review. Human Biology, 37, 75-90

Van Brunt, EE., Shepherd, MD., Wall, JR., Ganong, WF. & Clegg, MT. 1964. Penetration of light into the brain of mammals. Annals of the New York Academy of Sciences, 117, 217-227

Van Buskirk, C. et al. 1952. The effect of different modalities of light on the activation of the EEG. Clinical Neurophysiology, 4

Vander-Meer, AW. 1954. Relative effectiveness of color and black and white in industrial films. Audio-Visual Comm Rev, 2, 121-134

Van der Tweel, LH. 1964. Relation between psychophysics and electrophysiology of flicker. Docum Ophthal (Den Haag), 18, 287-304

Van der Tweel, LH. & Verduyn Lunel, HFE. 1965. Human visual responses to sinusoidally modulated light. Electroencephalography and Clinical Neurophysiology, 18, 587-598

Van Hoek, LD. 1972. The representation in the EEG of chromatic information in visual stimuli. Ophthalmology, 164, 335

Vannfalt, KA. 1929. Action de la lumière sur la composition du sange humain. C R Soc Biol, 101, 610

Van Noort, MR. 1965. Etude sur l'influence de la lumière de jour sur l'état de santé des ouvriers. Raport de IPO, Amsterdam-Gröningen

Vanzulli, A., Bogacz, J., Handler, P. & Garcia-Austt, E. 1960. Evoked responses in man. I: Photic responses. Acta Neurologica Latino Americano, 6, 219-231

Vaughan, G., Pelham, RW., Pang, SF., Loughlin, LL., Wilson, KM., Sandoch, KL., Vaughan, MK., Koslow, SH. & Reiter, RJ. 1976. Nocturnal elevation of plasma melatonin and urinary 5-hydroxyindole-acetic acid in young men: Attempts at modification by brief changes in environmental lighting and sleep and by autonomic drugs. Journal Clin Endocr Metab, 42, 752-764

Veen, RVD. 1956. Symposium on photoperiodicity in plants and animals. Final report. In: Proceedings of the first international photobiological congress, Amsterdam, Veenman & Zonen, Wageningen, 421-422

Vernon, J. & McGill, T. 1960. Utilization of visual stimulation during sensory deprivation. Perceptual and Motor Skills, 11, 214

Vernon, JA., McGill, TE. & Shiffman, H. 1958. Visual hallucinations during perceptual isolation. Canadian Journal of Psychology, 12, 31

Visscher, MB. & Halberg, F. 1954. Some physiologic effects of lighting. In: Proceedings of the first international photobiological congress, Veenman & Zonen, Wageningen, 396-398

Vitova, Z. 1973. Cerebral responses to flickering light in clinical research. Activ Nervosa Superior, 15(1), 63-69

Vitova, Z. 1973. Responsiveness to flickering light in waking and sleeping infants. Physiol Bohemoslov, 22, 47-52

Vitova, Z. et al. 1972. Develpmental study on the responsiveness of the human brain to flicker stimulation. Dev Med Child Neurol, 14, 476

Vollmer, H. 1938. Studies on biological effects of colored light. Archives Physical Therapy, April

Von Schumann, HJ. 1953. Fehlregulationen des Stoffwechsels als Folge von Erblindung. Med Klin, 48, 1772

Von Schumann, HJ. 1973. Disturbances of sexual function in blind people. In: "Intern Congress". The sun in the service of mankind, B19, UNESCO-House, Paris

Wald, G. 1959. Life and light. Scientific American, 201, 92-108

Wald, G. 1964. Recent progess in photobiology. Blackwell Scientific Publications, Oxford

Walker, AE., Wolf, JI., Halstead, WC. & Case, TJ. 1943. Mechanisms of temporal fusions: Effects of photic stimulation on electrical activity of visual structures. Journal of Neuro-Physiology, 6, 213-220

Walker, AE., Wolf, JI., Halstead, WC. & Case, TJ. 1944. Photic driving. Arch of Neurolog Psychiat, 52, 117-125

Wall, PD., Remond, AG. & Dobson, RL. 1953. Studies on the mechanism of visual afferents on motor cortex excitability. Electronecephalography and Clinical Neurophysiology, 5, 385-393

Walter, WG. 1964. The convergence and interaction of visual, auditory and tactile responses in human, nonspecific cortex. Annals of the New York Academy of Sciences, 112/1, 320-361

Walter, WG. 1972. Further comments. Federation of British Artists Quarterly. 1(3), 18

Walter, WG. & Dovey, VJ. 1947. Etude analytique des rythmes corticaux induits par une stimulation lumineuse intermittente. Marseille Med, 5, 240-248

Walter, WG., Dovey, VJ. & Shipton, HW. 1946. Analysis of the electrical response of the human cortex to photic stimulation. Nature, 158, 540-541

Walter, WG. & Shipton, HW. 1949. The effect of synchronizing light and sound stimuli with various components of the electroencephalogram. Journal of Physiology, 108, 15

Wassner, L. 1954. Untersuchungen bei jugendlichen Blinden als Beitrag zur vegetativen Steuerung des Stoffwechsels über die Sehbahn. Med Wschr, 8, 530

Wayner, MJ., Greenberg, I., Tartaglione, R., Nolley, D., Fragley, S. & Corr, A. 1972. A new factor accepting the consumption of ethyl alcohol and other sapid fluids. Physiology and Behavior, 8, 345-362

Wells, CE. 1959. Modification of alpha wave responsiveness to light by juxtaposition of auditory stimuli. AMA Arch Neurol Psychiat, 1, 689-694

Wells, CE. 1963. Alhpa wave responsiveness to light in man. In: Glaser, GH. (ed). EEG and behavior. Basic Books, New York, 27-59

Weston, HC. 1952. Visual fatigue with special reference to lighting. Trans Illum Engng Soc, 17, 39-66

Weston, HC. 1954. Visual fatigue. Illuminating Engineering, 49(2), 63-76

Wetterberg, L. & Osterman, PO. (undated). Light synchronization of the circadian rhythm of plasma melatonin in man. (In preparation 1978, S:t Göran's Hospital, Stockholm)

Wever, R. 1970. Autonomous circaidan rhythms in men as influenced by different light conditions. J Interdiscip Cycle Research, 1, 106

Wever, R. 1973. Der Einfluss des Lichtes auf die circadiane Periodik des Menschen. I Teil: Einfluss auf die autonome Periodik. Z Physik Med, 3, 121

Wever, R. 1974. Der Einfluss des Lichtes auf die circadiane Periodik des Menschen. II Teil: Zeitgeber-Einfluss. Z Physik Med, 3, 137

Whipple, HE., Spitzer, MI. & Hague, EB. (eds). 1964. Photo-neuro-endocrine effects in circadian systems, with particular reference to the eye. Annals of the New York Academy of Sciences, 117, 1-645

White, EH. 1965. Autonomic responsitivity as a function of level of subject involvement. Behavioral Science, 10, 39-50

Whitting, HT. et al. (undated). Level of illumination and performance in a simulated table-tennis task. International Journal of Sport Psychology, 3(1), 32-41

Wilson, GD. 1966. Arousal properties of red versus green. Perceptual and Motor Skills, 23, 947-949

Wilson, NH. & Wilson, WP. 1959. The duration of human electroencephalograpic arousal responses elicited by photic stimulation. Electroencephalography and Clinical Neurophysiology, 11, 85-91

Winfree, AT. 1975. Resetting biological clocks. Physics Today, 28, 34-39

Winget, CM. & Card, DH. 1967. Daily rhythm changes associated with variations in light intensity and color. Life Sciences and Space Research, 5, 148-158

Withrow, RB. (ed). 1959. Photoperiodism and related phenomena in plants and animals. Publ No 55, Am Assoc Adv Sci, Washington DC

Wohlfarth, H. 1956. Versuche zur Bestimmung eines eventuellen Effektes von Farbstimuli auf das autonome Nervensystem. Psychotherapie, 1, 216

Wohlfarth, H. 1957. Psychophysische Auswertung der Versuche zur Bestimmung eines evtl. Effektes von Farbstimuli auf das autonome Nervensystem. Psychotherapie, 2, 86

Wolfson, A. 1964. Animal photoperiodism. In: Giese, AC. (ed). Photophysiology, Volume II. Academic Press, New York, London, 1-49

Wolken, JK. 1975. Photoprocesses, photoreceptors and evolution. Academic Press

Wood, CL. & Bitterman, ME. 1950. Blinking as a measure of effort in visual work. American Journal of Psychology, 63, 584-588

Wurtman, RJ. 1967. Effects of light and visual stimuli on endocrine function. In: Martini, L. & Ganong, WF. (eds). Neuroendocrinology, Academic Press, New York, 2, 19-59

Wurtman, RJ. 1968. Biological implications of artificial illumination. Illuminating Engineering, 63, 523-529

Wurtman, RJ. & Neer, RM. 1970. Good light and bad. The New England Journal of Medicine. 282(7), 394-395

Wurtman, RJ. & Weisel, J. 1969. Environmental lighting and neuroendocrine function: Relationship between spectrum of light source and gonadal growth. Endocrinology, 85, 1218-1221

Yano, K. 1954. A comparative study of the growth in height and weight of normal, blind and deaf school-children. Kurume Med Journal, 1, 71

Yochim, JM. 1970. Influence of environmental lighting on duration of pregnancy in the rat. Endocrinology, 87(3), 472

Zacharias, L. & Wurtman, RJ. 1969. Blindness and menarche. Obstet Gynecol, 33, 603-608

Zeiner, AR. et al. 1972. Physiological effects of backscatter of high intensity light pulses on the human pilot. Aerospace Med, Sept, 1008

Zietz, K. 1931. Gegenseitige Beeinflussing von Farb- und Tonerlebnissen. Zeitschrift für Psychologie, 121, 257-356

Zinnitz, F. 1959. Beitrag zur Pharmakologie sichtbaren Lichtes. Klin Mbl Augenheilk, 134, 161-172

Zubek, JP. 1973. Behavioral and physiological effects of prolonged sensory and perceptual deprivation. A review. In: Rasmussen, J. (ed). Man in isolation and confinement. Aldine Publishing Company, Chicago, Illinois

Zubek, JP., Aftanas, M., Hasek, J., Sansom, W., Schludermann, E., Wilgosh, L. & Winocur, G. 1962. Intellectual and perceptual changes during prolonged perceptual deprivation: Low illumination and noise level. Perceptual and Motor Skills, 15, 171-198

Zubek, JP., Flye, J. & Aftanas, M. 1964. Cutaneous sensitivity after prolonged visual deprivation. Science, 144, 1591-1593

Zubek, JP., Flye, J. & Willows, D. 1964. Changes in cutaneous sensitivity after prolonged exposure to unpatterned light. Psychonomic Science, 1, 283-284

Zubek, JP., Pushkar, D., Sansom, W. & Gowing, J. 1961. Perceptual changes after prolonged sensory isolation (darkness and silence). Canadian Journal of Psychology, 15, 83-100

Zucker, I. 1976. Light, behavior and biologic rhythms. Hospital Practice, 11(10), 83-91

Zuckerman, S. 1959. Light and living matter. Trans Illuminating Engineering Society, 24(3)

Östberg, O. 1974. Fatigue in clerical work with CRT display terminals. Göteborg Psychological Reports, University of Göteborg, Sweden, 4(19), 1-4

Anonymous. 1947. The influence of lighting, eyesight, and environment upon work production. Joint report by the US Public Buildings Administration and the US Public Health Service, Washington DC, USA

———— 1956. Proceedings of the First International Photobiological Congress (4th International Light Congress). Amsterdam. Veenman & Zonen, Wageningen

———— 1957. Proceedings of the 2nd International Photobiology Congress. Minerva Medical Monography

———— 1960. Biological clocks. Cold Spring Harbor Symposia on Quantitative Biology, XXV, Cold Spring Harbor, New York

———— 1962 - . Photochemistry and photobiology. Pergamon Press, London

SECTION 3

PSYCHOLOGICAL EFFECTS OF LIGHT AND COLOUR

Preferences for light, colour and visual patterns

Almost every year since the end of the 19th century there has been some study concerning colour preferences. Eysenck, in 1941, compiled over 20.000 colour preference ratings previously carried out in diverse experiments and concluded that people prefer colours in the following order: blue, red, green, violet, orange and yellow (198). He also found sex differences and a personal component, some people preferring shades and others tints. However, owing to the lack of control of various colour characteristics, there were many inconsistencies in the original studies (184, 192, 193, 198, 204, 236).

Preference ratings of colours might be regarded as part of an emotional evaluation process in terms of liking and disliking. There are many other secondary meanings associated with colour, so called connotations. Numerous studies have been carried out in order to analyze and describe such connotations, mostly employing semantic ratings of colours, using adjectives, e.g. beautiful, ugly, warm, cold, fast, slow, strong, weak, and subsequently treating data with factor analysis (211, 242, 243, 251, 256, 265).

In studies of this type it seems the three fundamental dimensions initially identified by Osgood in his studies on meaning - evaluation, activity and potency - might also be used to differentiate between colours. Hogg, in 1969, found four dimensions, which he called strength, pleasantness, warmth, and usualness (209).

Guilford was one of the first to vary not only hue but also tint and chroma of the colour (204, 205). The systematic approach was carried on by Sivik in his work on colour connotations, where the relations between colours and meanings are illustrated by means of iso-semantic mapping based on the Natural Color System. (Developed by Hård and Sivik and now employed as Swedish Standard.) Sivik's studies show the affective value for a certain hue varies widely with its coloristic position. It is, for instance, quite easy to find a yellow sample that is preferred to a blue one, etc (246, 247, 249, 250). Another technique is exemplified in a study by Wittenberg, 1969, where a thousand men and women had to select the most and the least sympathetic colour out of ten and tell about their associations to the colours selected (263). From results such as these the emotional values or

mood-tones of colours might be assessed with reasonable accuracy (189, 211, 219, 234, 236, 254, 261, 262, 265).

In many of the studies special attention has been paid to the apparent warmth and coolness of colours and also their apparent heaviness. The former is obviously related to the subjective redness or blueness of the colour sample and the latter to the whiteness-blackness. Some authors prefer to interpret their findings in physical terms of wavelength and intensity; a habit which might give rise to confusion (106, 217, 229, 235, 236, 237, 253, 254, 264).

An objection which can be raised against many of the psychological colour studies is that the colours were applied to pieces of paper and the like. This lack of context means we do not know if the preference order obtained will be valid when it comes to real life situations. In one study it was even concluded that colour names and hues are virtually equivalent in terms of the connotative meanings which they evoke (262). Furthermore, while an astonishing amount of effort has been spent studying preference for or meaning of colour samples one at a time, there have been rather few studies of colour combinations. There do exist a few studies where colours have been assessed two or three at a time. The conclusion in one of these is that pleasantness of a colour combination is derived not merely from the summation of the affective tones of its components but from another factor depending on the combination itself (259). Results such as this makes one wonder whether it is sensible to go on with the single-colour-without-context studies. Instead there seems to be a definite need to study light as well as colour as part of a complex and meaningful situation (210, 230, 259).

A number of studies have been devoted to the subjective assessment of light and illumination. Here, the evaluation of discomfort glare takes the foremost position. Various kinds of subjective methods have been employed, i.e. verbal description ranging from 'intolerable' to 'comfortable' or 'imperceptible', or magnitude estimation where the subject is requested to assign different numbers to different glare levels. Östberg et al, 1975, found that the subjective ratings were highly correlated to the corresponding objective glare indices. Of particular interest was the finding that increased task difficulty meant increased discomfort glare, and vice versa (268).

A related group of studies concerns the perceived quality of illumination, comparing various types of fixtures or light sources. One classic study was reported by Kruithof in 1941. He found that when the illumination was intense, subjects preferred a rather cool colour temperature. When the illumination was low, a warmer colour temperature was preferred. In a study carried out in an office landscape, Küller demonstrated that the preference for fluorescent daylight tubes decreased in the evening. When there was no natural

daylight outside the windows, the artificial daylight indoors became unpleasant, unnatural, monotonous, cold and hard (Küller, forthcoming).

Ross, in 1938, studied the mood-reactions to light of various colours as it might be seen in the theatre. The author concluded that warm coloured lights were associated with activity and comedy, and cool coloured lights with tragedy and possibly romance (240). Influenced by these results, amongst others, Kohn, almost thirty years later, explored the influence of colour and illumination on the interpretation of tape-recorded emotional phrases. There were, however, no significant differences in the judgment of an emotion's intensity with variation of room colour or illumination (219). There also exist a few studies dealing with the subjective response to flickering light sources (72, 138, 180, 183, 190, 195, 196, 197, 218, 219, 236, 240, 241, 268. Concerning flicker, see also references, Section 2).

Regarding psychological reactions to visual patterns this is in itself a large and well explored field, usually referred to as experimental aesthetics. I have chosen to include two studies by Berlyne and Boudewijns on the hedonic effects of uniformity and variety, which illustrate the importance of patterns in any study of the visual field. A study on the relationship between colour, graffiti and supergraphics was reported by Mikellides in 1979 (185, 186, 229). In reality, light and colour almost always appear together with - or as parts of - a visual pattern. The evaluations, or even the physiological reactions, might therefore depend not on the light and colour, but to a certain extent, on the pattern itself.

The psychological world of man encompassing not only the thoughts and feelings about the environment but also about himself is extremely complicated. It is therefore difficult to make specific statements about the emotional impact of light, colour and patterns. It is quite feasible, however, to indicate in general terms how the physiological processes of the nervous system might have their psychological counterparts. Any change in the visual field is likely to start a train of physiological events, the first step being the orienting response on behalf of the subject. In man, behaviors like turning toward, looking at, and paying attention to the light, colour or pattern will have their mental counterparts in feelings of interest, curiosity, or apprehension. There will also be an immediate increase in the arousal level of the nervous system. The shift in arousal level will be experienced in terms of heightened awareness, activation or even excitement. At the same time, the cause of stimulation will be assessed and classified according to its significance for the subject in question. The classification process will include aspects of hedonic evaluation including feelings of pleasure and displeasure. Finally, if the resulting action on behalf of the subject turns out to be satisfactory, there might be feelings of control and dominance of the situation.

Let me apply this model to the main result from the many studies of preference ratings. Why did the subjects in Eysenck's compilation prefer blue to red, green, violet, orange and finally yellow? The problem lies in the very nature of preference ratings. Somebody might prefer one colour to the other simply because it attracts attention to a higher extent. In this way a strong red might be preferred to a weak red, or to a brown. It is also a fact that some colours are more exciting than others in a physiological sense. This, in itself, might be another reason for preference. Other persons might instead prefer the colour because they find it pleasant or beautiful. The red of an apple is pleasant because it tells us that the apple is ripe and edible. Preferences of this kind are based on biological experience acquired over the millennia. There might also be personal reasons for liking or disliking, e.g. a colour that we remember because of a pleasant experience. Finally, a colour might be preferred because it is useful in a specific situation, thus giving rise to feelings of control and satisfaction. The average rank order of colour preferences found by Eysenck might obviously depend on all these factors, intermixed in a way that makes further analysis impossible.

The classic review on colour and affect, by Norman and Scott, 1952, is still useful today (236). For a more recent review refer to Plack and Shick, 1974 (147). It may be supplemented by the chapters on colour preferences in Pickford, 1972, and the meaning of colours, in Kreitler and Kreitler, 1972. A review of various techniques of subjective scaling and discomfort glare will be found in Östberg and Stone, 1974 (268). Concerning experimental aesthetics, refer to Berlyne, 1971 (reference, Section 2).

The impact of culture and personality

One of the most striking features of the results concerning preferences, connotations and colour-mood associations is the consistency from one individual to another, from group to group and cross-culturally. There has been a great number of cross-cultural studies comparing subjects in America, Lebanon, Kenya, Botswana, Greece, just to mention a few. Monkeys have been compared to Man, men to women, children to adults, laymen to architects. As one author concludes: "It would indicate either that our heritage is such that we all learn the 'correct' responses, or that there is some innate mood-reaction to different colours." (240). However, there is no reason to search for an explanation in terms of either-or. In the previous sections we have seen that the biological experience common to mankind has left its mark on every level of the organism from the single cell to the brain itself. At the same time there is the continuous impact of the traditions

and artifacts of society. It would be strange indeed, if biology and culture were found to be in total opposition to each other. A much more sensible hypothesis will be that they interact, giving rise to similarities as well as differences in a complicated but not altogether incomprehensible way (188, 192, 198, 203, 205, 211, 212, 223, 229, 233, 236, 246, 254, 257).

Each culture, or subculture, seems to have its own colour-and-pattern tradition, which is conveyed to its members through the mechanism of repetition. By using the same colours of patterns over and over again in specific settings, every member of the group will incorporate them and value them in the same way. Other groups may value them differently or not at all. Any attempt at explaining colour preferences must consider this cultural impact. In a study on the effect of hues of walls and spectral composition of light-sources on perceived magnitude of space, Aksugür, 1979, using data from the indexes of paint sales in Turkey, was able to show the influence of cultural factors (182). In a personal communication drawing on as yet unpublished data, Aksugür stressed the importance of economical, geographical and religious factors, the educational level of the consumer and also fluctuations of taste occuring on an international level. As an example he mentioned a certain green colour of specific significance in the Islamic relgion. This colour, Munsell 7.5G 8/4, was preferred in highly religious parts of Turkey and also brought along by people moving into the big cities.

Studies on colour connotation, performed by Sivik both in Sweden and in Greece, further illuminate the importance of the cultural context (246). While the overall correlation was high between the Greeks and the Swedes, there were some obvious differences. While the Greeks interpreted all colours as equally cultivated, the Swedes judged the saturated colours as more vulgar than the unsaturated ones. The Greeks also judged all colours as more feminine than did the Swedes. Concerning the scale 'summer-winter', discrepancies appeared for certain light-blue and light-green colours which the Swedes associated with snow, ice, and winter, while the Greeks thought that they belonged to summer. On the other hand, certain grass-green colours were associated with summer by the Swedes but not by the Greeks, because not much of grass-green is to be seen in Greece during the summer (192, 193, 198, 211, 213, 233, 236, 240, 246, 257, 266).

For many years the psychologist has been using colours as a means of testing his patient. It is possible to identify two main approaches, the first one based on colour preferences. The subject is presented with a set of coloured cards and asked to make a first choice, a second choice, etc, or to sort or place the cards according to certain instructions. The idea behind this is that the response - interpreted according to rigid rules or in some studies by means of multidimensional scaling - will reveal something about the subject's

personality. Well known examples of tests of this kind are the Lüscher Color Test, the Frieling Test and the Color Pyramid Test of Pfister and Heiss (184, 191, 193, 202, 222, 236, 244, 245).

The second approach is based on the idea that colour in itself is emotionally loaded. This is exemplified by the famous Rorschach test, consisting of a number of cards with apparently nonsensical inkblots, which are used as a means of eliciting the subject's unconscious fantasies. Most of the inkblots are in black and white but a few are in colour and these are supposed to be especially potent in evoking responses of an emotional kind (184, 191, 194, 201, 224, 236, 244, 258).

The literature on colour and personality is enormous and would demand a separate bibliography. Furthermore, a large part of it is rather naive. Therefore I have tried to include only examples of the different techniques and some critical reviews as well as some studies which seem more relevant to our point of view than the conventional clinical material.

Personality may also be assessed in terms of psycho-physiological status. Concepts like 'arousal-seeking tendency' and 'emotionality' are in common use today. So called arousal seekers are believed to have greater inclination for intensive stimulation and to enjoy lively environments. The arousal avoiders, on the other hand, are supposed to prefer environments with a rather low degree of stimulation. The emotional person seems to be predisposed to react intensively to various types of stimulation, while the stable person seems predisposed to show milder reactions. These various differences are partly related to inherent differences of the nervous system. The tendency of certain persons to react with strong affect might also be at work as far as light and colour are concerned. Naturally, the physiological status of the person includes factors like age, visual capacity and health. These factors might also have an influence on light and colour preferences. Unfortunately, there seems to be very little research with direct bearing upon these questions (96).

Colour has been used for therapeutic purposes in order to induce mood changes in depressive or anxious patients. Using a combination of music and colour, Neboschick, in 1975, managed to direct a depressed group of patients towards a more happy mood-state (231). It is evident, that studies of this kind suffer from the lack of experimental control. There are simply too many factors at work to enable any firm conclusion about the relative importance of colour. However, seen together with the results of other studies, it would not be astonishing to find that colours and coloured light do have a therapeutic influence. This line of approach will certainly profit once we have a better understanding of the mechanisms behind the physiological effects described in section 2 (231, 236).

General reviews of research on colour and personality will be found in Norman and Scott, 1952 (236), Cerbus and Nichols, 1963 (191), Schaie, 1966 (244), Pickford, 1972, and Kreitler and Kreitler, 1972. A critical review of the relationship between colour and affect in the Rorschach test is given by Frank, 1976 (201). The books by Pickford, and Kreitler and Kreitler, also contain discussions of the cultural impact on colour choice.

Light and colour in the built environment

Light and colour belong in a very concrete way to the daily environment of man. But not always are they at the centre of attention - they are there without being noticed. When we ask questions about effects on man we must therefore consider light and colour not by themselves but, as constituents of man-made environment as a whole. Unfortunately, systematic studies are scarce, where light and colour are related to architecture and the built environment. There exists a small group of studies where the appreciation of an environment as a totality is studied as a function of its colours. Typical for this group of studies is the attempt to vary coloration in a systematic way and analyze the changes in appreciation by means of multivariate statistical techniques. The results indicate there exists a number of lawful relationships between various colour dimensions on one hand and the appearance of the built environment on the other (181, 182, 211, 213, 220, 221, 229, 238, 248, 256).

In spite of the general colour preference order established by Eysenck and others, studies employing drawings of interiors as well as full scale and model rooms seem to show that neither hue, lightness nor chromatic strength will affect the pleasantness of the interior space in any consistent way (181). Other studies indicate that the presence of colour gives rise to positive evaluations while the absence of colour is generally considered to be negative (Küller, 1980). In one study of building exteriors, yellow buildings were found to be more pleasant than others (248).

In a study by Küller, 1971, it was demonstrated that the use of strong or saturated colours in interiors will contribute to the impression of complexity. This is true not only for the bright reds but also for the strong yellow, blue and green hues. However, at the same time, the impression of unity will decrease when many different colours appear in the same space. If the complexity is far exceeded by unity the environment might appear dull and monotonous, whereas if the scale tips the other way the environment may appear too chaotic. The balance between complexity and unity might be thought of in terms of over- and understimulation. More recent experiments by the same author indicate a change in the balance between complexity and unity of an interior space by means of light, colour and pattern may be accompanied by a change in mood of the subjects staying

in the space. The choice of light or dark colours on walls, floor and ceiling of an interior space will have a considerable influence on the impression of enclosure. The use of dark coloration may also lend an expression of wealth and power to both building interiors and facades. (111, 220, 221, and Küller 1980).

Another main group of studies deals with effects of lighting on the appreciation of interior space. A systematic approach to the problem is exemplified in the various studies by Flynn, Hendrick, Martyniuk and Spencer, employing semantic rating scales, factor analysis and observation of overt behaviour in a full scale lighting laboratory. Their findings suggest that as the designer changes the character of light in the room, he changes the composition and relative strength of visual signals and cues and this in turn alters some shared impressions of spatial meaning for the room occupants (159, 183, 190, 200, 207, 218, 227, 241).

Using scale models, Watson and Payne, in 1968 studied the effects of different fluorescent lamps on the assessment of room volume. Their results indicate that cool white light will contribute to an impression of largeness, while warm white light will give the opposite impression. The results of Aksugür, in 1979, support this conclusion. He found the model space illuminated by daylight fluorescent tubes appeared larger than the same space illuminated by tungsten filament lamps. Aksugür also found the type of illumination interacted with the colour of the walls (66, 182, 195, 260).

A related group of studies concerns the importance of windows for the appreciation of interior space. A study of human requirements for sunlight inside schools, offices, hospitals and housing was carried out by Neeman and Hopkinson, in 1976, employing social surveys, on-site observations, as well as model and full scale experiments. People liked the sun to shine indoors provided it is not associated with visual or thermal discomfort. The visual experience of sunshine seems to produce physiological well-being and act as a contact with the outdoor world. The thermal experience of sunshine is welcomed in conditions of insufficient heat. The authors claim, the duration of sunlight penetration and not the size of the sunny patch, is the basic criterion by which sunlight indoors is appreciated. However, the location of the patch, in relation to the body and main direction of view, are also of great importance (232). In a number of studies Inui and Miyata investigated the relationship between window design on one hand, and behaviour and subjective assessment of view, spaciousness, satisfaction and friendliness on the other. Views of greenery or sky provided a sense of spaciousness while full facade views gave the occupants a sense of oppression (214, 215, 216).

The question of windows in school buildings has attracted much attention. Stewart, 1975, concludes that children like windows and the factors associated with them such as 'to see out', 'to see what is going on', 'to see nature',

and 'sun and light'. According to this author children also prefer positions in the classroom near the windows, a conclusion proven by the fact that children with high sociometric status occupy such positions (252). Comparing overhead windows and eye-level windows in ten classrooms, Tikkanen, in 1976, found that the quality of light affected the pleasantness of the interior environment (253). Wyon and Nilsson, 1980, made extensive interviews with people working in windowless factories, offices, shops and colleges in the south and the far north of Sweden. The attitudes towards windows depended on latitude as well as on category of employment and also differed from the attitudes of comparable groups working in rooms with windows (266). In conclusion, there seems to be no doubt that windows are of emotional importance not only because of the daylight and sunpatches entering the interior space but also because of the outlook they provide (226, 255).

Several of the studies mentioned above employ various methods of simulation like colour slides, or scale models, or as in the case of Rowlands and Loe, 1976, a small cube which was positioned with the faces parallel to the main surface of a room. These papers often include an appraisal of the simulation technique per se (181, 190, 207, 215, 232, 241, 248).

Although of small amount, the research on problems related to light and colour in the built environment have already been of great practical importance. Concerning light, the arguments today are in favour of quality rather than quantity or to cite Liljefors, 1973: "Good lighting does not need more energy, but better planning, with respect for individual needs and for good perception of the environment. To solve this problem is more important for the lighting planner than the calculation of illuminance values" (225).

As far as colour is concerned the awareness of its emotional impact seems to be growing amongst researchers in various fields. Unfortunately, here the 'application gap' is much wider. Therefore, it is strongly recommended that much more full scale field research be done within this area (187, 206, 225, 228, 238, 255).

Readers are referred to the following reviews: Lighting and the environment by Hewitt, 1976 (208), Environmental lighting by means of windows-daylight and sunshine by Klingenberg, 1980, and The influence of color in architectural environments by Flynn and Piper, 1980 (199). A treatise on windows and environment was edited by Turner, 1969 (255). An interesting collection of essays on colour for architecture was edited by Porter and Mikellides, 1976 (238). There also exist a number of handbooks on principles of colour and lighting, that also include discussions of non-visual aspects. The reader will find some of these in the reference list.

SECTION 3: SUMMARIES 181 - 268

181 Acking, CA. & Küller, R. 1972. The perception of an interior as a function of its colour. Ergonomics, 15(6), 645-654 (17 references)

Colour is a basic aspect of human perception. This paper considers whether it is possible to study how this aspect influences the perception of a total environment. In order to do this, colour was described in terms of two different versions of the Swedish Natural Colour System. Perception of the environment was measured by semantic scales which had previously been worked out for this purpose. In the experiments a drawing of a room was varied with respect to colour composition of walls and interior details. Some of the main results were then checked in full scale rooms.

182 Aksugür, E. 1979. The effect of hues of walls on the perceived magnitude of space in a room under two different light sources having different spectral energy distribution. Architectural Bulletin, 4, Karadeniz Technical University, 22-47 (no references)

The present study was concerned with the effect of the hues of walls on the perceived magnitude of space in relation to the spectral qualities of different light sources. In the first part, the visual properties of the physical environment which affect the "perceived magnitude of space" is examined in the three different perception modalities. The second part of this study dealt with two color properties of the physical environment. These were color characteristics of the wall surfaces and spectral characteristics of the light sources. In the third part, a new experimental method was suggested.

183 Aubree, A. 1978. Artificial lighting during the day of a deep room. Studies of the replies of the subjects as a function of the different proposed lightings. Paper presented at Illuminating Engineering Society Conference 1978 (also Centre Scientifique et Technique du Bâtiment, Nantes) (30 pages, no references)

If one wishes to give some recommendations about the artificial lighting of a deep room in daytime, so far as this investigation is concerned, we have brought out an important difference between the professional category (labourers and clerks) and higher grade students, which is valuable both for moderatly costly lighting systems and for expensive lighting systems. The labourers and clerks like and prefer lighting systems for which the light is uniformly distributed. The higher grade students like and prefer directional lighting systems (indirect lighting of the test wall). Nevertheless, there exist many other lighting systems, more expensive and better ones, which might be proposed if the economical point of view was not so important, e.g. indirect lighting of the walls and the periphery of the ceiling by fluorescent tubes, which was well accepted by all subjects in the study.

184 Barrett, DM. & Eaton, EB. 1947. Preference for color or tint and some related personality data. Journal of Personality, 15, 222-232 (4 references)

This paper is a report of some experiments which were developed to test the hypothesis that a preference for tints on the one hand or strong colors on the other hand is associated with certain characteristics of personality. The data of the experiments have been interpreted to mean that individuals who prefer colors respond more directly and with greater interest to the objects and objective events of the external environment while the persons who prefer tints view the external world from the point of view of subjective values and live more in their own thoughts. Preference for color has been associated with extratensiveness and preference for tints with introversiveness, concepts suggested by Rorschach.

185 Berlyne, DE. 1972. Uniformity in variety: Extension to three-element visual patterns and to non-verbal measures. Canadian Journal of Psychology, 26(3), 277-291 (6 references)

Subjects were required to rate patterns of three elements, presented simultaneously or successively, for complexity, interestingness, and pleasingness. Judged complexity generally varied inversely with the number of identical elements in a pattern and directly with the number of properties in which elements differed. Interstingness behaved, on the whole, like complexity with successive presentation, but showed no significant influence of any of the independent variables with simultaneous presentation. Pleasantness was heightened by the presence of similarities between elements when presentation was simultaneous and by the presence of variety when elements appeared successively. Other findings, intercorrelations of scales, and comparisons with the results of previous experiments using two-element patterns are discussed. A third experiment showed exploratory choice to favour two-element patterns that had been judged more complex and more interesting but less pleasing. A final experiment, using both two-element and three-element patterns, revealed no effects of the independent variables on looking time.

186 Berlyne, DE. & Boudewijns, WJA. 1971. Hedonic effects of uniformity in variety. Canadian Journal of Psychology, 25, 195-206 (20 references)

Two experiments used visual patterns each consisting of two elements that differed in zero to four properties but were otherwise alike. Different Ss rated the patterns for pleasingness, interestingness, liking, and complexity. With successive, but not with simultaneous, presentation of elements, pleasingness and liking reached maxima when there were both differences and similarities. Interstingness increased with the number of differences in both modes of presentation. Judged complexity increased with the number of

differences but was significantly higher when elements appeared simultaneously. When the hedonic ratings are plotted against judged complexity, the result can be related to the findings of previous experiments on hedonic effects of complexity.

187 Birren, F. 1973. The practical application of light and colour to human environment. In; Colour 73. The second congress of the international colour association, University of York 1973, Adam Hilger, London, 179-189 (18 references)

Colour is very much in the psychological and emotional realm. Judgements of it are always difficult to rationalize and values are difficult to establish. This paper is concerned with the environmental use of colour in man-made surroundings where work tasks may be performed, e.g. offices, schools, industrial and institutional facilities. On the basis of a few decades of active experiences and the conscientious screening of authoriative research, the author sets forth what he has found to be tangible benefits for light and color. These principles he believes to be scientifically valid and they are offered as acceptable guides to the specification of light and colour in functional environments: Artificial lighting systems in a functional interior should emit some measure of ultra-violet radiation; Light for the sake of light is not enough: there should be balance of spectral emission in artificial light sources; High brightness in the field of view should be avoided in functional interiors; Monotony of illumination, brightness and colour should be avoided; The choice specification of brightness, brightness differences and colour promises a new order; If there are no set rules in the choice of individual colours, there definitely are acceptable principles.

188 Bornstein, MH., Kessen, W. & Weiskopf, S. 1976. Color vision and hue categorization in young human infants. Journal of Experimental Psychology: Human Perception and Performance, 2(1), 115-129 (61 references)

Two studies examined the organization of color perception in 4-month-old human infants. In Study 1, infants looked at selected spectral stimuli repeatedly until their visual attention waned. The stimuli represented instances of basic adult hue categories - blue, green, yellow, and red. Following habituation, infants were shown a series of wavelengths which were the same as or different from the stimuli first seen. Analyses of infant attention during this dishabituation phase of the study indicated that infants categorize wavelengths by perceptual similarity; that is, they see hues in the spectrum much as adults do. In Study 2, a group of infants who looked at the alternation of two wavelengths from the same hue category habituated as did a group of infants who looked at the repetition of a single wavelength from that category, but a group of infants who looked at two wavelengths from different categories habituated at a slower rate. Data from the two studies suggest a high degree of organization of the color world prior to language acquisition.

. An ideal compromise would be to use a set of words which
stable in meaning and (b) uniformly spaced along the continuum
faction: the word-reactions of subjects can thenbe treated as
for statistical analysis. An experiment has been carried out to
the stability and spacing of fourteen words used to describe
tion in previous lighting surveys, with the object of
a smaller set of words which approximates this ideal compromise.

HD. & Naudé, DEH. 1963. Color-rendering preferences for
hting the face. Transactions of the Illumination Engineering
iety, 28(4), 149-154 (5 references)

num spectral distribution of warm white lighting for social
was investigated in a mass test: 1.300 observers compared
sources for lighting girls' faces. The results indicate
amp with enhanced red and green at the expense of the yellow
content would be widely preferred to a metameric Plankian
.

HJ. 1941. A critical and experimental study of colour
ferences. American Journal of Psychology, 54, 385-394
references)

estions were investigated, all connected with preferences
le colours. The results of the experiments agreed with
al reassessment of the results reported by other
ators. These results were: (1) There is a certain
agreement between the colour preferences of people.
eement is as high as that between intelligence tests;
restricted to Europeans, but also found among coloured
nd it is connected with a general factor of aesthetic
ion discussed elsewhere. (2) Subsidiary to this general
preference for colours is a bipolar factor, which
hose who prefer saturated colours from those who prefer
ed colours, i.e. tints and shades. (3) There is a high
between the two sexes with regard to their colour
es. Apart from a slight preference for orange among the
or yellow among the women, the average order given by
exes are identical, the correlation between them
5.

. & Piper, HA. 1980. The influence of color in
itectural environments. Department of Architectural
neering. The Pennsylvania State University (118 pages,
references)

y is a review of knowledge and procedures that support
cision-making in the field of color. It is an attempt
the status and adequacy of specification procedures
ield of architectural color. The authors are
rly searching for research patterns and taxonomies
t be useful in facilitating an understanding or
tion of design performance applicable to the field
The review contains the following sections:
e review and organizational matrix. Color systems
metrics. Color harmony systems. The potential of
(environmental) color studies. Conclusions and
ations.

ern im Alter
kholm, 1183-

whether and
ne meaning of
notions
of colour
children accept
relative

Problem der
onale de
, Bureau

ressing
lare, etc.,
ng of stadia
ere are two
"pleasantness
f functional
ot feeling well
, in real
importance of
e correlates
is suggested
hting

nd
566-575

to
sivity,
results
, or
upport
n
there
ding
eing
ach
ls, the
tible
ent is

ral and cross-
1-802 (3 references)

ifferent age
3 Ostwald
-blue,

200 Flynn, JE., Spencer, TJ., Martyniuk, O. & Hendrick, C. 1976. The influence of spatial light on human judgment. In: Commission Internationale de l'Eclairage, Compte Rendu 18e Session, Londres 1975. Bureau Central de la CIE, Paris, 39-46 (14 references)

The paper is a discussion of findings concerning study procedures for research into the subjective effects of lighting. It focuses principally on the interpretive potential of "semantic differential" and "multi dimensional" scaling procedures. The findings suggest that as the designer changes lighting modes (i.e. the character of patterns of light in the room), he changes the composition and relative strength of visual signals and cues .. and this in turn alters some shared impressions of spatial meaning for the room occupants. Utilizing the two scaling procedures an experimenter (or designer) can develop insight into the ways that light settings "cue" subjective impressions.

201 Frank, G. 1976. On the validity of hypotheses derived from the Rorschach: 1. The relationship between color and affect. Perceptual and Motor Skills, 43, 411-427 (173 references)

Interpretation of response to color on the Rorschach tests on Rorschach's assertion that color has affective connotations. His assumption was based on the connection of color and affect in culture and as regards the differential response to color by patients he tested. This review focused on research which could lend support to Rorschach's empirically derived notion. Ignoring clinical studies of psychiatric patients (in the absence of any theory of affects unique to specific psychiatric groups), this review focuses primarily on psychological tests of the hypothesis. Affect does seem to be associated with colors but not so specifically as to be useful in interpreting the meaning of the response by any one person. Moreoever, affects was seen to affect the many dimensions of the Rorschach stimuli. Interpretation of the response to color must take into account the unsystematic way in which factors that influence response to color on the Rorschach, e.g. saturation, context, area covered, etc, vary from card to card. These factors alone influence the response to color and make it impossible to draw conclusions using the plates as constructed. The interpretation of affect from response to color on the Rorschach was seriously questioned.

202 Frieling, H. & Frieling, E. 1969. Farbwahl und Farbbevorzugung bei Epileptikern. In: AIC Color 69, Volume I and II. Stockholm, 1118-1122 (4 references)

With 285 epileptic subjects their colors of preference and rejection and their behavior in working with the colors of the Frieling test were investigated. The strong increase of preference for red took no effect when placing the color chips on a given support. Some characteristic differences in the frequency of choice, placing and placing direction were observed. These differences, however, do not allow to state "epilepsy" from data sheet, but they point obviously to psychical characteristics of these patients.

203 Garrett, A. 1967. Colour stimulus. Building Materials, No 26-27, July, 69-72 (no references)

To meet the disciplines of science and to add something of value to the study of aesthetics and psychology, it was decided three years ago to produce a survey of colour schemes worked out professionally as well as by architecture students. By ruling out external influences, creative thinking could show clear patterns. With this survey, the personal colour idea when made visible can be accurately analysed and the elements and structure of colour language counted to produce irrefutable evidence of how creative people think when working on complete colour schemes. This is the nearest approach that can be made to uninhibited thinking in the infinite possiblities of colour.

204 Guilford, JP. 1934. The affective value of color as a function of hue, tint, and chroma. Journal of Experimental Psychology, 17, 342-370 (32 references)

Forty colors, evaluated for hue, tint, and chroma on the Munsell scheme, were judged repeatedly for affective value by five men and five women subjects. With tint and chroma held fairly constant, the functional relationship between affective value (AV) and hue appeared to be of a periodic type. Fourier analysis revealed two important harmonics (first and third) in this relationship, and two others of less important (second and fourth). With hue held constant, linear relationships were found to hold between AV and tint and chroma. Complete empirical formulas were set up, predicting AV from the three attributes of color. Some theoretical consequences of the periodic relationship between AV and hue are: (1) There are two distinct systems of color preference, the one being more primitive and fundamental than the other. (2) The more fundamental system is a yellow-blue affective discrimination, the short light waves being more agreeable than the long. (3) The other system is a red-green-blue preference over yellow, blue-green, and red-violet. (4) These two systems correspond in a striking way to the two evolutionary stages of the Ladd-Franklin color theory.

205 Guilford, JP. & Smith, PC. 1959. A system of color-preferences. American Journal of Psychology, 72(4), 487-502 (9 references)

This report pertains to a systematic and relatively exhaustive study of the affective values of 316 different color specimens, each of which had been calibrated in terms of color-specifications of the Munsell Book of Color. The color-stimuli were in the form av 2-in. squares of paper on a neutral gray background. Each was rated by 20 men and 20 women students on two different occasions. Smoothed graphic adjustments of the data were made to curvilinear funcional relationships, from which isohedonic charts were constructed showing the loci of equal preference-values applying to all colors in the color solid. Considerable consistency in ratings of affective values of colors was found from day to day for the same Os, from one set of Os to another within the same sex, and even between Os of different sex. Men rated colors generally a little higher than did women. Agreement as to relative affective values was better for colors of certain hues than for others, both within and between sexes. Preferences

were highest in the region of green to blue and lowest in the region of yellow and yellow-green, when brightness and saturation are held constant. With few exceptions, affective value is positively related to brightness and to saturation, all relationships being curvilinear. Predictions of affective values from the specified hue, brightness and saturation of colors were generally excellent within the sample of Os who rated the colors. Predictions of a more general scope will depend upon information concerning other populations, other variables of color-stimuli, other viewing-conditions, and particular uses of colors. Considerable gain in accuracy of prediction should be possible from further basic research of the kind reported here.

206 Guth, SK. 1970. Lighting for visual performance and visual comfort. Journal of the American Optometric Association, 41(1), 63-71 (14 references)

The increasing complexity of educational and commercial activities and industrial operations in our modern world make it imperative that occupational vision specialists are fully aware of the many factors which influence human performance, efficiency, comfort and safety. Light and lighting are important environmental factors. However, full consideration must be given to the entire visual environment to insure that all brightnesses are in proper balance.

207 Hendrick, C., Martyniuk, O., Spencer, TJ. & Flynn, JE. 1977. Procedures for investigating the effect of light on impresson. Simulation of a real space by slides. Environment and Behavior, 9(4), 491-510 (9 references)

This paper reports findings concerning the effect of environmental lighting as a medium that affects user impressions and judgments. Our previous work on this problem used multidimensional scaling and semantic differential techniques to assess changes in impression as a function of variation in the lighting arrangements. This research was conducted in a lighting demonstration room at the General Electric Lighting Institute at Nela Park in Cleveland. Six different lighting arrangements were used. Results from both multidimensional scaling and ratings on semantic differential scales showed that user impression changed in orderly ways for different lighting arrangements. The present study assessed whether slides of the lighting arrangements could adequately simulate results from the real space. Comparable results would indicate that slides are a useful simulation tool, and would also be of general theoretical interest. The data indicated that in many important respects the results for the slides matched the results for the real space for ratings on semantic differential scales, but that less consistent results were obtained for multidimensional scaling.

208 Hewitt, H. 1976. Lighting and the environment. Progress Report. In: Commission Internationale de l'Eclairage. Compte Rendu 18e Session. Londres 1975. Bureau Central de la CIE, Paris, 329-332 (97 references)

The report reviews the approach of the Committee to the study of lighting in the environment, pointing out that this involves considerations which do not arise in the lighting of visual tasks. Appraisal work is shown to have had educational value in encouraging more critical observation by those concerned about quality in lighting. The work of the committee has helped the development of the prelude to a design process which starts with the nature and function of the interior and requires a decision about the visual qualities to which the lighting must contribute before proceeding to the engineering considerations. This process, together with typical questionnaires, appears in a draft Technical Report also submitted by the committee. Much work remains to be done in this field of lighting, and the report includes proposals for its future programme and also a revised and extended bibliography.

209 Hogg, J. 1969. A principal components analysis of semantic differential judgements of single colors and color pairs. Journal of General Psychology, 80, 129-140 (22 references)

Two Principal Components analyses were carried out on SD ratings of single colors and color combinations. Similar factors were found in both analyses. These related to strength, pleasantness, warmth, and usualness. The relation between these dimensions and the attributes of the colors is described. The present findings are compared in detail with previous work on color.

210 Hogg, J. 1969. The prediction of semantic differential ratings of color combinations. Journal of General Psychology, 80, 141-152 (22 references)

The logical relation between experiments on the prediction of preference for color combinations and Gestalt theory is discussed. Logical difficulties entailed in interpreting the implications of such experimental work for Gestalt theory are noted. Existing work on color is extended by investigating the prediction of SD ratings of color combinations on four dimensions of judgement relating to pleasantness, strength, warmth, and usualness of the combinations. Statistically significant prediction of varying accuracy was found with the use of two simple additive predictive formulae.

211 Hogg, J., Goodman, S., Porter, T., Mikellides, B. & Preddy, DE. 1979. Dimensions and determinants of judgements of colour samples and a simulated interior space by architects and non-architects. British Journal of Psychology, 70, 231-242 (19 references)

Architects and non-architects made Semantic Differential ratings of colour samples (chips) and a simulated interior space (a model).

In analyses of the total sample's ratings five factors occured: These were: (i) dynamism; (ii) spatial quality; (iii) emotional tone; (iv) evaluation; (v) complexity. Linear correlations between parameters of the Munsell Color System and the above factors were calculated, while parallel analyses were carried out employing a graphical technique described by Sivik (1974) involving iso-semantic maps. In all analyses, linear correlations between the colour parameters and judgements were found for the dynamism factor, spatial quality factor, and emotional tone factor. They were associated respectively with chroma, value, and hue. Inspection of the isosemantic maps indicated subsidiary effects of the non-dominant dimensions of a non-linear sort, though the maps also exhibited the linear relations. Linear correlations were low or non-existent for the evaluation and complexity factors, and the complex nature of their determinants was clear from the isosemantic maps. The determinants of judgements were similar for architects and non-architects, with the exception of evaluative judgements for the models in which markedly different determinants were noted. Comparability of the present findings with other studies carried out in a variety of countries over a 20 years period was high for dynamism, spatial quality, and emotional tone, and it is suggested that there may be something inherent in the response to colour in relation to such judgements. Recent physiological work is discussed, and its limitations in terms of colours sampled and an overconcentration on the hue dimension noted. In contrast, it is suggested that dimensions of judgement, such as evaluation or complexity, reflect to a greater extent culture or training, and are hence independent of the basic colour attributes.

212 Humphrey, NK. 1971. Colour and brightness preferences in monkeys. Nature, 229, 615-617 (2 references)

A method was developed for testing the preferences of monkeys for simple visual stimuli. Preliminary results for colour and brightness were obtained. Monkeys had strong preferences related to both brightness and colour. These preferences were not, as might have been expected in a two-choice situation, all or none, but were finely graded. The brightness preferences were monotonically related to brightness over the range used, and, more surprisingly, the colour preferences were monotonically related to wavelength. Repeated measurements were highly consistent, and there was remarkably little variation even between the monkeys.

213 Inui, M. 1969. Colour in the interior environment. Lighting Research and Technology, 1(2), 86-94 (9 references)

Work carried out in Japan on planning the colour of interior environments is reported. A survey has been made of the colours used in cinema and hotel foyers, hospitals, schools, homes and flats located mainly in Tokyo. The results are analysed and presented as frequency curves for Munsell hue, value and chroma. Preferences are also discussed in terms of Munsell notation and the ISCC-NBS designations. The balance point for each type of room is computed and the type of colour composition is classified. From a subjective appraisal of different colour schemes using slides and models, acceptable colour schemes for the different types of room are given in terms of the balance point and colour composition.

214 Inui, M. 1980. Views through a window. In: Krochmann, J. (ed). Proceedings of the symposium on daylight. Physical, psychological and architectural aspects. Commission Internationale de l'Eclairage. Institut für Lichttechnik, TU, Berlin, 323-332 (7 references)

A series of studies undertaken at the Building Research Institute in Tokyo is described which investigates the relation between preferred window arrangements and views through a window. These studies were carried out by means of scale models in which observers assessed the spaciousness of predetermined conditions using the method of magnitude estimation, or alternatively, adjusted a variable window aperture in order to arrive at the most satisfactory arrangement. Views of greenery from a window appeared to provide more spaciousness in interiors than views of buildings; this suggests that the former does not give the occupants a sense of oppression which the latter, most typically the facade of a nearby building, does. It was also found that views having certain amount of sky produced more spaciousness than full facade views, but that open sky did not necessarily produce the maximum spaciousness because of the lack of visual cues. Since those views providing much spaciousness were abundant in attractive features like open space, greenery and information content, a bigger window was preferred for such views. The classification of window types is also discussed.

215 Inui, M. & Miyata, T. 1973. Spaciousness in interiors. Lighting Research and Technology, 5(2), 103-111 (6 references)

Since traditional criteria for window design, e.g. the daylight factor, have lost their force, interest in re-evaluating the function of windows has been growing rapidly. The concept of spaciousness as an alternative criterion is introduced, and observations in scale models differing in spaciousness under an artificial sky have been carried out. From these, spaciousness for different sky luminances has been shown to be a function of interior illuminance, room size and window size. Observations in full scale interiors were also made to confirm the validity of the results. From additional experiments, it has been found that a lower limit of just acceptable spaciousness does exist. This would be a useful criterion for use in design.

216 Inui, M. & Miyata, T. 1977. Spaciousness, behaviour and the visual environment. Journal of Light and Visual Environment, 1, 59 (21 pages, 3 references)

The paper describes the results of a study which examines the degree of relevance of various aspects of behaviour to the visual environment as well as the relationships between behaviour measured and the subjective assessments of spaciousness, satisfaction and friendliness. Some correlations between these assessments are also examined.

217 Kimura, T. 1950. Apparent warmth and heaviness of colours. Japanese Journal of Psychology, 20(2), 33-36 (in Japanese with English summary)

This study was intended to determine experimentally the orders of apparent warmth and heaviness of colours. We arrived at the following conclusions: The order of apparent warmth of colour was: R→O→Y→G→Bk→Be→W. Excepting achromatic colours (W and Bk), this is roughly in accordance with the order of wave-lengths of light. In the case of apparent heaviness, the order was: Bk→Be→R→V→O→G→Y→W. Except achromatic colours, this order corresponds roughly with the inverse order of apparent brightness.

218 Knave, B., Ottosson, A., Werner, M., Bergqvist-Poppen, M. & Paasikivi, J. 1974. Belysningen i kontorslandskap - risk för kontrastbländning vid höga belysningsstyrkor. Nordisk Hygienisk Tidskrift, 55, 116-128 (5 references)

The present investigation was performed on a large office landscape, in which 22 per cent of the personnel complained of bad lighting. On inquiry most of the employees, who complained of the lighting stated subjective eye discomfort and glare. High illuminance values were generally registered in the working places as well as relatively high luminance contrasts between different adjacent areas within the vision fields of the employees. Thus, the basic conditions are fulfilled for so called discomfort glare, which then is supposed to be the reason behind the complaints presented by the personnel.

219 Kohn, IR. 1967. The influence of color and illumination on the interpretation of emotions. Thesis for Master of Arts, Department of Psychology, University of Utah (108 pages, 53 references)

The study explored differences in the interpretation of an expressed emotion's intensity as a function of painted hues and light intensities within the environment. In the main experiment 135 men and 135 women were divided into groups and each group was assigned to one of 54 experimental conditions (combinations of 3 colors, 3 hue lightnesses, 3 light intensities, 2 sexes, 3 time periods, and 6 emotions). A tape recording, which contained 204 emotional portrayals of fear, anger, indiffernce, happy, sad, and, flirting, was used as the emotional stimuli. Data from previous research were used to generate the following hypotheses: 1/ The judged intensities of emoted phrases differ significantly across varying combinations of color and light for all six emotions. 2/ the mean judgment of one emotion increases significantly over the mean judgment of the other emotions under the following conditions: (a) anger in a red room and a yellow room (illumination level "dim"), (b) happy in a room of dark hue lightness and medium hue lightness (illumination level "comfortable"), (c) fear in a blue room and a yellow room (illumination level "dim"), and (d) flirting in a dark red room (illumination level "dim"). 3/ The mean judgment of each emotion differs significantly between men and women. 4/ The mean judgment of each emotion differs significantly with increased exposure of the

subjects to the varying conditions. The first two hypotheses were not supported by the results; there were no significant differences in the mean judgment of an emotion's intensity with variations of room color, hue lightness and illumination. The third hypothesis on differential judgments of emotions by sex was confirmed in part, and the fourth hypothesis on differential judgments over time was confirmed in full.

220 Küller, R. 1971. The perception of an interior as a function of its colour. In; Honikman, B. (ed). Proceedings of the architectural psychology conference at Kingston Polytechnic, 1970, Kingston Polytechnic & RIBA Publications, London, 49-53 (22 references)

Colour is a basic factor of human perception. The question was raised whether it is possible to study how this factor influences perception of an environmental totality. In order to do this, colour was described in terms of two different colour-systems, the natural colour system and the modified version of it. Perception of the environment was measured by semantic scales that had previously been used to describe the perception of the built environment. In the experiments a drawing of a room was varied with respect to colour composition of walls and interior details. In spite of the very limited design rather meaningful conclusions could be drawn. The pattern of significant main effects and correlations hinted at several general tendencies. The relations between pleasantness evaluation and the colour variables turned out to be very complicated. The material also pointed to the existence of individual differences. The social evaluation varied with lightness and to a lesser extent with chromatic strength. Perceived openness also increased with a corresponding increase in the chromatic strength of interior details. The perception of complexity showed a marked dependence on chromatic strength. The results also gave rise to a further question. Is the dependence on colour in large surfaces comparable with the dependence on the same colour in two smaller surfaces? Can we add up the colours in a milieu, each colour variable by itself, and thus predict the total experience? The problem "whether the whole is more than the sum of the parts" is implicitly contained in this line of reasoning. It might eventually be necessary to find variables of a higher order. It was concluded that the approach has been promising and that further experiments should be done along the same lines.

221 Küller, R. 1977. Psycho-physiological conditions in theatre construction. In: Arnott et al (eds). Theatre Space. International Federation for Theatre Research. Prestel Verlag, München, 158-180 (also in German, 166-189) (46 references)

The auditorium of a theatre is a framework either facilitating in various ways, or prohibiting contact between the actors and the public. The design of theatre auditoriums has been analysed on the basis of the psychological and physiological processes taking place in actors and spectators as a result, among other things, of changes in the degree of activation of the nervous system. While an actor can be regarded as having a high degree of activation which must find an outlet during the performance, the public instead has a demand for being activated. In both cases special demands are placed on the auditorium's design, colour scheme, articulation and acoustic properties as well as the design and lighting of the stage. A number of studies indicate that the total impression of an auditorium in terms of enclosure and complexity are particularly important when a suitable level of

activation must be maintained from communication view-points. Especially in old theatres there is often a wealth of detail and a variety of colour, the theatre hall abounding in golds and reds. Intense hues will contribute to visual complexity and also red hues seem to provide higher physiological arousal than green and blue hues. Therefore, it is probably no coincidence that red has been and still is a very popular hue in theatre design. The effect of colour is discussed in relation to many other factors influencing the totality of theatre buildings. The report also discusses the design of foyers and actors' back-stage areas as well as the importance of these areas during preparations for a performance and for rest and relaxation during intermissions.

222 Lakowski, R. & Melhuish, PW. 1973. Objective Analysis of the Lüscher Color Test. Die Farbe 22, Nr 1/6, 239-250 (also in: Color 73. Second Congress of the International Colour Association. University of York, July 1973. Adam Hilger, London) (19 references)

Objective analysis of three versions of the Lüscher color test shows significant colorimetric differences between versions, particularly between the blue-green samples. Luminance measurements by red-green color defectives are compared to those of normal subjects. The implications of these findings in terms of structure and interpretation of the Lüscher test are discussed.

223 Lawler, CO. & Lawler, EE. 1965. Color-mood associations in young children. Journal of Genetic Psychology, 107, 29-32 (3 references)

Twenty first-grade children were divided into four groups of five Ss each for the purpose of studying effects on subsequent response variability of the prior experiences of fixed-ratio, variable-ratio, and regular-reinforcement schedules. Similarities and differences between responses for first graders, used in the study, and kindergarten and preschool children, used in previous similarly designed studies, are discussed.

224 Levy, JR. 1950. Changes in the galvanic skin response accompanying the Rorschach test. Journal of Consult. Psychology, 14, 128-133 (25 references)

Record was made of change in palmar skin conductance accompanying each of the Rorschach plates upon presentation, by means of a Guhin card changer, to 50 male college students individually. On the assumption that increased conductance is indicative of "affective tone", a finding of significantly greater increases accompanying the colored and the heavily shaded plates would serve to strengthen the position of Rorschach theorists who maintain that these cards possess "affective value" for the subject. To counteract the adaptation effect of the GSR and at the same time to preserve as nearly as possible the normal Rorschach sequence, the order of presenting the cards was systematically

rotated. Significant individual differences in galvanic response to the cards were obtained, implying differences in "affective" reaction to the test as a whole. The sample was found to be normally distributed. Change in conductance among the cards was not found to be significantly different: therefore, there is not statistical evidence that the cards differ among themselves in "affective value". The experimental design introduced consideration of effect on the GSR on card position. Position in the series was found to have a significant effect on changes in conductance for the sample investigated.

225 Liljefors, A. 1973. Light planning with minimum energy consumption. The quality of light. In: Küller, R. (ed). Architectural Psychology. Proceedings of the Lund Conference. Studentlitteratur, Lund & Dowden, Hutchinson & Ross, Stroudsburg, 68-75 (2 references)

When energy is restricted, it is no longer possible to plan light according to the principle ordinarily used: general lighting at highest possible illumination. The more light the better it has been said. This is wrong because it does not give good lighting but costs a lot. Good lighting does not need more energy, but better planning, with respect for individual needs, and for good perception of the environment. Also needed is a technique that permits ajustable light on the work place. This is fairly simple in the office but more difficult in industry. To solve this problem is more important for the lighting planner, than the calculation of illuminance values.

226 Markus. TA. 1967. The function of windows - a reappraisal. Building Science, 2, 97-121 (28 references)

Traditional criteria for window design relate to daylight and ventilation requirements. Some criteria deriving from sunlight studies are also used. In the light of rapidly developing technology, rising standards of environment and changes in the depth of buildings, these criteria are beginning to lose their force. This paper examines current knowledge on the contribution of windows to sunshine awareness and desire and to the provision of a visual link with the outside world. It also describes working hypotheses and current experimental work concerning interference "meshes", such as woven or slatted blinds which to a greater or lesser degree obscure external views. Some data in summary form is given on a survey in a new office block and critical points on which further research is needed are given.

227 Martyniuk, O., Flynn, JE., Spencer, TJ. & Hendrick, C. 1973. Effect of environmental lighting on impression and behavior. In: Küller, R. (ed). Architectural Psychology. Proceedings of the Lund Conference. Studentlitteratur, Lund & Dowden, Hutchinson & Ross, Stroudsburg, 51-63 (13 references)

The study presented in this paper is concerned with a search for evidence that the "behavior setting", modified or altered by environmental lighting, produces (creates) environmental cues or signals, and that the participants may tend to respond or act upon these cues in some consistent way. The experiment was conducted in a room in which the

only physical alterations were changes in the lighting arragnements. The methods for evaluating the subjective quality of space were a number of scientific techniques, most notably: (1) semantic differential rating scales for factor analysis, (2) multidimensional scaling, and (3) observation and mapping of overt behavior.

228 Medd, D. 1967. Colour tolerance. Building Materials, 26-27, July, 59-61 (no references)

Colour tolerances are not specified in architectural practice. The increasing use of factory made coloured materials and ready mixed paints, in place of mixing colours on the site, emphasises the need for accurate colour specification. The architect's responsibility is for the appearance of materials and coloured surfaces in or on completed buildings, and he is therefore more concerned with the several factors affecting this appearance than he is with the physical and chemical properties of the colour. Variables of concern to the architect include: size of surface, distance of viewing, effect of sunlight and shade, effect of inter-reflection, character of situation.

229 Mikellides, B. 1979. Conflicting experiences of colour space. In: Simon, JG. (ed). Conflicting experiences of space. Proceedings of the 4th IAPC. Tome II. Catholic University of Louvain, Louvain-la-Neuve, 679-703 (12 references)

The aim of this paper is twofold: To summarize the 'state of art' on conflicting experiences of colour space based on psychological and architectural interpretations, and to present the preliminary findings of ongoing longitudinal studies at Oxford on colour attitudes to full scale colour spaces by architects and laymen. Architects and laymen evaluations of 2 large seminar spaces one painted Red (BSI 04E53) and the other Turqoise (BSI 16E53) are compared using R. Küller's theoretical model for describing perceived colour space. The results are related to L. Sivik's isosemantic maps and give support to the apparent warmth and coldness of colours as being hue dependant. Both spaces are considered by the participants as exciting giving support to the importance of chromaticness (saturation) on the calming/exciting dimension. Architects and laymen tastes to external colour on buildings are reported by reference to Oscar Newman's experiments at Clason Point, New York and an experiment carried out at Oxford where participants were shown slides of coloured buildings, supergraphics, and colour restoration work. Despite the fact that architects expressed stronger preference for colour than laymen on personal evaluation architects did not consider the buildings as consistent with or fitting in to the urban milieu, while laymen did. The relationship of colour and graffiti is reported by reference to an experiment where 6 identical library cubicles at Oxford were painted in different colours B, Y, O, G, R, V, and the amount of graffiti in them was compared to a white cubicle. The distinction is made between synchronic conflict - apparent conflict arising at most levels of conceptualising at any given time - and diachronic conflict - brought about through changes mainly of the time factor but also in taste, habituation.

230 Nayatani, Y., Tsujimoto, A., Asano, C., Machihara, S., Ikeda, J., Namba, S., Sobagaki, H. & Hirata, M. 1969. An analysis of affective values on three-color harmony by the semantic differential method. In: AIC Color 69. Volume I & II, Stockholm, 1073-1081 (9 references)

Affections on three-color harmony consists of pleasantness (23 to 24%), floridness (11 to 15%), contrast (12 to 17%), warmth (6 to 9%) and balance (2 to 6%) in most cases. Four representative affections were predetermined by using physical quantities of three component colors. For example, for the affection of floridness, the correlation coefficient is 0.67 between factor score and estimated values. By using the established relations, several three-color harmony samples have been performed.

231 Neboschick, MR. 1975. A treatment of the psychopathology of depression through inducement of appropriate mood changes by a combination of music and comparable colors with complementary counseling. Dissertation Abstracts International. 35(10-B), April

This study suggests that the treatment of employing color/music therapy and counseling both separately and together shows promise as a potentially useful therapeutic intervention in a clinical depressed university population. All clients who were available after the treatment reported being helped in some ways. Throughout the treatment the general trend was a movement from the baseline to more happy mood-states. When compared to the other phases of the treatment, the composite treatment consisting of color/music theraphy combined with counseling appeared to be the most effective.

232 Neeman, E. & Hopkinson, RG. 1976. Sunlight in buildings. Requirements and recommendations. In: Commission Internationale de l'Eclairage Compte Rendu 18e Session, Londres 1975, Bureau Central de la CIE, Paris, 431-444 (9 references)

A study of human requirements for sunlight inside buildings was carried out with the aim of using its conclusions as a basis for new recommendations for the admission of sunlight indoors. Schools, offices, hospitals and housing were investigated. The experimental procedure consisted of social surveys, visits by a team of experienced observers in a selections of buildings in sunny conditions, experiments in a controlled room and a scaled model. A detailed analysis of the availability of sunshine was also carried out. Results have shown the importance occupants attach to sunlight indoors and outdoors, and where they put it in the ranking order of other environmental and social preferences. People like the sun to shine indoors provided it is not associated with visual or thermal discomfort. The visual experience of sunshine seems to produce physiological well-being, to enhance colours of interior surfaces and to act as a contact with the outdoor world. The thermal experience of sunshine is welcomed in conditions of insufficient heat, but it is not desirable when warmth is not required. However, attempts to correlate physical measurements with subjective assessments of preferences and visual comfort have now shown a significant relationship. It seems that the duration of sunlight penetration, and not the size of the sunny patch, is the basic criterion by which sunlight indoors is appreciated. However, the location of the surface in the sun, in relation

to the body and main direction of view, are of great importance. While preparing the draft of the proposed recommendations for sunlight admission, it was anticipated that planning for sunlight has to be closely integrated with all other aspects of design related to the type of building and surroundings. The proposed recommendations relate to a classification of interiors according to their "use" and an "Activity-Position-Direction of View" grouping. A classification for the need of solar control is also given. The recommendations are based on available sunshine and not on possible sunshine, which ignores the effects of cloud and heavy haze. They specify a given number of hours, to be spread over at least 6 months of the year, during which penetration of sunlight indoors should be secured. To make the recommendation readily usable, a sunlight protractor, as well as an easy procedure, were also developed.

233 Nemcsics, A. 1969. Les préférences de couleurs de l'homme dans les époques historiques et aujourd'hui, In: AIC Color 69. Volume I & II, Stockholm, 1096-1104 (5 references)

The attempt to establish relationships between several million colour-preference test data has demonstrated that man's attitude towards colour depends essentially on his age, sex, personality, but also on his occupation. Rather than to depend on man's experience alone, this attitude depends also on the collective colour sensations of mankind, by the way of colour traditions. Cultures also are divided by their attitude towards colours. Correspondences can be detected between colour attitudes of different periods of the European cultural sphere and colour preferences of today's man in his different ages. Colour preference values as colour characteristics can exactly be described on the colour spheroid.

234 Nemcsics, A. 1976. The theoretical and experimental exploration of the relationship between man, colour and the environment. AIC Color Dynamics 76. Budapest (17 pages, 14 references)

In conclusion we would like to stress that theoretical colour dynamics should explore the elementary relationship between man and colour and the complex relationship between man and his coloured environment. We intended to formulate these relationships theoretically to explore the relationships experimentally and to establish them into a system to be able to utilize them directly in the practise of establishing coloured spaces.

235 Newhall, SM. 1941. Warmth and coolness of colors. Psychological Record, 4, 198-212 (19 references)

Our purpose was twofold, i.e., to secure estimates of this apparent warmth and coolness from numerous closely stepped samples, and if possible to secure evidence testing an hypothesis which has long been favored implicitly. That is the view that the apparent warmth and coolness are due to hue association with chromatic thermal objects. Within the experimental limitations, several generalizations seem indicated; The reds and yellow reds are the thermally "warmest" hues. The cool hues range from yellow through green and blue to purple with no unequivocal "coolest" mode. This result comfirms the reality of the artist's difficulty which instigated this study. The preceeding

supports the plausible view that the apparent warmth and coolness of color depends upon dimodal reception from common chromatic sources of temperature stimulation. There is overlapping of the warm and cool colors in the yellow and the purple blue regions, and this overlapping may be due in part to conflicting associations.

236 Norman, RD. & Scott, WA. 1952. Color and affect: A review and semantic evaluation. Journal of General Psychology, 46, 185-223 (93 references)

Ignoring operational considerations, leads many investigators to draw conclusions outside the limitations of the experiment, or to assume that the phenomena they have measured are equivalent to those concepts represented by words in common usage. In order to measure the effect of color on the human organism 'color' must be regarded as something in the external world, as well as in psychological experience. Similarly, the response of the organism must be defined in terms of behavior, rather than by inference words referring to assumed psychological experience. 'Psychological experince' may be successfully measured only when terms are operationally defined. The paper discusses the following topics: Tests of color preference; Factors presumed to influence preference, Guilford's system of color preferences, Conditioning of preferences, Semantic considerations of preference studies. Experimental studies concerning the association of color and emotional pattern; Mood associations with colored lights and designs, Mood associations of color and music, Relation between personality traits and preference, Color and non-color attitude, Jaensch's color vision types and personality types, Relation between mental/emotional disorder and preference, Suggested experiments to relate color and mood. Clinical studies; General consideration of color on the Rorschach test, Experimental validation of color reactions on the Rorschach test, Other projective tests. Behavior correlates of color; Physiological effects, Effects on mental and motor skills, Goldstein's theory, Color and psychotherapy.

237 Payne, MC. 1961. Apparent weight as a function of hue. American Journal of Psychology, 74, 104-105 (4 references)

The present study indicates that the hue of an object does influence the perceived weight of an object. The extent of this influence does not appear, however, to be as great as that of brightness (reflectance) which was shown by the earlier study to correlate very greatly ($p = 0.94$) with apparent weight.

238 Porter, T. & Mikellides, B. (eds). 1976. Colour for architecture, Studio Vista, London (151 pages, 29 references)

Introduction. 1. The effects and meaning of colour (a short review). The need for colour and light in future man-made-spaces (Birren, F), The dialectics of colour (Smith, P). 2. Colour in the architectural environment. The primitive and ancient environment: the modern concept of form. The separate paths of architecture and art: the modern concept of space. The artist and architecture: the promise

of a new environmental colour tradition. Colour, competence and cognition: notes towards a psychology of environmental colour (Friedman, S. & Thompson, S.). The future role of the artist (Vasarely, V). 3. The functions of colour in architectural settings; Colour as a function of multi-dimensional space: a new architecture of urban environment (Pasmore, V), The use of colour and texture at Clason Point (Newman, O), The temptation of colour: a legitimate attitude for an architect (Deroche, J), Colour in buildings (Esherick, J), The colour approach of Piano and Rogers (Rogers, R), On the use of colour in buildings (Foster Associates), Notes on a colour palette (Sussman, D & Prejza, P), Living in colour colour (Lenclos, JP). 4. A definition of colour for the designer; Light, Object, The eye and brain, Psychological factors. 5. Test findings, observations and notes on the effects of colour. Studies on the psycho-physiological effects of light and colour: Coloured Illumination and the environment (Preusser, R), The significance of light and colour in the urban environment (Birren, F), Colour preferences; The colour currency of nature (Humphrey, N), The effect of colour on our perception of space. The study and application of colour in extraterrestial habitats (National Aeronautics and Space Administration). 6. The Natural Colour System and its application to interior and exterior environments (The Swedish Studies). The Natural Colour System and its universal application in the study of environmental design (Hård, A). Interior space and colour (Acking, CA & Küller, R). The language of colour; Colour connotations (Sivik, L). Towards the meaning of environmental colour.

239 Rathbone, A. 1969. The generation of aesthetic reponses to colour. In: AIC Color 69. Volume I & II, Stockholm, 1056-1063 (16 references)

The generation of aesthetic responses derives from the satisfaction achieved by pattern recognition due to faculties which have evolved from elementary sensory response mechanisms. Tension-seeking and avoidance of incapacity and uncertainty distress are key aspects of an extension from instinctive responses to conscious sensory exploration and aesthetic manipulation.

240 Ross, RT. 1938. Studies in the psychology of the theater. I. Preliminary studies of audience reactions to color. Psychological Record, 2, 127-190 (no references)

The studies represent an attempt to measure the mood-reactions of audiences to lights of different colors as they might be seen in the theater. Only single colors on evenly illuminated surfaces were presented. The scales used in these studies allow the audience to state the suitability of the various colors for scenes according to their emotionality, affectivity (pleasantness or unpleasantness), activity, tension, temperature, tragedy, comedy, melodrama and romance. One of the most striking features of the results is their consistency from group to group. It would indicate either that our cultural heritage is such that we all learn the "correct" responses, or that there is some innate mood-reaction to different colors. Irrespective of the hue, the results indicate that high brightnesses are associated with hot, active and comic scenes, whereas low bright-

nesses are associated with emotional, tense, tragic, melodramatic and romantic scenes. High saturation, on the other hand, goes with scenes which are emotional, tense, hot, comic and melodramatic. The temperature is related to the brightness and saturation of a color, but a further analysis indicates that hue is by far the most determining factor. The warm colors are associated with activity and comedy, and the cool colors with tragedy and possibly romance. Agreement between the experimental results and many of the artistic intuitions which are extant in the theater; that warm colors denote comedy and cool ones tragedy, for example.

241 Rowlands, E. & Loe, DL. 1976. Preferred illumination distribution in interiors. In: Commission Internationale de l'Eclairage. Compte Rendu 18e Session, Londres 1975, Bureau Central de la CIE, Paris, 333-342 (11 references)

The inadequacy of illuminance on a horizontal working plane as a design parameter for interior lighting installations has been frequently acknowledged, but proposed alternative procedures which will provide preferred overall appearance using techniques such as luminance design, and incorporating parameters such as vector/scalar ratio and lighting effectiveness factor (LEF), have not come into very general use partly because they are considered to be complicated. This work studies the distribution of illuminance on the surfaces of a small cube: this concept can lead to a simplified design procedure particularly if the surfaces of the cube are positioned with the faces parallel to the main surfaces of a room. Investigations have been conducted for a variety of light distributions in laboratory and real conditions, and observers, including both experienced and inexperienced persons in lighting work, have made subjective assessments of people, objects and office interiors using a series of bi-polar scales and forced choice tests. Recommendations are provided in the form of a range of illuminance relationships with reference to the surfaces of a cube, for a preferred illumination pattern in office interiors. These indicate that although the lighting should not be too soft, it should not be too dramatic: the illumination of vertical surfaces is important and azimuth modelling requires careful attention. It is found that the recommended conditions are not usually obtained with conventional lighting installations and therefore some other lighting arrangements have been considered particularly those with a strong horizontal component.

242 Schaie, KW. 1961. A Q-sort study of color-mood associations. Journal of Projective techniques, 25, 341-346 (12 references)

The association beween eleven adjective mood-descriptions with ten colors was rated by 20 professional judges by means of a Q-sort of 110 cards each containing a description and color patch. The analysis of variance of the ratings showed that significant differences exist in the strength of association depending upon the specific colors and mood-tones rated. A factor analysis of the correlations among raters resulted in the identification of four distinct rating patterns. A rationale for the use of response to color as a means of personality study is provided by showing that color associations conform to consistent group stereotypes.

243 Schaie, KW. 1961. Scaling the association between colors and mood-tones. American Journal of Psychology, 74, 266-273 (9 references)

The association between 11 adjectival mood-descriptions as well as the term "pleasant" with 10 colors was scaled by means of a variation of the constant-sum method using the constant-stimulus model. Scale-values show reasonably good replication from one group of raters to the other and for the same group over time. Some colours are found to be associated with several mood-tones and some mood-tones are associated with more than one color. Intercorrelations of scale-values between colors and mood-tones were factored and four factors were identified. These factors were interpreted as the dimensions of activity-passivity, quality of emotional tone, mood-strength and emotional control.

244 Schaie, KW. 1966. On the relation of color and personality. Journal of Projective Techniques and Personality Assessment. 30. 512-524 (41 references)

The history of psychological studies of the relation between color and personality was reviewed. Models were related which conceptualize response to color as a means of studying emotional behavior, personality differentiation and the indirect influence of observable behavior traits. The relation of response to color and emotional behavior was discussed in terms of the color attributes of excitation potential, arousal value and affective content. Attention was drawn to the possibility of identifying modes of personality differentiation along the dimensions of rigidity-flexibility and stability-instability from extent of color use and from the study of color-form dominance. Finally, color preferences were applied to the actuarial prediction of personality patterns in terms of observable traits.

245 Scott, IA. (ed). 1969. The Lüscher Color Test. Random House, New York (also 1970, Jonathan Cape, London. 1971, Pan Books, London, 1971, Pocket Books, New York) (207 pages, 142 references)

Instructions for conducting the test. Color Psychology; The origin of colour significance, The physiology of colour, The development of colour vision. "Colour blindness" makes no difference. The Lüscher Test. Functional psychology; The significance of the eight positions, Interpreting the functions. The basic and auxiliary colours; colour-coding of the eight colours, Categories of the four basic colours, Combined basic colours, Basic colours should be preferred, The auxiliary colours. Grouping and marking the eight-colour sequence. Anxieties, compensations and conflicts; Stress-sources, Compensation, Exaggerated compensations, Intensity of the anxiety and compensation, Prognosis, Summary of rules for marking anxieties and compensations, The "actual problem", Ambivalence, The rejected or supressed characteristic, "Emotional" personalities. Conflict between objective and behaviour, Instability of the autonomic nervous system, Work and exhaustibility. The meaning of the eight colours: Grey, Blue, Green, Red, Yellow, Violet, Brown. Black. Structural meaning of the colour pairs. Test interpretation; A word of warning, Examples of test analyses. Interpretation tables.

246 Sivik, L. 1969. Colour connotations and perceptive variables. AIC Color 69. Volume I & II. Stockholm, 1064-1072 (no references)

An investigation showing the connection between the perceptive dimensions of colors and connotative variations of meaning. The color variables after Natural Color System and the connotation variables operationally defined as semantic differential scales. It is possible to map out graphically the required relations as isobar structures in various sections from the color solid. This graphical method of presentation makes comparisons between hues possible - with the other perceptive color variables constant. The method also gives diversified information on systematic differences between color areas, between meanings and between people. The studies were performed both in Sweden and in Greece. A factor analysis of the scales used gave four distinct, independent factors.

247 Sivik, L. 1974. Color meaning and perceptual color dimensions: A study of color samples. Göteborg Psychological Reports, 4(1), University of Göteborg, Sweden (31 pages, 19 references)

71 color samples were judged with 26 SD-scales and the results were factor analysed. The factors of meaning were congruent with those of earlier studies. It is claimed that the relations between colors and meanings are advantageously illustrated and understood by means of so-called isosemantic mapping of the color-descriptive model used. Isosemantic patterns, based on factor-scores, for each of the four factors and for each of the four elementary hue triangles (according to the Natural Color System) are analysed. Localized variations of semantic dimensions within the color world show complex, though systematic, relations with the color variables, indicating the importance of "secondary" color areas as brown, orange, pink and the like.

248 Sivik, L. 1974. Color meaning and perceptual color dimensions: A study of exterior colors. Göteborg Psychological Reports, 4(11), University of Göteborg, Sweden (41 pages, 13 references)

The present report deals with an investigation of colors on the exterior of buildings. Sixty-seven different colors were individually considered as if they were applied to each of two different types of buildings; this was done by using a photographic means of simulating. The relationships are presented both in the form of linear correlations and also as isosemantic mapping of the color space; the latter is claimed to be the better when making psychological analyses of the results. Results obtained were compared firstly as between the two types of buildings and secondly as between the ratings of exterior colors and ratings of isolated colors. The variables were grouped by means of factor analyses. The different types of variables gave results which were further investigated with respect to their varying results in the color space and the extent to which they varied in different contexts or modes of appearance. Attempts to validate the experimental results have been made in interview enquiries about actual buildings and areas, which have given promising results. A theory is suggested concerning ways in which the connotative patterns (that subsume the evaluative patterns) derived from the condition of isolated color differ from those derived from other modes of color appearance.

249 Sivik, L. 1974. Measuring the meaning of colors: Reliability and stability. Göteborg Psychological Reports, 4(12), University of Göteborg, Sweden (14 pages, 11 references)

Two kinds of reliability estimates concerning semantic differential measurements of color connotations are discussed: 1. test-retest for the same groups and 2. consistency between groups. Studies of stability are presented from a number of different studies. The stability of color connotations seems to depend on the relevance of the scale to the color judged. As a particular scale differs in relevance to different colors, this implies that interaction between scales and concepts affects the reliability. Finally another interacting factor is demonstrated, namely inter-individual differences in stability of judgement.

250 Sivik, L. 1974. Measuring the meaning of colors: Problems of semantic bipolarity. Göteborg Psychological Reports, 4(13), University of Göteborg, Sweden (13 pages, 15 references)

The bipolarity of semantic variables are discussed and studied in the context of color connotations. Nine unipolar scales of the type: Warm (little.....much) were compared with their opposites. Three of these opposite-pairs deviated significantly on the level of group data from the expected -1.0-correlation. Analysis of the data for each individual reveals that individuals differ considerably in their perception of scale-antonymy in judging color. The present results support earlier studies of concepts other than colors, which concluded that the general assumption of SD-bipolarity is unwarranted. Unipolar scales, such as those used in this study, may reveal sources of variance that remain hidden when ordinary bipolar methods are used.

251 Stamm, JS. 1955. Fourier analyses for curves of affective value of color as functions of hue. American Journal of Psychology, 68, 124-132 (7 references)

The present analysis is concerned with a series of curves of affective value (AV) of color as functions of hue, for constant tint and chroma designations, according to the Munsell color notation. The curves were constructed by Guilford, as the result of judgments for 316 color samples by a group of 20 women. The series of curves includes the tints and chroma available for the total range of hue. When these curves were subjected to Fourier analyses the following results were obtained. (1) The constant terms of the Fourier equations increase linearly as functions of both tint and chroma. (2) The first two harmonic components account for approximately 75% of the fluctuations of the curves of AV. No appreciable component higher than the fifth harmonic were obtained. (3) The magnitudes of the first two harmonics are related to tint and chroma by first or second order equations. (4) The maximal and minimal points of the first and second harmonies fall within relatively narrow limits on the hue scale. The accuracy of these findings may be limited by inconsistencies in the spacings of the Munsell notation. More correct designations have recently been developed and these should be applied to further investigations on color preference as a function of the visual dimensions.

252 Stewart, DM. 1975. Primary school children and their attitude to visual environment. School of Architecture, University of Liverpool (214 pages, 8 references)

How often do we ask the children? Do they have views on the building which forms the environment around them? And if they do, are they important and helpful to the architect in his task? It is the contention of this thesis that even comparatively young children may well have such views and that they are worth investigating. The investigation was concentrated upon the visual environment, but regard was had to other environmental and social factors. Children prefer outside positions - that is positions which are relatively near to windows. This does not appear to apply to children in old schools with windows which have high cills and restricted outlook. Their movements in a completely free choice are outwards towards windows. Variety in the visual environment over the room is probably an influencing factor. Children like windows and the factors associated with them such as "to see out", "to see what is going on", "to see nature", and "sun and light". Children of very high sociometric status occupy outside positions near windows. Sociometric cliques bear some relationship to table groups. No convincing evidence could be found of a relationship between the personality measures for extraversion and neuroticism and position in the classroom or visual stimulus.

253 Tikkanen, KT. 1976. A study of emotional reactions to light and colour in a school environment. Lighting Research and Technology, 8(1), 27-30 (4 references)

A field study was made of five Swedish comprehensive schools. Two classrooms per school were used for testing in the darkest season and the same ones were reused in spring. A total sample size of 400 pupils averaging 16 years of age was taken during two seasons. The overhead window test group consisted of 160 pupils in four classrooms. The other group with common eye-level windows consisted of 240 pupils in six classrooms. It is concluded that the observed sensation of colour changed with the quality and quantity of light. There was a relationship between the quality of light and the pleasantness of the observed environment. Warm was associated with the pleasantness and cold with the unpleasantness in this cold climate for both light and colour.

254 Tinker, MA. 1938. Effect of stimulus-texture upon apparent warmth and affective value of colors. American Journal of Psychology, 51, 532-535 (5 references)

The purpose of this experiment is to investigate the effect of stimulus-texture upon apparent warmth and upon affective value of colors in two situations where the surface-texture is considerably different. The two types of stimulus-objects are, respectively, cloth and coated paper. Surface texture, as represented by coated paper versus cloth, has little or no effect upon apparent warmth or affective value of colors. Warm colors tend to be preferred over cool colors or achromatic stimuli. The ranking for apparent warmth of colors by men is practically identical to that for women. There is, however, a slight tendency toward sex differences in color preferences.

255 Turner. DP. (ed). 1969. Windows and environment. McCorquodale & Co on behalf of the Pilkington Environmental Advisory Service (204 pages, 150 references)

Authors: W Burt, DA Button, P Foulkes, JA Lynes, TA Markus, PGT Owens, PH Parkin. The book contains the following six parts: Light and life, Windows and light, Windows and heat, Windows and sound, Windows in buildings, Overlays and charts. The book is built around parts 2, 3 och 4 which examine the physical facts of the lighting, heating and acoustic components of the environment and the ways that they are affected by the window. These factual analyses are proceeded by a dissertation, mainly pictorial, on the less tangible features of window design, the requirements of view and contact, the effects of form and symbolism. The fifth part reassembles the facts of the first four parts, for a variety of building types, and discusses them in a form of annotated bibliography. The charts and overlays are packed in the separate part 6; they are working tools and, to keep them to a useful scale, the principles of size standardization had, reluctantly, to be abandoned.

256 van Es, M., Drexler, H. & Bottema, V. 1978. De invloed van de kleur der wanden op de beoordeling van een ruimte. Nederlands Tijdschrift voor de Psychologie, 33, 389-402 (12 references) (in Dutch with English summary)

One room was painted in three different colors. In every color the room was judged by about 30 persons on a number of rating-scales. Correlations between rating-scales were obtained and factor analysed (principal components). The results of the factor analysis were somewhat ambiguous. By gathering new data, it could be proved however that three factors were at least to some degree stable. These factors could be interpreted as an evaluative factor, an activity factor and a light-dark factor. Differences between the different rooms were only significant for the last factor. Further clear differences were only found for the items cold, cool, and conservative. These differences were thought of as rather trivial by the researchers, especially in view of the literature that suggests numberless differences. Another rather astonishing result was that the mean correlation between persons who judged the same room was not significant higher than the mean correlation between persons who judged different rooms. Besides this, the man correlation between persons who judged the same room, was very low (.19). These results seem to indicate that propositions over the way in which colors are perceived, are as good as useless. The question is raised, why these inter-individual differences are so enormous.

257 van Essen, J. 1960. Wesen und Herkunft der Farben. Die Farbe 9, Nr 1/3, 31-47 (no references)

About nature and origin of colors (a more metaphysical theme rather than a scientific one) some scientifically useful statements may be made today. It is pointed out here that the sensorial pecularity of colors, i.e. their specific chromacy, probably is to be reduced to the history of

light on the earth. The hues are genetic reminiscences and, as such, have an archetypical meaning. This is immediately related to their biological meaning which is so much fluctuating. Colors have little biological tasks, therefore they are at the disposal of man's mental life as a means for symbols of his cultural experiences.

258 Wallen, R. 1948. The nature of color shock. Journal of Abnormal and Social Psychology, 43, 346-356 (6 references)

In order to study affective reactions to the Rorschach cards, men at a military training station were asked to tell whether they liked or disliked each card. By constructing achromatic renderings of the colored cards, and by varying the method of presentation, several aspects of the stimulus situation could be isolated. Results justified the following conclusions: 1. If cards appear late in the series they are more popular than if they appear early in the series. 2. Inverting the cards has little effect on expressed liking for them. 3. Multi-colored cards are better liked in the standard form than when they are rendered achromatically. 4. Cards II, VI and IX elicit more dislike reactions among unstable men than among stable men, but only for card II does color appear to be important as the source of the dislike. 5. Simultaneous comparisons of chromatic and achromatic versions of the five colored cards reveals that unstable men show more preference for the achromatic version in the case of three cards. 6. Questioning discloses that the unstable men dislike color cards frequently because the red reminds them of blood. In the discussion it was pointed out that color produces shock because it facilitates associations which have a disturbing effect upon the individual. The same principle will explain shading shock. In some instances the shape of the blot makes it hard to develop a meaningful percept, and this difficulty may produce an emotional reaction in the insecure person. These principles operate in other situations than the Rorschach test, but usually there is no way of observing the reactions satisfactorily. The data provide some evidence of the diagnostic validity of the Rorschach method, because they objectively demonstrate that unstable persons show affective reactions different from those of stable persons.

259 Washburn, MF., Haight, D. & Regensburg, J. 1921. The relation of the pleasantness of color combinations to that of the colors seen singly. American Journal of Psychology, 32, 145-146 (no references)

The design of our own experiments was to see whether the principle that the pleasantness of a color combination varies directly as that of its components would hold good when absolute rather than comparative judgments of affective value were made. These figures support the conclusion to which ordinary experience points, that the unpleasantness or pleasantness of a color combination is derived not merely from summation of the affective tones of its components but from another factor dependent on the combination itself.

260 Watson, N. & Payne, I. 1968. The influence of fluorescent lamps of different colour on the perception of interior volume. Environmental Research Group, University College, London (6 pages, 4 references)

An experiment was designed to study the effects of certain fluorescent lamps on the assessment of volume, using scale models. The greatest discrepancies were not found in the predicted lighting combinations but there were some indications that white fluorescent light tending towards the blue end of the visible spectral range gave an impression of a larger volume than white fluorescent light tending towards the red end of the visisble spectral range. Reasons for the results are speculated and a further experiment is suggested.

261 Wexner, LB. 1954. The degree to which colors (hues) are associated with mood-tones. Journal of Applied Psychology, 38(6), 432-435 (14 references)

In an attempt to determine to what degree colors (hues) are associated with mood-tones, 94 subjects were presented with eight stimulus colors (red, orange, yellow, green, blue, purple, brown, and black) and a list of eleven moods. It was found, however, that for each mood-tone certain colors were chosen to "go with" that mood-tone significantly more often than the remaining colors, and the results were stated.

262 Williams, JE. & Foley, JW. 1968. Connotative meanings of color names and color hues. Perceptual and Motor Skills, 26, 499-502 (7 references)

The study was designed to investigate the connotative meanings of color signs and corresponding color significates among young adult subjects. Semantic differential ratings of 10 color names and 10 corresponding color hues revealed highly similar meanings along Evaluation, Potency, and Activity dimensions. It was concluded that color names and hues are virtually equivalent in terms of the connotative meanings which they evoke.

263 Wittenberg, JJ. 1969. Der psychodiagnostische Wert der Assoziationen zu Farben mit subjektivem Gefühlswert. In: AIC Color 69. Volume I & II, Stockholm, 1109-1117 (no references)

616 men and 351 women had to select the most and the least sympathetic color out of 10 colors and to tell about their associations to the colors selected. From the results of these tests the emotional value of the colors is concluded.

264 Wright, B. 1962. Influence of hue, lightness, and saturation on apparent warmth and weight. American Journal of Psychology, 75(2), 232-241 (21 references)

Forty-five colors were rated independently on the semantic differential adjective-pairs "kalt-warm" and "leicht-schwer". The effect of hue on apparent warmth seems to be established beyond the need for further research. The effects of lightness and satuaration, however, while strongly implied, still need additional study. It may be worthwhile

to investigate the existence of non-linear terms, especially interactions between hue and lightness and hue and saturation, in the relation between color and apparent warmth. Research on the effect of lightness on apparent weight seems complete. The effect of saturation, while strongly suggested by the present study and by Monroe's data, needs further investigation.

265 Wright, B. & Rainwater, L. 1962. The meanings of color. Journal of General Psychology, 67, 89-99 (23 references)

This is a report on a factor analytic study of the connotative meanings of colors. The report is divided into three parts: first, a description of the mechanics of the study; second, a presentation of the six dimensions of connotative meaning found in the factor analysis; third, an analysis of the linear relation between these color connotations and the color perceptions of hue, lightness and saturation.

266 Wyon, DP. & Nilsson, I. 1980. Human experience of windowless environments in factories, offices, shops and colleges in Sweden. In: Krochmann, J. (ed). Proceedings of the symposium on daylight. Physical, psychological and architectural aspects. Commission Internationale de l'Eclairage, Institut für Lichttechnik, TU Berlin, 216-225 (6 references)

Attitudes to windows are usually dominated by daylight and view-out considerations. The other functions performed by windows are often taken for granted, since window size affects primarily the above aspects. Only when windows are totally absent are these other functions likely to be missed. Attitudes to windows among people working in windowless environments were thought likely to reveal the relative importance of various window functions to the occupants of different categories of building. About 250 people working in windowless environments in factories, offices, shops and colleges documented their experience in carefully structured invidual interviews. An equal number of people in comparable employment, often within the same organisation, but working in rooms with windows, were similarly interviewed and formed a control group. Statistically significant differences in attitudes to windows were found between categories of employment and across the window/windowless dichotomy within each category. Office workers in the far north of Sweden differed in their attitudes to windows from comparable office workers in the south of Sweden. A number of blind people were similarly interviewed on the non-visual aspects of windows. Their attitudes differed significantly from those of the rest.

267 Zimmermann, W. 1969. Äussere und innere Farben des Menschen. AIC Color 69. Volume I & II, Stockholm, 1128-1133 (12 references)

Starting from the outside and inside colors of the healthy and ill human body, it is tried here to point to certain relations between color and the primaries of color vision and color defiency as well as to further biological and psychological connections to color. It is guessed that all aspects of color are related to each other, that there exist causal relationship, this idea could be fruitful to many an open field for further research work.

268 Östberg., O. & Stone, PT. 1974. Methods for evaluating discomfort glare aspects of lighting. Göteborg Psychological Reports, 4(4), University of Göteborg, Sweden (19 pages, 82 references)

After a review of the different attempts to relate physiological mechanisms to discomfort glare, brief summaries are given of all encountered techniques of subjective scaling. The summaries are given in order of appearence in the literature, from 1900 to 1973, so as to show the steps in the evolution of the scaling of discomfort glare. The main sources of assessment variance, as well as means of controlling them, are also discussed. It is found that none of the scaling techniques presently in use can be appointed the rank of final standard, especially as individual variability has not been dealt with properly.

SECTION 3: ADDITIONAL REFERENCES

Aaronson, B. 1964. Hypnotic induction of colored environments. Perceptual and Motor Skills, 18, 30

Adams, FM. & Osgood, CE. 1973. A cross-cultural study of the affective meanings of color. Journal of Cross-Cultural Psychology, 4, 135-152

Akhtar, SN. & Swigh, UP. 1974. Colour preferences of criminals and noncriminals. Manas, 21(2), 35-41

Aksugür, E. 1977. Effects of surface colors of walls under different light sources on the 'perceptual magnitude of space' in a room. In: Color 77. The third congress of the international colour association, Rensselaes Polytechnic Institute, Troy, New York, 10-15 July 1977, Adam Hilger, Bristol, 388-391

Albers, J. 1971. Interaction of color. Yale University Press, New Haven, London

Allen, EC. & Guilford, JP. 1936. Factors determining the affective values of color combinations. American Journal of Psychology, 48, 643-648

Allen, RM. 1951. The influence of color in the Rorschach test on reaction time in a normal population. Journal of Projective Techniques, 15, 481-485

Arndt, W. & Fischer, D. 1956. Uber das Angenehme oder Behagliche in der Beleuchtung. Lichttechnik, 8, 99-103

Aspinall, PA. & Dewor, J. 1980. Lighting and perceived guilt. Lighting Research and Technology, 12(3), 140-143

Aubree, A. 1979. The psycho-sociology of colour. Lux 104, 285-286 (in French)

Auer, X. 1953. Farbendynamik und ihre Anwendung in der Industrie. Der Maschinenmarkt, H 79, Oktober

Baker, M. (undated), The aesthetics of light and color. Toronto Psychol. Stud, 1, 201-250

Balder, JJ. (undated). Preferred luminances in offices. Bull Soc Franc Elect, 7th Series (France), 9 February

Ball. VK. 1965. The aesthetics of colour: A review of fifty years of experimentations. J Aesthetic art Crit, Vol 23, 441-452

Banks, L. & Holister, FD. 1967. The problems of windowless environments. Research Paper No 1, Greater London Council, County Hall, London

Bansels, HG. 1960. Farbenpsychologie im Kulmbacher Krankenhaus. Krankenhaus Umschau, 29, 527-529

Bayes, K. 1967. The therapeutic effect of environment on emotionally disturbed and mentally subnormal children. Unwin Bros, London (also: Design Research Unit, 37 Duke Street, Wigmore Street, London W1)

Bedwell, CH. 1972. The eye, vision and visual discomfort. Lighting Research and Technology, 4(3), 151-158

Bennett, A. 1977. The demographic variables of discomort glare. Lighting Design and Application, January

Bennett, CA. & Rey, P. 1972. What's so hot about red? Human Factors, 14, 149-154

Berlyne, DE. & Peckham, S. 1966. The semantic differential and other measures of reaction to visual complexity. Canadian Journal of Psychology, 20(2), 125-135

Birren, F. 1950. Color psychology and color therapy. McGraw-Hill, New York (also: 1961. University Books, New York)

Birren, F. 1952. The emotional significance of color preferences. American Journal of Occup Therapy, 6(2), 61-63

Birren, F. 1959. The effects of color on the human organism. American Journal of Occup Therapy, 13(3), 125-129

Birren, F. 1963. Color for interiors. Whitney Library of Design, New York

Birren, F. 1969. Light, color and environment. Van Nostrand Reinhold Co, New York

Birren, F. 1973. Color preference as a clue to personality. Art Psychotherapy, 1, 13-16

Birren, F. 1973. A colorful environment for the mentally disturbed. Art Psychotherapy, 1(3-4), 255-259

Birren, F. 1978. Color and human response. Van Nostrand Reinhold Co, New York

Bitter, C. & van Ierland, JFAA. 1967. Appreciation of sunlight in the home. In: Hopkinson, RG. (eds). Sunlight in buildings. Proceedings of the CIE Intersessional Conference, Bouwcentrum International, Rotterdam

Bjerstedt, Å. 1959. Färgarrangemang och färgassociationer. Nord Psykol, 11, 96-106

Black, JC. 1965. The meaning of color: A semantic differential study. Unpublished Master's Thesis, University of Utah

Blin, JR. 1954. Influence des couleurs sur la quatriéme dimension de l'etre. Voir et Traduire, Lille

Bornstein, MH. 1973. Color vision and color naming: A psychophysiological hypothesis of cultural difference. Psychological Bulletin, 80, 257-285

Boyce, PR. 1973. Age, illuminance, visual performance and preference. Lighting Research and Technology, 5(3), 125-144

Brackbill, GA. 1951. Some effects of color on thematic fantasy. Journal of Consult Psychology, 15, 412-418

Bradford, EJG. 1913. A note on the relation and aesthetic value of perceptive types in color appreciation. American Journal of Psychology, 24, 545-554

Brandt, HJ. 1976. Physiological and psychological importance of daylight for man and inferences for construction planning. Gesundheits-Ingen, 97(6), 143-146

Brinkmann, D. 1947. Psychologie der Farbe. In: Boller, E., Brinkmann, D. & Walter, EJ. Einführung in die Farbenlehre, A Franke, Bern, 91-126

Brown, AL. & Campione, JC. 1971. Color dominance in preschool children as a function of specific cue preferences. Child Development, 42, 1495-1500

Bullough, E. 1907. On the apparent heaviness of colours, a contribution to the aesthetics of colour. British Journal of Psychology, 2, 111-152

Bullough, E. 1908. The 'perceptive problem' in the aesthetic appreciation of single colours. British Journal of Psychology, 2, 406-463

Bullough, E. 1910. The 'perceptive problem' in the aesthetic appreciation of simple colour-combinations. British Journal of Psychology, 3, 406-447

Burner, M. 1966. Influence de l'éclairage sur le comportement de l'être humain dans son travail. Z Präv Med, 11, 345

Busch, L. 1965. Die physiologischen Komponenten bei farbpsychologischen Untersuchungen. Die Medizinische Welt, 2582

Bylund, L. & Liljefors, A. 1979. Fönster och dagsljus i arbetslokaler. Förstudie. R111, Statens Råd för Byggnadsforskning, Stockholm

Çakir, A. 1973. A study of discomfort glare by floodlighting for color-TV. In: Küller, R. (ed). Architectural Psychology. Proceedings of the Lund Conference, Studentlitteratur, Lund & Dowden, Hutchinson & Ross, Stroudsburg

Chandler, AR. 1928. Recent experiments in visual aesthetics. Psychological Bulletin, 25, 720-732

Chauvel, P., Collins, JB., Dogniaux, R. & Longmore, J. 1980. Glare from windows: Current views of the problem. In: Krochmann, J. (ed). Proceedings of the symposium on Daylight. Physi psychological and architectural aspects. Commission Internationale de l'Eclairage. Institut für Lichttechnik, TU Berlin, 294-302

Cheskin, L. 1947. Colors - what they can do for you. Liveright Publishing Corporation, New York

Child, IL. & Iwao, S. 1969. Comparison of color preferences in college students of Japan and the United States. Proceedings of the 77th Annual Convention of the American Psychological Association, 4(pt 1), 469-470

Child, IL., Hansen, JA. & Hornbeck, FW. 1969. Age and sex differences in children's color preferences. Child Development, 39, 237-247

Chou, SK. & Chen, HP. 1935. General vs. specific color preferences of Chinese students. Journal of Social Psychology, 6, 290-314

Choungourian, A. 1967. Introversion-extraversion and color preferences. Journal of Proj Techn and Pers Assessment, 31(4), 92-94

Choungourian, A. 1968. Color preferences and cultural variation. Perceptual and Motor Skills, 26, 1203-1206

Clark, JH. 1948. Some MMPI correlates of color responses in the group Rorschach. J Consult Psychology, 12, 384-386

Cohn, J. 1894. Experimentelle Untersuchungen über die Gefühlsbetoning der Farben, Helligkeiten und ihre Combinationen. Philos Stud, 10, 562-602

Cohn, J. 1900. Gefühlston und Sättigung der Farben. Philos Stud, 15, 279-286

Collingro, C. & Roessler, G. 1972. Influence of window width on the communiation with the external environment in a room with PSALI. Proceedings of CIE Study Group A Symposium, Varna

Collins, BL. 1976. Review of the psychological reaction to windows. Lighting Research Technology, 8(2), 80-88

Collins, BL. 1977. Evaluation of human response to building fenestration. ASHRAE HA-77-4 No 1

Collins, N. 1924. The appropriateness of certain color combinations in advertising. M.A. Thesis, Columbia University (Summarized in Poffenberger, AT. 1932. Psychology in advertising, McGraw Hill, New York, 450-459)

Cooper, JR., Wiltshire, TJ. & Hardy, AC. 1974. Attitudes towards the use of heat rejecting/low light transmission glasses in office buildings. Work Report, Newcastle-upon-Tyne

Corcoran, AL. 1956. Children's responses to color stimuli. In: Barkan, M. (ed). Research in art education. Yearb Nat Art Educ Ass, 7, 84-95

Coss, RG. 1965. Mood provoking visual stimuli and their origins and applications. University of California, Los Angeles

Currie, KH. 1966. Colour preferences and personality. M.A. Thesis, Psychology Department, University of Glasgow

Cuttle, C., Valentine, WB., Lynes, JA. & Burt, W. 1967. Beyond the working plane. In: Commission Internationale de l'Eclairage Compte Rendu, Seizième Session, Washington, June. Volume B, Bureau Central de la Commission, Paris, 471-482

Dalkvist, J. & Gärling, T. 1971. Visually apparent restricted space as a function of number of screens and brightness level delineating an empty space. In: Hesselgren, S. (ed). Experimental studies on architectural erception, Document D2, National Swedish Building Research, Stockholm, 58-65

Danger, EP. 1968. Using colour to sell. Gower Press, London

Dasgupta, PC. & Basu, MN. 1936. Possibility of racial significance of color preference. Indian Journal of Psychology, 11, 201-204

Dashiell, JF. 1917. Children's sense of harmonies in colors and time. Journal of Experimental Psychology, 2, 466-475

Day, H. 1967. Evaluations of subjective complexity, pleasingness and interestingness for a series of random polygons varying in complexity. Perception and Psychophysics, 2, 281-286

Day, HI. 1968. The importance of symmetry and complexity in the evaluation of complexity, interest and pleasingness. Psychonomic Science, 10, 339-340

de Boer & Fischer. 1977. Interior Lighting. Philips Technical Library, Antwerpen

DeCamp, JE. 1917. The influence of color on apparent weight. Journal of Experimental Psychology, 2, 347-370

Deribere, M. 1967. Lumiére, couleur et psychologie. Communic Inst Optique, Cycle Couleurs, Mai

Deribere, M. 1968. Sociologie de la couleur, Journées Lyonnaise Couleur, 11 Janvier, Lyon

Deribere, M. 1968. La couleur dans les activités humaines (3rd edition). DUNOD, Paris

Dietschy, H. & Dietschy, N. 1958. Farbwahl und Charakter von zentralbrasilianischen Indianern. Acta Tropica, Basel, 15, 241

Dorcus, RM. 1926. Color preferences and color associations. Journal Genet Psychology, 33, 399-434

Dubash, PS. 1944. Colour psychology, Bombay

Dubrovner, RJ., von Lackum, WJ. & Jost, H. 1950. A study of the effect of color on productivity and reaction time in the Rorschach test. Journal of Clinical Psychology, 6, 331-336

Dumond, J. 1957. La couleur dans le cadre de la vi. Couleurs, 20, 10, Juin

Eicher, JB., Decker, PM. & Shipley, ML. 1964. An operational definition of color prefererences. Journal of Psychology, 57. 195-199

Einhorn, HD. 1969. A new method for the assessment of discomfort glare. Lighting Research and Technology, 1(4), 235-247

Eisman, BS. 1955. Attitude formation: The development of a color preference response through mediated generalization. Journal of Abnormal and Social Psychology, 50, 321-326

Ellis, H. 1900. The psychology of red. Pop Sci Mon, 57, 365-375

Ellis, H. 1906. The psychology of yellow. Pop Sci Mon, 68, 456-463

Emery, M. 1942. Color therapy. Occupational Therapy, 21-43

Erbslöh, J. 196 . Farbenpsychologie, Farbentherapie und Farberziehung. Scientific Supplement to Materia Medica, Nordmark, Nr 51

Farnsworth, PR. & Chichizola, TL. 1931. Color preference in terms of sigma-units. American Journal of Psychology, 43, 631

Faulkner, W. 1972. Architecture and color. John Wiley & Sons, New York

Fernberger, SW. 1914. Note on the affective values of colors. American Journal of Psychology, 25, 448-449

Fischer, D. 1972. Illuminance, luminance and colour in working rooms. Lichttechnik, 24(8), 411-416

Flehinghaus, K. 1959. Innere Gestimmtheit und Farb-Umwelt des Kindes. Ergebnisse einer Untersuchung an 1000 Volksschulkindern. Praxis der Kinderpsychologie und Kinderpsychiatrie, 8, 231

Flynn, JE. 1972-1973. The psychology of light. (Series of eight articles) Electrical Consultant Magazine, 88:12-89:7

Flynn, JE. 1977. A study of subjective responses to low energy and non-uniform lighting systems. Lighting Design and Application, 7(2), 6-14

Flynn, JE. & Spencer, TJ. 1977. The effect of light source color on user impression and satisfaction. Journal of the IES, 6(3), 167-178

Fortier, RH. 1953. The response to color and ego functions. Psychological Bulletin, 50, 41-63

Frean, RM. & Calderwood, DM. 1959. Colour and the child. South African Council for Sicentific and Industrial Research, Pretoria

French, CA. & Alexander, B. 1972. The Lüscher Color Test: An investigation of validity and underlying assumptions. Journal of Personality Assessment, 36, 361

Frieling, H. 1956. Psychologische Raumgestaltung und Farbendynamik mit Farbtonblock.(3rd edition). Musterschmidt-Verlag, Göttingen, Frankfurt, Berlin

Frieling, H. 1963. Die Tendenz der Farbbevorzugung und Farb-Ablehnung während der Entwicklung. In: Actes VII. Journées Intern Couleur, Firence-Prato-Padova, 325-345

Frieling, H. 1964. Psychologische Raumgestaltung und Farbdynamik. Musterschmidt-Verlag, Göttingen

Frieling, H. 1965. Kompensationsfarben - ihre phänomenologische und psychologische Bedeutung, insbesondere für die Gestaltung. Tag-Ber Inter Farbtagung Luzern, Bd 2, 886-894

Frieling, H. 1974. Farbe im Raum - Angewandte Farbenpsychologie. Callwey Verlag, München

Frieling, H. 1977. Humanisierung des Arbeitsplatzed durch Licht und Farbqualität. Qualität und Zuverlässigkeit, 22, 1

Frieling, H. & Auer, X. 1956. Mench - Farbe - Raum. Angewandte Farbenpsychologie. Verlag Georg DW Callwey, München

Frieling, H. & Schmidt, ET. 1956. Der Frieling-Test, Göttingen (also: 1961. Marquartstein)

Fritzell, B. & Löfberg, HA. 1970. Dagsljus inomhus. Statens Institut för Byggnadsforskning

Fry, GA. 1956. The evaluation of discomfort glare. Illuminating Engineering, 51(11), 722-728

Furrer, W. 1955. Der Lüscher Test. In: Stern, E. (ed). Die Tests in der klinischen Psychologie. Rascher Verlag, Zürich, 432-462

Gale, AV. 1933. Children's preferences for colors, color combinations, and color arrangements. University of Chicago Press, Chicago

Garth, TR. 1922. The color preferences of 559 full blood Indians. Journal of Experimental Psychology, 5, 392-418

Garth, TR. 1924. A color preference scale for 1000 white children. Journal of Experimental Psychology, 7, 233-241

Garth, TR. & Collado, IR. 1929. The color preferences of Filipino children. Journal of Comparative Psychology, 9, 397-404

Garth, TR., Ikeda, K. & Landon, RM. 1931. The color preferences of Japanese children. Journal of Social Psychology, 2, 397-402

Garth, TR., Moses, MR. & Anthony, CN. 1938. Color preferences of East Indians. American Journal of Psychology, 51, 709-713

Garth, TR. & Porter, EP. 1934. The color preferences of 1032 young children. American Journal of Psychology, 46, 448-451

Geissler, LR. 1917. The affective tone of color combinations. In: Studies in psychology. Titchener Commemorative Volume, Clark University Press, Vorcester, Mass, 150-174

George, CE. & Bonney, WC. 1956. Rorschach's affect-color hypothesis and adaptation-level theory. Psychol Rev, 63, 294-298

Gesche, I. 1927. The color preferences of 1152 Mexican children. Journal of Comparative Psychology, 7, 297-311

Goldschmidt, L. 1953. Lieblingsfarben bei Kindern? Zeitschr für Heilpädagogik, Januar

Goodman, HW. 1950. An experimental investigation of the affective value of color in the Rorschach test. American Psychologist, 5, 321-322

Graham, M. 1973. Color therapy in a psychiatric rehabilitation program. Report to the 42nd Annual Meeting of ISCC, New York, April

Gramm, H. & Ries, W. 1960. Farbpsychologische Alternsstudien im Lichte der Statistik. Zeitschr für Alternsforschung, 14(2), 112-126

Gramza, A. & Witt, P. 1969. Choices of colored blocks in the play of preschool children. Perceptual and Motor Skills, 29, 783-787

Granger, GW. 1955. An experimental study of color preferences. J Gen Psychol, 52, 3-20

Granger, GW. 1955. An experimental study of color harmony. J Gen Psychol, 52, 21-35

Granger, GW. 1955. Aesthetic measure applied to color harmony: an experimental test. J Gen Psychol, 52. 205-212

Granger, GW. 1955. The prediction of preference for color combinations. J Gen Psychol, 52, 213-222

Graves, M. 1941. The art of color and design. McGraw Hill, New York, London

Grossman, JD. 1975. Reticle color preference as a function of luminance and background. Human Factors, 17, 215-217

Guilford, JP. 1931. The prediction of affective value. American Journal of Psychology, 43, 469-478

Guilford, JP. 1939. A study in psychodynamics. Psychometrika, 4, 1-23

Guilford, JP. 1940. There is system in color preferences. J Opt Soc Amer, 30, 455-459

Guilford, JP. 1949. System in color preferences. J Soc Motion Picture Engineers, 52, 197-210

Gupta, PCO. & Basu, MN. 1936. Possibility of racial significance of color preference. Indian Journal of Psychology, 11, 201-204

Guth. SK. 1951. Comfortable brightness relationships for critical and casual seing. Illuminating Engineering, 46(2), 65-75

Guth, SK. 1963. A method for the evaluation of discomfort glare. Illuminating Engineering, 58(5), 351-364

Guth. SK. & McNelis, JF. 1961. A discomfort glare evaluator. Illuminating Engineering, 54(6), 398-406

Hanes, RM. 1962. Fact and fancy concerning derived reactions to color. Die Farbe 11, No 1/6

Hansson, M. & Jägnert, BM. 1970. Upplevelser av exteriörfärger. En jämförelse mellan arkitekter och lekmän, samt metodstudier. Department of Psychology, University of Göteborg, Sweden

Harbin, SP. & Williams, JE. 1966. Conditioning of color connotations. Perceptual and Motor Skills, 22, 217-218

Hardy, A. 1967. Colour in building. Building Materials, 26/27, 35-36

Hardy, AC. (ed), 1967. Colour in architecture. Leonard Hill Books, London

Hardy, AC. 1974. The importance of windows in relation to other environmental factors in office buildings. In: Perception of the external world, CIB W45 Colloqium, BRS, London

Hardy, H., Graves, M. & Bohlin, P. 1978. Three architects, three approaches to color use. American Institute of Architects Journal, 67(12), 56-69

Hare, FG. 1974. Artistic training and responses to visual and auditory patterns varying in uncertainty. In: Berlyne, DE. (ed). Studies in new experimental aesthetics. Steps toward an objective psychology of aesthetic appreciation. John Wiley & Sons, 159-168

Hare, FG. 1974. Verbal responses to visual patterns varying in distributional redundancy and in variety. In: Berlyne, DE. Studies in new experimental aesthetics. Steps toward an objective psychology of aesthetic appreciation. John Wiley & Sons, 169-173

Harker, SDP. 1971. Investigations into subjective reactions to high intensity lighting: a comparison of two levels of illumination in a large office. LUTERG Report No 40, Department of Human Sciences, Loughborough

Harris, FE. & Bills, RE. 1953. Psychological considerations of color selection. The Am Sch and Univ, 25, 157

Harrison, W. & Meaker, P. 1947. Glare factors and their significance. General Electric Review, 50(8), 31-48

Harrison, W. & Meaker, P. 1947. Further data on glare ratings. Illuminating Engineering, 42(2), 153-179

Haubner, P. & Johanni, H. 1970. Untersuchungen über die psychologische Blendung in Innenräumen. I. Lichttechnik, 22(6), 304-306

Haubner, P. & Johanni, H. 1970. Untersuchungen über die psychologische Blendung in Innenräumen. II. Lichttechnik, 22(7), 345-347

Hauser, J. 1977. Colour ecology as retrospection. In: Color 77. The third congress of the international colour association. Rensselaes Polytechnic Institute, Troy, New York, 10-15 July. Adam Hilger Ltd, Bristol, 374-376

Hayward, DG. 1974. Psychological factors in the use of light and lighting in buildings. In: Lang, J., Burnette, C., Moleski, W. & Vachon, D. (eds). Designing for human behavior. Dowden, Hutchinson & Ross, Stroudsburg, 120-129

Heiss, R. 1960. Uber psychische Farbwirkungen. Studium Generale, 13(7)

Heiss, R. & Hiltmann, H. 1951. Der Farbpyramiden-Test nach Max Pfister. Huber, Bern

Heline, CD. 1945. Healing and regeneration through color. JF Rowney Press, Santa Barbara

Helson, H. & Lansford, T. 1970. The role of spectral energy of source and background color in the pleasantness of object colors. Applied Optics, 9(7), 1513-1562

Herbst, CH. 1973. Shaping living rooms with light. Elektrizitat, 11, November, 325-328 (Germany)

Hevner, K. 1935. Experimental studies of the affective value of colors and lines. Journal of Applied Psychology, 19, 385-398

Hewitt, H. 1963. The study of pleasantness. Light and Lighting, 56, 154-164

Hewitt, H., Bridgers, DJ. & Simons, RH. 1965. Lighting and the environment. Trans IES (London), 30, 91

Hildreth, GH. 1936. Color and picture choices of young children. J Genet Psychol, 49, 427-435

Hill, AR. 1969. Visibility and privacy. In: Canter, D. (ed). Architectural Psychology. Proceedings of the conference held at Dalandhui, University of Strathclyde, RIBA, London, 39-43

Hill, EF. 1966. Affect aroused by color, a function of stimulus strength. Journal of Projective Techniques and Personality Assessment, 30, 23-30

Hirahashi, B. 1926. Some experiments on beauty of color. Japanese Journal of Psychology, 1, 406-432

Hofstätter, PR. 1956. Farbsymbolik und Ambivalenz. Psychol Beitr, 2, 526-540

Hofstätter, PR. & Lübbert, H. 1958. Die Eindrucksqualitäten von Farben. Z diagn Psychol u Persönlichkeitsforsch, 6, 211-227

Holden, WA. & Bosse, KK. 1900. The order of development of color perception and color preference in the child. Arch of Opthal, 29, 261-278

Holm, DL., Pleijel, G. & Ronge, H. 1964. Dwelling and sun (in Swedish). Statens Råd för Byggnadsforskning, Stockholm

Holzberg, JD. & Schleifer, MJ. 1955. An experimental test of the Rorschach assumption of the impact of color on the perceptual and associative processes. J Proj Tech, 19, 130-137

Hopkinson, RG. 1940. Discomfort glare in lighted streets. Transactions of the Illuminating Engineering Society (UK), 5(1), 1-24

Hopkinson, RG. 1950. The multiple criterion of subjective appraisal. Quarterly Journal of Experimental Psychology, 2(3), 124-131

Hopkinson, RG. 1957. Evaluation of glare. Illuminating Engineering, 52(6), 305-316

Hopkinson, RG. 1958. Magnitude of discomfort caused by high brightness. Nature, 181(4), 107

Hopkinson, RG. 1972. Glare from daylighting in buildings. Applied Ergonomics, 3, 206-215

Hopkinson, RG. & Bradley, RC. 1959. The estimation of magnitude of glare sensation. Illuminating Engineering, 54, 500-504

Hopkinson, RG. & Collins, JB. 1970. The ergonomics of lighting. McDonald, London

Hopkinson, RG., Loe, DM. & Rowlands, E. 1969. Performance, preference and colour of fluorescent lighting. University College Environmental Research Group Note, No 3, London

Hopkinson, RG., Longmore, J., Woods, PC. & Craddock, J. 1971. Glare discomfort from windows. Compte Rendu CIE Barcelone, Commission Internationale de l'Eclairage, Paris, P-71.37, 1-23

Hopkinson, RG., Petherbridge, P. & Longmore, J. 1966. Daylighting. Heinemann, London

Hopson, J., Cogan, R. & Batson, C. 1971. Color preferences as a function of background illumination. Perceptual and Motor Skills, 1083-1088

Hughes, H., Epstein, LJ. & Jost, H. 1951. The relationship between certain measurable functions of autonomic nervous system activity and color responses on the Rorschach Test. Journal of Clinical Psychology, 7, 244-249

Hultgren, GV. & Knave, B. 1974. Discomfort, glare and disturbances from light reflections in office landscape with CRT display terminals. Applied Ergonomics, 5(1), 2-8

Humphrey, NK. 1972. Interest and pleasure: two determinants of a monkey's visual preferences. Perception, 1, 395-416

Humphrey, NK. 1976. The colour currency of nature. In: Porter, T. & Mikellides, B. (eds). Color for architecture. Studio Vista, London

Hurlock, EB. 1927. Color preferences of white and Negro children. J Comp Psychol, 7, 389-404

Imada, M. 1926. Color preferences of school children. Japanese Journal of Psychology, 1, 1-21

Imada, M. 1938. Preference of color combinations. Rep 6th Congr Jap Psychol Assoc, 62-68

Imamoglu, V. & Markus, TA. 1973. The effect of window size, room proportion and window position on spaciousness evaluation of rooms. CIE Symposium on Windows and their function in architectural design. Istanbul, October

Inui, M. 1966. Practical analysis of interior color environment. Occasional Report No 27, Building Research Institute, Tokyo

Inui, M. 1967. Proposed color ranges for interiors. Occasional Report No 28. Building Research Institute, Tokyo

Itten, J. 1961. Art of color. Reinhold Publishing Co, New York

Ivanova, NS., Perova, NS. & Skobareva, ZA. 1970. Experimental evaluation of optimum illuminances for offices. Svetotekhnika, 16(7), 7-9 (USSR)

Iwawaki, S., Sonoo, K., Williams, JE. & Best, DL. 1978. Color bias among young Japanese children. Journal of Cross-Cultural Psychology, 9(1), 61-73

Jaeckel, G. 1928. Die Blendung durch farbiges Licht. Naturwissenschaften, 979

Jaensch, E. 1936. Gefühl und Empfindung (Untersuchung ihres Verhältnisses am Beispiel des Farbensinnes). Ber 15 Kong Dtsch Ges Psychol, Jena, 65-70

James, D. & Hurwich, LM. 1975. From contrast to assimilation: in art and in the eye. Leonardo, 8, 125-131

Jastrow, J. 1897. The popular aesthetics of color. Pop Sci Mon, 50. 361-368

Judd, DB. 1967. A flattery index for artificial illuminants. Illuminating Engineering, 62, 593-598

Judd. DB. 1971. Choosing pleasant color combinations. Lighting Design and Application, 1(3)

Judd, DB. & Wyszecki, GW. 1963. Color in business, science and industry. John Wiley, New York

Kansaku, J. 1963. The analytical study of affective values of color-combinations. A study of color pairs. Japanese Journal of Psychology, 34, 1-12 (in Japanese)

Karmel, BZ. 1969. The effect of age, complexity and amount of contour on pattern preferences in human infants. Journal of Experimental Child Psychology, 7, 339-354

Kastl, AJ. & Child, IL.1968. Comparison of color preferences in Vietnam and the United States. Proc 76th Ann Convention APA, 437-438

Katz, SE. 1931. Color preference in the insane. Journal of Abnormal and Social Psychology, 26, 203-211

Katz, SE. & Breed, FS. 1922. The color preferences of children. Journal of Applied Psychology, 6, 255-266

Keehn, JD. 1954. The color-form responses of normal, psychotic, and neurotic subjects. Journal of Abnormal and Social Psychology, 49, 533-537

Keighley, EC. 1974. Preferred window shape and size in relation to view. In: Daytime Lighting of Buildings. Report of an IES-Symposium. Lighting Research and Technology, 6(2)

Kendrick, JD. 1968. The lighted space. Appraisal and specification. IES Lighting Review (Australia)

Kendrick, JD. (undated). Attitudes to daylight and daylighting design. To be published in IES Lighting Review (Australia)

Ketcham, H. 1958. Color planning for business and industry. Harper and Row

Kimmel, PS. & Blasdel, HG. 1972. Multidimensional scaling of luminous environment. Paper presented at the IES National Conference, Tulsa 1972. University of California, Berkeley

Kittler, R. 1967. Problems in evaluating the luminous effect of the architectural environment. Zivotne prostredie (Human environment), I, 4/67 (Czechoslovakia)

Klar, H. 1958. Farbpsychologische Untersuchung von 1000 Persern (Vergleich mit Europäern in Persien). Acta Tropica (Basel), 15(3), 234

Klingenberg, H. 1980. Environmental lighting by means of windows - daylight and sunshine. University of Hannover

Knighton, PH. 1962. The purposeful use of color: Part I. Hospitals, JAHA, 36(Feb 1), 36-41, 107-108

Knighton, PH. 1962. The purposeful use of color: Part II. Hospitals, JAHA, 36(Feb 16), 62-64, 122

Kobayashi, S. 1977. The Japanese seasons and their colors. In: Color 77. The third congress of the international colour association. Rensselaer Polytechnic Institute, Troy, New York, 10-15 July. Adam Hilger Ltd, Bristol, 373-374

Kobayashi, S. & Sato, K. 1977. The theory of the color image scale and its application. In: Color 77. The third congress of the international colour association, Rensselaes Polytechnic Institute, Troy, New York, 10-15 July. Adam Hilger Ltd, Bristol, 382-383

Koch, BC. 1928. The apparent weight of colors. Ohio State University Studies: Graduate School Series: Contributions to Psychology, No 9

Koehn, JD. 1955. Rorschach validation III: An examination of the role of colour as a determinant in the Rorschach test. J Ment Sci, 90, 410-438

Kouwer, BJ. 1949. Colors and their character: A psychological study. Martinus Nijhoff, The Hague

Kreitler, H. & Kreitler, S. 1972. Psychology of the arts. Duke University Press, Durham NC

Krewinkel, HW. 1965. Psychologie der Farben von Avicenna bis lüscher. DLW-Narchrichten, 38, 5-7

Krivohlavy, J. 1967. Psychological effects of the light in the working environment. Zivotne prostredie (Czechoslovakia), I, 4/67

Krochmann, J. 1973. On the physical and psycho-physiological meaning of windows for the environment in interiors. In: International Congress on the Sun in the Service of Mankind. UNESCO House Paris, July. EH 55

Krochmann, J. 1974. Uber die Bedeutung des Tageslichts für den Menschen im Innenraum. Klima- und Kälteingenieur, 4, 71-76

Kruithof, AA. 1941. Röhrenlampen mit Leuchtstoffen für allgemeine Beleuchtungszwecke. Philips Teschniche Rundschau, 6(3), 65-73

Kugelmass, S. & Douchin, E. 1959-60. Color and emotional situations. Megamot, 10, 271-281

Küller, R. 1971. Rumsperception. Department of Theoretical and Applied Aesthetics. Lund Institute of Technology

Küller, R. 1973. A comment on T Porter's article: An investigation into colour preference, in Synthesis 2, 1973. Synthesis, Architectural Research Review, 3, July, 1-2, Oxford Polytechnic

Küller, R. 1980. Architecture and emotions. In: Mikellides, B. (ed). Architecture for people. Studio Vista, London, 87-100

Küller, R. (forthcoming). Subjective effects of office lighting (preliminary title). Environmental Psychology Unit. School of Architecture. Lund Institute of Technology

Lacey, J., Bateman, D. & van Lehn, R. 1952. Autonomic response specificity and Rorschach color responses. Psychosomatic Medicine, 14, 256-260

Ladd-Franklin, C. 1901. Color-introspection on the part of the Eskimo.Psychological Review, 8, 396-402

Lam, W. 1970. Discomfort glare or sparkle? A question of relevance. Abstracts of the CIE Study Group A Papers. Architectural Psychology(CIE Study Group A Conference, 1970. School of Architecture & Civic Design, Kingston Polytechnic

Larson. CT. 1965. The effect of windowless classrooms on elementary school children. Architectural Research Laboratory, Department of Architecture, University of Michigan, Ann Arbor

Lau, JJH. 1969. Subjective assessment of artificial lighting quality. PhD Thesis, University of Strathclyde, Glasgow

Lau, JJH. 1970. Differences between full size and scale-model rooms in the assessment of lighting quality. In: Canter, D. (ed). Architectural Psychology. RIBA Publishers, London, 43

Lazarus. RS. & Oldfield, M. 1955. Rorschach responses and the influence of color. Journal of Personality, 23, 356-372

Lee, SA., Hodgkiss, R. & Jennings, R. 1978. A study of the lighting of multipurpose sports halls: A case study of three sport halls (abstract). Architectural Psychology Newsletter, 8(1), 5-6, Kingston Polytechnic, Kingston upon Thames

Leijonhielm, C. 1967. Colours, forms and art. Studies in differential aesthetic psychology. Acta Universitatis Stockholmiensis. Stockholm Studies in Educational Psychology, 14. Almqvist & Wiksell, Stockholm

Lemaigre-Voreaux, P. 1979. Some links between lighting and psychology (in French). Lux No 104, 278-284

Levy, LH. & Kurz, RB. 1957. The connotative impact of color on the Rorschach and its relation to manifest anxiety. Journal of Personality, 25, 617-625

Lewinski, RJ. 1938. An investigation of individual responses to chromatic illumination. Journal of Psychology, 6, 155-160

Liedemit, F. 1966. Zur Problematik der Wirkung von Licht und Farbe auf den Menschen und ihrer Erfassung in psychophysischen Kenngrössen. Internationale Farbentagung. Interfarbe 66, Vortrag 2.4

Liljefors, A. 1971. Belysning i kontor. (Office lighting. Summary in English 40E). KBS Rapport Nr 40, Stockholm

Liljefors, A. & Sällström, P. 1979. Ljusfärg som belysningskvalitet. Förstudie. Statens Råd för Byggnadsforskning. R146, Stockholm

Lindberg, BJ. 1938. Experimental studies of colour and non-colour attitude in school children and adults. Acta Psychiat Supp 16. Levin & Munksgaard, Copenhagen

Lo, C. 1936. The affective value of color combinations. American Journal of Psychology, 48, 617-624

Loef, C. 1972. Fensterlose Bauten als menschlisches und technisches Problem. Industrie Eletrik und Elektronik, 17, Nr 22

Logan, HL. & Lange, AW. 1952. The evaluation of visual comfort data. Illuminating Engineering, 47(4), 195-205

Longmore, J. & Neeman, E. 1974. The availability of sunshine and human requirements for sunlight in buildings. Journal of Architectural Research, London 3/2, May

Lowson, JC., Dresler, A. & Holman, S. 1954. A pratical investigation on discomfort glare. Illuminating Engineering, 49(10), 497-500

Luckiesh, M. 1916. A note on color preference. American Journal of Psychology, 27, 251-255

Luckiesh, M. 1923. Light and color in advertising and merchandising. D van Nostrand, New York

Luckiesh, M. 1938. Color and colors. D van Nostrand, New York

Ludlow, AM. 1976. The function of windows in buildings. Lighting Research and Technology, 8(2), 57-68

Lundholm, H. 1918. Om färgers inverkan på medvetenhetstillståndet. Psyke, 13, 156-166

Lüscher, M. 1948. Lüscher-Test. Anleitung und Farbtafeln. Klinischer Test zur psychosomatischen Persönlichkeitsdiagnostik. Test-Verlag, Basel (also 1969)

Lüscher, M. 1961. Die Farbwahl als psychosomatischer Test. Dtsch Med Journal, 12(11), 406

Lynes, JA. 1968. Principles of natural lighting. Elsevier Publishing Company, Amsterdam, London, New York

Lynes, JA. 1974. The window as a communication channel. Light and Lighting, December

Löfberg, HA. 1969. Belysning i skolsalar (Classroom lighting. In Swedish with English summary). Statens Institut för Byggnadsforskning, 29, Stockholm

MacCambridge, SY. 1975. Efficacy of color combinations on perception of educationally handicapped and noneducationally handicapped children. Dissertation Abstracts International, 35(9A), 5972

Mackinney, G. & Little, AC. 1962. Color of food. AVI Publishing Company Inc, Westport, Connecticut

Markle, A. 1975. Color and form perception on the Rorschach as a function of eye color. Perceptual and Motor Skills, 41, 831-834

Markus, TA. 1965. The significance of sunshine and view for office workers. Paper given at CIE meeting on 'Sunlight' at Newcastle-upon-Tyne, 5-9 april

Markus, TA., Brierly, E. & Gray, A. 1972. Criteria of sunlight, daylight, visual privacy and view in housing. Building Performance Research Unit, University of Strathclyde, Glasgow

Marmor, GS. 1978. Age of onset of blindness and the development of the semantics of color names. Journal of Experimental Child Psychology, 25(2), 267-278

Marston, WM. 1927. Primary colors and primary emotions. Psyche, 30, 4-33

Marthin, P. 1976. Ljus, färg och funktion. Handbok i praktisk planering av arbetsmiljöer. LTs förlag, Stockholm

Martin, L. 1921. Die Gefühlsbetonungen von Farben und Farb-Kombinationen bei Kindern. Pädagog Magazin 831 (Philosoph und Psychol Arbeiten H2), Langensalza

McElroy, WA. 1953. Colour form attitudes: An analogue from music. Australian Journal of Psychology, 5(1), 10-16

Meaker, P. 1951. Discussion contributions to Taylor, GJ. Appraisal of modern fluorescent office lighting systems. Illuminating Engineering, 46(3), 140-162

Mercer, FM. 1925. Color preferences of 1.006 Negroes. Journal of Comp Psychology, 5, 109-146

Mercer, JC. 1971. On measuring the effect of a window. Architectural Research and Teaching, 2, 53

Metcalf, JT. 1927. The pleasantness of brightness combinations. American Journal of Psychology, 38, 607-623

Meyer, BT. 1951. An investigation of color shock in the Rorschach test. Journal of Clinical Psychology, 7, 367-370

Michaels, GM. 1924. Color preference according to age. American Journal of Psychology, 35, 79-87

Mills, E. 1967. Oriental colour. Building Materials, 26-27, 42

Milova, A. 1967. Light environment research in civil and lodging buildings. Zivotne prostredie (Czechoslovakia), I, 4/46

Minato, S. 1977. Color in industrial design. In: Color 77. The third congress of the international color association. Rensselaer Polytechnic Institute, Troy, New York, 10-15 July. Adam Hilger Ltd, Bristol, 199-207

Minor, A. 1909. Uber die Gefälligkeit der Sättigungsstufen der Farben. Zsch f Psychologie, 50, 433-444

Mizuguchi, F. & Aoki, S. 1926. Color preferences of adults. Japanese Journal of Psychology, 1, 22-23

Mogensen, MF. & English, HB. 1926. The apparent warmth of colors. American Journal of Psychology, 37, 427-428

Monroe, M. 1925. The apparent weight of color and related phenomena. American Journal of Psychology, 36, 192-206

Moon, P. & Spencer, DE. 1944. Aesthetic measure applied to color harmony. J Opt Soc Amer, 34, 234-242

Mori, N. & Kambe, N. 1965. Individual differences of colour rendering preferences for lighting the face. Acta Chromatica, 1, Oct, 181-186

Mori, N., Nayatani, Y., Tsujimoto, A., Ikeda, J. & Namba, S. 1967. An appriasal of two-color harmony by paired comparison method (Part 1). Acta Chrom, 1, 221-235

Mosse, EP: 1942. Color therapy. Occup Ther Rehabil, February

Murray, DC. & Deabler, HL. 1957. Colors and mood-tones. Journal of Applied Psychology, 41, 279-283

Murray, H. 1952. Colour in theory and practice, London

Neeman, E. 1974. Visual aspects of sunlight in buildings. Lighting Research and Technology, 6(3), 159-164

Neeman, E. 1974. Minimum window size in relation to contact with the outside. In: Daytime lighting of buildings. Report of an IES-Symposium. Lighting Research and Technology, 6(2)

Neeman, E. & Hopkinson, RG. 1970. Critical minimum acceptable window-size. Lighting Research and Technology, 2(1)

Nemcsics, A. 1965. Bestimmung von Farbenpräferenz-Indexwerten für farbige Raumgestaltung. Tag-Ber Intern Farbtagung Luzern, 957-964

Nemcsics, A. 1967. Das Farbenpräferenz-Indexzahlensystem im Dienste der farblichen Raumgestaltung. Diss Techn Univers, Budapest. (also in: Tudományos Közlemények (Budapest), 13, 21-161, 1967)

Nimeroff, I. 1971. Psychology of color. Amer Paint J, 55, 65

Normore, LF. 1974. Verbal responses to visual sequences varying in uncertainty level. In: Berlyne, DE. (ed). Studies in new experimental aesthetics. Steps toward an objective psychology of aesthetic appreciation. John Wiley & Sons, London, 109-119

Nowakowski, BA. 1962. The measurement of glare. American Journal of Hygiene, 6(1), 1-31

Obonai, T. & Matsouka, t. 1956. The color symbolism personality test. Journal of General Psychology, 55, 229-239

Ofner, M. 1934. The affective values of color combinations. Unpublished Master's Thesis, University of Chicago, Illinois

O'Reilly, PO., Holtzinger, R. & Blewett, D. 1957. The Pfister color pyramid test. J Nerv Ment Dis, 125, 385-387

Oyama, T., Tanaka, Y. & Chiba, Y. 1962. Affective dimensions of colors: A cross-cultural study. Jap Psychol Res, 4, 78-91

Parejo, M. 1956. Untersuchungen über die Psychologie der Farbe. Acta Med Tenerife, 6, 171

Parson, JH. 1910. Glare, its causes and effects. The Illuminating Engineer, 3, 98-130

Pasto, TA. & Kivisto, P. 1956. Group differences in color choice and color rejection. Journal of Clinical Psychology, 12, 379-381

Payne, MC. 1958. Apparent weight as a function of color. American Journal of Psychology, 71, 725-730

Peretti, PO. 1974. Color-mood association in young adults. Perceptual and Motor Skills, 39, 715-718

Peters, HN. 1943. Influence of set upon affective values of colors. Journal of Experimental Psychology, 33, 285-298

Petherbridge, P. & Hopkinson, RG. 1950. Discomfort glare and the lighting of buildings. Transactions of the Illuminating Engineering Society (UK), 15, 39-79

Pfister, M. 1950. Der Farbpyramidentest. Psychol Rundshau, 1, 192-194

Pfister, OH. 1934. Farbe und Bewegung in der Zeichnung Geisteskranken. Schweiz Arch Neurol Psychiat, 34, 325-365

Philip, BR. 1945. A method for investigating color preferences in fashions. Journal of Applied Psychology, 29, 208-214

Phillips, D. 1964. Lighting in architectural design. McGraw Hill Book Company, New York

Pickford, RW. 1971. Review article: The Lüscher colour test. Occupational Psychology, 45, 151-154

Pickford, RW. 1972. Psychology and visual aesthetics. Hutchinson Educational, London

Piebenga, HT. 1955. Frequenzverteilung der Farbwahlen bei 400 Friesen. Test-Verlag, Basel

Pinkerton, E. & Humphrey, NK. 1974. The apparent heaviness of colours. Nature, 250, 164-165

Plack, JJ. & Shick, J. 1976. Elementary school child's perception of weight as a function of color. Journal of the Association for the Study of Perception, 11(2), 16-20, 30

Podolsky, E. 1938. The doctor prescribes colors. National Library Press, New York

Poole, D. 1966. Colour in buildings. Building Materials, 26(7), 73

Porter, T. 1973. An investigation into colour preference. Synthesis. Architectural Research Review 2, April, Oxford Polytechnic, 1-4

Porter, T. 1973. A reply to Rikard Küller's article. Synthesis. Architectural Research Review 3, July. Oxford Polytechnic. 3-4

Prajecus, WG. 1967. Preliminary report on a new approach to color acceptance studies. Trans Illum Eng Soc, 62(2), 663-672

Preiswerk, F. 1956. Analyse und Förderung der Intelligenzleistung auf Grund des Lüscher-Tests. Der Psychologie, 471

Prescott, BD. 1942. Psychological analysis of light and color. Occupational Therapy and Rehabilitation, 21, 135-146

Priest, IG. 1927. Note on the relative comfort in reading by artificial daylight and unmodified gas-filled tungsten lamps. J Opt Soc Amer and Rev Sci Instrum, 15, 131

Prill, JH. & Oppelt, C. 1962. Die prognostische Beurteilung des Geburtsverhaltens durch den Lüscher-Test. Dissertation. University Clinic for Women, Würzburg

Rahn. RC. 1976. Lüscher color theory: Civilians and criminals. Art Psychotherapy, 3(3-4), 145-155

Rakshit, DP. 1946. Color preferences of extroverted and introverted individuals. Indian Journal of Psychology, 21, 89-92

Ramkumar, V. & Bennett, CA. 1979. How big is dark? In: Bensel, CK. (ed). Compass for Technology. Proceedings of the 23rd Annual Meeting of the Human Factors Society, Boston Massachusetts, October 29 - November 1, 116-118

Range, HD. 1971. Bevorzugte Beleuchtungsniveaus im Freien. Lichttechnik, 23, 356-359

Ratleff, A. 1958. Form, farve og emotioner. Nyt Nordisk Forlag, Arnold Busch, Köpenhamn

Reger, JA. 1968. Feeling states evoked by colored lighting. School of Health, Physical Education, and Recreation, University of Oregon

Reid, KM. & Toenjes, DA. 1951. Appraisal of discomfort glare on lighted streets. Illuminating Engineering, 46(9), 470-471

Renninger, CA. & Williams, JE. 1966. Black-white color connotations and racial awareness in preschool children. Perceptual and Motor Skills, 22, 771-785

Richter, CP. 1977. Discovery of fire by man - its effects on his 24-hour clock and intellectual and cultural evolution. John Hopkins Medical Journal, 141(2), 47-61

Ries, W. 1959. Das Altern in farbpsychologischer Sicth. Psycho-Experimentelle Untersuchungen mit dem Lüscher-Test. Zeitschrift für Alternsforschung, 13, 237

Risler, J. 1927. L'influence psychologique de la lumière. Cour Mèd, 77, 40-42

Ritchie, JC. 1978. An investigation concerning color preferences of selected primary, elementary and secondary students for a rural and urban area. Diss Abst Internat, 38(9-A), 5176

Ritter, E. 1930. Die teilinhaltliche Beachtung von Form und Farbe bei Jugendlichen in ihrer Beziehung zur strukturpsychologischen Typenlehre. Zeitschrift für Psychologie, 117, 307-338

Robinson, C. 1975. Color preference as a function of introversion and extraversion. Perceptual and Motor Skills, 140, 720

Roedler, F. 1970. Arbeiten aus dem Bundesgesundheitsamt zur Problematik fensterloser Räume. Bundesgesundheitsblatt, 13, 269-276

Roessler, G. 1976. Fenster als visuelle Verbindung zwischen Räumen mit ständiger Tageslicht-Ergäzungsbeleuchtung und der Aussen-Welt. Lichttechnik, 28, 451

Roessler, G. 1976. Fenster als visuelle Verbindung zwischen Räumen mit ständiger Tageslicht-Ergäzungsbeleuchtung und der Aussen-Welt. II. Lichttechnik, 28, 490

Roessler, G. 1980. The psychological function of windows for the visual communication between the interior of rooms with permanent supplementary artificial lighting and the exterior. Lighting Research and Technology, 12(3), 160-168

Rogers, ME. 1950. A study of color preferences. Unpublished Master's Thesis, Purdue University

Roi, AG. 1969. Light, colour and materials. Building Materials, 29(7), 34-38

Rowlands, E. 1959. Discomfort glare in interior lighting installations - comparison of appraisal and calculated values. Light and Lighting, 52(3), 102-107

Ruys, T. 1979. Windowless offices. Unpublished Master's Thesis, University of Washington

Saffre, E. 1959. Le dynamisme psychologiue des couleurs. Couleurs, No 32-33, 4e trimestre, 136

Sammer, F. 1966. Relativität der psychologischen Bewertung der Farbe. Internationale Farbentagung, Interfarbe 66. Vortrag 3.3

Sampson, FK. & Jones, BF. 1972. Prediction, evaluation and specification of visual comfort and performance in classrooms. Journal of the Illuminating Engineering Society, 1, 153-165

Sander, GG. 1926. Color in health and disease. CW Daniel, London

Sanders, CL. 1959. Color preferences for natural objects. Illuminating Engineering (New York), 54, 452-456

Sarason, SB. & Potter, EH. 1947. Color in the Rorschach and Kochs block design. J Consult Psychol, 11, 202-206

Saunders, JE. 1969. The role of the level and diversity of horizontal illumination in an appriasal of a simple office task. Lighting Research and Technology, 1(1), 37-46

Savidge, R. & de Marē, E. 1967. Functional colour. Building Materials, 26-27, July, 63-68

Schachtel, EG. 1943. On color and affect: Contributions to an understanding of Rorschach's test. II. Psychiatry, 6, 393-409

Schaie, KW. 1962. The performance of mentally defective children on the Color Pyramid Test. Journal of Projective Techniques, 26, 447-454

Schaie, KW. 1963. The color pyramid test: A non-verbal technique for personality assessment. Psychological Bulletin, 60, 530-547

Schaie, KW. 1965. Developmental changes in response differentiation on a color-arrangement task. J Consult and Clin Psychology, 32(2), 233-235

Schaie, KW. & Heiss, R. 1964. Color and personality. A manual for the color pyramid test. Hans Huber, Bern, Stuttgart

Schiffenbauer, AI., Brown, JE., Perry, PL., Shulack, LK. & Zanzola, AM. 1977. The relationship between density and crowding. Some architectural modifiers. Environment and Behavior, 9(1), 3-14

Schmidt, HG. 1967. Der Lüscher-Farbtest zur Diagnose der vegetativen Störungen. Die Terapiewoche, 17, 642

Schneider, JA. 1964. Farbwahl, Krankheit und vegetative Störung. Med Klin, 59(37), 1460

Schneider, L. 1959. Die Einwirkung des Lichtes auf die Stimmung des Menschen. Ein Beitrag zur Behaglichkeit der Beleuchtung. Lichttechnik, 11 Heft 5, 263-267 & Heft 6, 312, 314-319

Seidl, M. 1978. Ausreichendes Tageslicht und akzeptable Fenster-Abmessungen in Wohnräumen. Dissertation, Technische Universität, Berlin

Shapiro, D. 1956. Color reponses and perceptual passivity. Journal of Projective Techniques, 20, 52-69

Sharpe, DT. 1974. The psychology of color and design. Nelson-Hall, Chicago

Shen, NC, 1937. Color preferences of 1.368 Chinese students with special reference to the most preferred color. Journal of Social Psychology, 8, 185-204

Sheppard, JJ. 1968. Human color perception. A critical study of the experimental foundation. Elsevier, New York, London, Amsterdam

Shikiba, T. 1927. Color preferences of deranged persons and delinquent boys. Japanese Journal of Psychology, 2, 677-700

Siedow, H. 1958. Untersuchungen mit dem Farbpyramidentest an Psychopathischen Persönlichkeiten. Zeitschrift f Diagnost Psychol, 6, 18-38

Siipola, EM. 1950. The influence of color on reactions to ink blots. Journal of Personality, 18, 358-382

Siipola, E., Kuhns, F. & Taylor, V. 1950. Measurement of the individual's reactions to color in inkblots. Journal of Personality, 19, 153-171

Simon, WE. 1971. Number and color response of some college students: Preliminary evidence for a 'blue seven' phenomenon. Perceptual and Motor Skills, 33, 373-374

Sivik, L. 1970. Om färgers betydelser. Perceptiva färgdimensioner relaterade till associativa betydelsevariabler (with English summary: Colour connotations and perceptive variables) Svenskt Färgcentrum, Fackskrift Nr 9. Stockholm

Sivik, L. 1973. General and applied research on colour perception - A review of current Swedish projects. In: Küller, R. (ed). Architectural Psychology. Proceedings of the Lund Conference. Studnetlitteratur, Lund and Dowden, Hutchinson & Ross, Stroudsburg, 23-34

Sivik, L. 1974. Studies of color meaning. Göteborg Psychological Reports, 4(14), University of Göteborg, Sweden

Sivik, L. 1974. On the meaning of colours in general and on buildings. Synthesis. Architectural Research Review 4, Oxford Polytechnic, 1-6

Slatter, PE. & Whitfield, TW. 1977. Room function and appropriateness judgements of color. Perceptual and Motor Skills, 45(3), 1068-1070

Spears, WC. 1966. Visual preference in the four-month-old infant. Psychonomic Science, 4, 237-238

Spencer, DE. 1954. Comparative analysis of 'comfort' and 'glare'. Illuminating Engineering, 49(1), 39-49

Spiegel, D. & Acker, CW. 1960. The Brentwood Color Test, Authors, Los Angeles

Spiegel, D. & Keith-Spiegel, P. 1971. Manifest anxiety, color preferences and sensory minimizing in college men and women. Journal of Clinical Psychology, 27, 318-321

Spillman, W. 1977. Farbgestaltung des Primarschulgebaudes Killwangen Ch. In: Color 77. The third congress of the international colour association. Rensselaer Polytechnic Institute, Troy, New York, 10-15 July 1977. Adam Hilger Ltd. Bristol, 384-387

Staples. R. 1931. Color vision and color preferences in infancy and childhood. Psychological Bulletin, 28, 297-308

Staples, R. 1932. The responses of infants to colors. Journal of Experimental Psychology, 15, 119-141

Staples, R. & Walton. WE. 1933. A study of pleasurable experience as a factor in color preference. J Genet Psychol, 43, 217-233

Steen, P. 1969. Experiments with estimation of perceptive qualitative color attributes. Proc Ist AIC Congr Color 69. Musterschmidt, Göttingen

Stefanescu-Goanga, F. 1911. Experimentelle untersuchungen zur Gefühlsbetonung der Farben. Psychologische Studien, 7, 284-335

Stensman, M. 1971. Väggmålning och färgsättning av en fabriksmiljö. En undersökning. Institutionen för konstvetenskap, Lunds Universitet

Stern, E. 1955. Der Farbpyramidentest von Pfister-Heiss. In: Stern, E. (ed). Die Tests in der klinischen Psychologie. Rascher Verlag. Zürich, 462-485

Stewart, RL. 1961. An experimental art performance task to determine the effect of color upon the overall aesthetic quality of three-dimensional forms. Doctoral Dissertation, Pennsylvania State Universtiy

Stewart, R. & Baxter, J. 1969. Color preferences of three ethnic groups of elementary school children. In: Jakob, I. (ed). Art interpretation and art therapy. Psychiatry and Art, Vol 2, 186-190 (Karger, Basel/New York)

St George, MW. 1938. Color preferences of college students with reference to chromatic pull, learning and association. American Journal of Psychology, 51, 714-716

Stone, PT. & Groves, SDP. 1968. Discomfort glare and visual performance. Transactions of the Illuminating Engineering Society (UK), 33(1), 2-8

Stone, PT. & Harker, SDP. 1973. Indivudual and group differences in discomfort glare responses. Lighting Research and Technology, 5(1), 41-49

Stone, PT., Harker, SDP., Coley, WZ., Ruff, HR. & Jones, G. 1974. Subjective responses to high intensity room illuminances. In: Stone, PT. et al. Human reactions to high intensity lighting. LUTERG Report No 156, Section 5, 183-262 Department of Human Sciences, Loughborough

Stone, PT., Parsons, KC. & Harker, SDP. 1975. Subjective judgements of lighting in lecture rooms. Lighting Research and Technology, 7(4), 259-261

Strenski, A., Payson, JM., Muzekari, LH. & Bohr, RH. 1970. Preferences and dislikes for color among cronic schrizofrenics. Journal of Clinical Psychology, 26, 310-311

Styne, AF. 1979. Lighting and colour in architectural space. IES Lighting Review, 41(6), 142-144

Styne, AF. & Klesh, SA. 1978. Recent innovations in design and lighting of health care facilities. University of Miami

Subin, LF. 1979. Die Rolle der Farbe im Porduktionsmileu von Industriegebäuden. Wiss Zeitschr Hochsch Leipz. 3(4), 193-196

Switras, JE. 1977. A color image hierarchy. Perceptual and Motor Skills, 45(3), 1337-1338

Söllner, G. 1965. Ein einfaches System zur Blendungsbewertung. Lichttechnik, 17, 59-66

Tatibana, Y. 1937. Color feelings of the Japanese. I. The inherent emotional effects of colors. Tohoku Psychol Fol, 5, 21-46

Taylor, CD. 1930. Visual perception versus visual plus kinaesthetic perception in judging coloured weights. J Gen Psychology, 4, 229-246

Terwilliger, RR. 1963. Pattern complexity and affective arousal. Perceptual and Motor Skills, 17, 387-395

Thomaschewski, E. 1935. Die Farbe in der experimentellen Charakterforschung. Z Jugendk, 5, 50-53

Thornton, WA. 1977. Characterizing prime-colour illuminants. In: Color 77. Proceedings of the third congress of the international colour association. Rensselaer Polytechnic Institute, Troy, New York, 10-15 July 1977, Adam Hilger, Bristol, 412-414

Tikkanen, KT, 1974. Significance of windows in classrooms. Evaluation of built-in environments by a comparative method Statens Råd för Byggnadsforskning, Stockholm (unpublished report, summary in Swedish and in English 1976)

Tinker, MA. 1941. Effect of visual adaptation upon intensity of light preferred for reading. University of Minnesota, 559-563

Todd, GA. 1973. Perceptual factors in color-affect arousal. Journal of Personality Assessment, 37, 225-234

Togrol, B. 1961. An experimental study of color-harmony. Istanbul Universitesi Tecrübi Psikoloji Calismalari Cilt 3, 49-80

Togrol, B. 1969. An experimental study of two-colour combinations. Istanbul Universitesi Tecrübi Psykoloji, Calismalari Cilt 7, 11-24

Trevor-Roper, P. 1970. The psychopathology of color. Trans Opthalmologists Society United Kingdom, 89, 251-257

Valentine, CW. 1914. The colour perception and colour preference of an infant during its fourth and eight months. British Journal of Psychology, 6, 363-386

van de Castle, RL. & Spicher, RS. 1964. A semantic differential investigation of color on the Holtzman. Journal of Projective Techniques, 28, 491-498

Van Ierland, J. 1965. Field investigations into desired quality and illumination level. Elektrotechnik 43(18), 409 (Holland)

Verity, E. 1967. Colour. Leslie Frewin, London

Verity, E. 1980. Colour observed. Macmillan, London

Vitz, PC. 1966. Preference for different amounts of visual complexity. Behavioral Science, 11, 105-114

von Allesch, GJ. 1925. Die ästhetische Erscheinungsweise der Farben. Psychologische Forschung, 6, 1-91, 215-281 (Berlin)

Voronetz, LA. 1967. Dependence of artificial interior lighting on its appearance. Svetoteknika, No 2 (USSR)

Wake, T. et al. 1977. The effects of illuminance, colour temperature and colur rendering index of light sources upon comfortable visual environments - in the case of offices. Journal of Light and the Visual Environment, 1(2), 31-39

Waldram, JM. 1954. Studies in interior lighting. Transactions of the Illuminating Engineering Society (UK), 19, 95

Waldram, JM. 1971. A note on the evaluation of modelling. Lighting Research and Technology, 3, 284-285

Wallnöfer, H. 1966. Der Lüscher-Farbtest zur Diagnose des vegetativen Verhaltens. Ärztliche Praxis, 18(70), 2348

Walton, WE., Guilford, RB. & Guilford, JP. 1933. Color preferences of 1279 university students. American Journal of Psychology, 45, 322-328

Walton, WE. & Morrison, BM. 1931. A preliminary study of the affective value of colored lights. Journal of Applied Psychology, 15, 294-303

Warden, CJ. & Flynn, EL. 1926. The effect of color on apparent size and weight. American Journal of Psychology, 37, 398-401

Warner, SJ. 1949. The color preference of psychiatric groups. Psychol Monogr, 63(6) (Whole No 301)

Washburn, MF. 1911. A note on the affective value of colors. American Journal of Psychology, 22, 114-115

Washburn, MF., MacDonald, MT. & Van Alstyne, D. 1922. Voluntarily controlled likes and dislikes of color combinations. American Journal of Psychology, 33, 426-428

Washburn, MF., McLean, KG. & Dodge, A. 1934. The effect of area on the pleasantness of colors. American Journal of Psychology, 46, 638-640

Wells, BWP. 1964. A psychological study with office design implications. Architects' Journal, 140, 877

Wells, BWP. 1965. Subjective responses to the lighting installation in a modern office building and their design implications. Building Science, 1, 57-68

Wells, NA. 1910. A description of the affective character of the colors of the spectrum. Psychological Bullein, 7, 181-195

Wellwood Ferguson, WJ. 1964. Hospital lighting: General and medical aspects. Transactions of the Illuminating Engineering Society, 29(4), 105-112

Whitfield, TWA. 1978. A categorization approach to environmental design with special reference to colour. Doctorial Thesis, Building Science, University of Newcastle-upon-Tyne

Whitfield, TWA. & Wiltshire, TJ. 1977. The influence of contextual variables on colour selection for buildings. In: Color 77. The third congress of the international colour association. Rensselaer Polytechnic Institute, Troy, New York, 10-15 July. Adam Hilger, Bristol, 391-393

Williams, JE. 1964. Connotations of color names among Negroes and Caucasians. Perceptual and Motor Skills, 18, 721-731

Williams, JE. 1966. Connotations of racial concepts and color names. Journal of Personality and Social Psychology, 3, 531-540

Williams, JE. & Carter, DJ. 1967. Connotations of racial concepts and color names in Germany. Journal of Social Psychology, 72, 19-26

Williams, JE. & McMurtry, CA. 1970. Color connotations among Caucasian seventh graders and college students. Perceptual and Motor Skills, 30, 707-713

Wilson, G. & Danco, J. 1976. Color preference in the Gibbon. Perceptual and Motor Skills, 43, 155-158

Wilson, RF. 1960. Colour in industry today. George Allen and Unwin, London

Winch, WH. 1909. Colour preferences of school children. British Journal of Psychology, 3, 42-65

Wineman, J. 1978. Building evaluation research: Lighting evaluation. Applied Environmental Research, Division of Smith, Hinchman & Grylls, Ann Arbor, Michigan

Woods, W. 1956. A polychrome index of social maturity. Paper read at the Chicago Meeting of the American Psychological Association, September 4, 1956

Woods, WA. 1956. Some determinants of attitudes towards color in combination. Perceptual and Motor Skills, 6, 187-193

Wotton, E. (forthcoming). Office windows and employee wellbeing. Light, Health and Design Conference, May 20-22, 1981, Ottawa, Ontario

Wright, WD. 1958. The measurement of color. The MacMillan Company, New York (also; 1969. Van Nostrand, New York)

Wöien, P. 1966. Kunstig belysning i Oslo-skolene. Liv og Helse, Nr 10, December, 219-222

Yamagishi, M. & Mori, Y. 1977. Colors of the historical city of Kanazawa, Japan. In: Color 77. The third congress of the international colour association. Rensselaer Polytechnic Institute, Troy, New York, 10-15 July. Adam Hilger, Bristol, 377-382

Yond, EW. & Armington, J. 1975. Color and brightness contrast effects as a function of spatial variables. Vision Research, 15, 917-929

Zgraggen, H. 1967. Der Lüscher-Test bei milieugestörten Kindern. Disseration at the Institute for Abnormal Children, Freiburg University, Switzerland

Zimmermann, W. 1965. Abstimmung von Farben und Beleuchtung im Operationssaal. Tag-Ber Intern Farbtagung Luzern. Bd 2, 933-944 (also in: 1967. Farbe 16, 157-168)

Zollinger, H. 1973. A correlation between linguistics of colour naming and colour perception. In: Colour 73. Second congress of the international colour association, University of York, 2-6 July 73, Adam Hilger, London, 389-391

Anonymous. 1956. Color in school buildings. Ministry of Eudcation Building Bulletin No 9, HMSO

———— 1960. Street lighting and accidents. Technical Report No 8. Commission Internationale de l'Eclairage. Bureau Central de la CIE, Paris

———— . 1965. Färgboken. Färglära för praktiskt bruk. Svenska Slöjdföreningen. Raben och Sjögren, Stockholm

———— 1965. The effect of window-less classrooms on elementary school children. University of Michigan Architectural Research Laboratory. Department of Architecture. Michigan

———— 1979. Farben für Kinder. Kinderzimmer gestalten - aber richtig! Dt Malerbl 50(10), 908-912

———— (undated). Environmental colour. Subject bibliography. Ergonomics Information Analysis Centre

———— (undated). Windowless buildings. Subject bibliography. Ergonomics Information Analysis Centre

CONCLUSION

Theoretical considerations

Light will influence man along various routes and on many different functional levels. We must realize at least five major functional systems and several minor ones. Two of the major systems act through radiation of the skin, while the other three act through light entering the eye.

There are several processes going on in the human skin, which are dependent on the photo-chemical effects of ultraviolet radiation, one being the synthesis of calciferol or vitamin D. Vitamin D promotes the metabolism of calcium and phosphorus in the body. A deficiency might result in dental caries and rickets in small children, and in aged people in brittle or easily broken bones. An overdose of ultraviolet radiation on the other hand may cause reddening of the skin (erythema) and in sensitive persons lacking in protective pigmentation give rise to a variety of photo-allergies or even skin cancers.

Interesting from our point of view is the fact that ultraviolet radiation also might have effects of a general physiological nature, including a lowering of the pulse rate, a fall in blood pressure, changes in general metabolic rate, in reaction time, and in general activity, as well as an improvement of health conditions and resistance to certain kinds of infection. Thus, we can be quite confident that light has a general physiological effect on man cuased by ultraviolet radiation of the skin. As far as is known today, vitamin D is the most likely mediator.

Light also contains infrared energy which penetrates deeply into the skin and muscles resulting in an increased circulation of the blood. When the surrounding temperature is above that of the body, heat will be taken up by radiation. The primary action of infrared radiation on the skin is that of heating, generally leading to a vasodilation of cutaneous blood vessels. This in turn gives rise to a number of other reactions. Man has learnt to a certain extent to regulate the temperature of his environment to fit his needs. Should the body temperature however become excessively high or low, the organism becomes alerted and tries to restore the balance. It is also a well established fact that body temperature will influence physical as well as mental performance on a wide range of activities.

Thus, infrared radiation of the human skin serves as a regulator that will influence the general activity level of the organism. This regulation is partly autonomic but also depends on sensors in the skin for cold, heat and pain. The hypothalamus is the primary centre for regulation of body temperature and general body metabolism. Therefore, any description of the impact of light on man must consider the infrared-radiation / hypothalamus system.

Perhaps the most conspicious relationship between light and man is the diurnal rhythm, relating the light and dark cycle of day and night to complex physiological and biochemical variations of wakefulness and sleep. The amount of light entering the eye as well as its spectral composition have been demonstrated to influence food an water consumption, body temperature, hormone secretion, ovulation and a variety of other basic functions.

It seems that the synthesis of melatonin in the pineal gland holds a central position in mediating the effects of occular light. Thus, we may safely conclude that light entering the eye controls or affects many of the highly complex endocrine and autonomic processes taking place in the human body.

Every impulse which via afferent nerves reaches the central nervous system's higher centres also activates part of the brain stem, the reticular formation. In addition to activation there might be inhibition and together they will determine the arousal level of the nervous system including the cortex. The reticular system can be divided into two functionally separate units, of which one is the ascending reticular activation system, ARAS.

Visual factors bound to influence the ARAS include the wavelength and intensity of light and also contrast, glare and flicker. In order to understand this process, we might think of light as a complex set of signals. The ARAS of man will react to many light signals with responses established in the biological heritage over the millennia. These reactions will be similar from one individual to the other and they are highly resistant to change.

Whereas many kinds of variation in the visual field will have an affect on the ARAS, it is important to realize that light is only part of the total stimulation constantly impinging upon man. The ARAS might be regarded as a clearing station for all kinds of stimulation ranging from sensory deprivation at one extreme to sensory overload at the other. Therefore, light must always be considered together with the other sources of stimulation at hand.

Whenever we consider light as part of the visual field, there is always a context and a content. Thus, light will be the carrier of all kinds of visual information, some of which might be far more important at the moment than the quality of light itself. A great part of this information will be highly complex and must therefore be analyzed on the cortical level in order to be properly dealt with. This will involve the highest of all the non-visual systems, the descending reticular activation system, DRAS.

It is now well established that reticular activation occurs not only by means of external stimulation but also through impulses coming from the highest nervous centres, descending from the cortex on the reticular formation. The consequence of this process is to place the cognitive meachnisms in charge of arousal regulation. Thus, light might either influence the arousal level via the ARAS, already before the signals have reached the cortex, or via the DRAS, after the cortex has had the time to make a more elaborate analysis.

In order to separate these two systems it might be useful to distinguish between 'light as signal' and 'light as symbol'. While the ARAS seems concerned mainly with light as signal, the DRAS concerns itself with 'light as symbol'. Unlike the other functional systems, the DRAS depends on cognitive mechanisms, including thinking on the conscious level.

In conclusion, the synthesis of vitamin D in response to ultraviolet radiation of the skin is likely to have a general physiological effect on the organism, and might also influence the individual's health status. Infrared radiation will influence the metabolic state of the organism by means of the hypothalamic function of heat regulation. Light reaching the eye will affect the endocrine and nervous systems of the entire organism. Together, these processes will set the stage for the reticular activation system by which means the visual world may be decoded in terms of signals, ascending from the environment via the ARAS, or symbols, descending from the cortex via the DRAS.

Impediments to progress

For an overview of the various effects consider table 1. Some of the listed effects are related to the biochemistry or physiology, while others may be referred to as psychological. Obviously, it is difficult to integrate these various effects into one general theoretical framework. Let me mention some of the stumbling-blocks that prevent the construction of a model of a more general kind.

Table 1. Some non-visual effects on man of different kinds of radiation.

Radiation	Notation	Wavelength nm*	Effects on man
Ultraviolet	UV-C	100-280	Actinic effects on skin, Erythema, Production of vitamin-D, General physiological effects
	UV-B	280-315	
	UV-A	315-(400)	
Visual	Violet	380-436	Entrainment of circadian rhythms, Activation of pineal organ, Endocrine and autonomic effect, Influence on nervous arousal through reticular activation, Effect on performance and fatigue, Cognitive, emotional and behavioural correlates, Dermo-optic perception?
	Blue	436-495	
	Green	495-566	
	Yellow	566-589	
	Orange	589-627	
	Red	627-780	
Infrared	IR-A	780-1400	Heating effect on skin, Vasodilation, Influence on body temperature and metabolism, Effects on behaviour, Sensations of cold, heat and pain
	IR-B	1400-3000	
	IR-C	3000-1.000.000**	

* nanometer = 10^{-9} meter

** 10^{6} nm = 1 millimeter

Light is radiation and also perception. This somewhat unfortunate diversity might be traced as far back as 1810, when Goethe, in opposition to Newton's model of light, produced another very different model. As a consequence we are left with two different languages of light, one physical and one perceptual, and this confusion is mirrored in almost every single piece of scientific work on the subject.

We would be fortunate, however, if it was only a question of languages, because then, one might easily be translated into the other. Instead, the use of two languages has lead many students of light to believe that the physical language can only be used 'out there', in front of the eyes, and the perceptual language 'in there', behind the eyes. Naturally, this is pure nonsense. We are entitled to use a physical model to describe what is going on in the brain with the same right that we might use a perceptual model to describe the world around us.

A second stumbling-block is the scientist's blindness to anything but his own master hypothesis. Light affects man in a variety of ways, thereby employing different functional systems; any fair overview of the field will tell us that. The ultraviolet and infrared radiation of the skin might, for instance, interact

on the cellular level. The hypothalamus plays an important part in heat regulation as well as in occular light perception.

Still, most scientists pay homage to one single master hypothesis, claiming that the functional system they are devoted to, is by far the most important. An experimental result might by one author be explained in terms of ultraviolet radiation while another author will explain the same result in terms of occular perception. The outcome of this one-eyedness is twofold. Other hypotheses are likely to be completely disregarded and man is degraded into a mono-system, a simple mechanic monstrosity. In most experimental designs the possibility of interaction between the different functional systems is not controlled for or even realized. Any model of man-environment interaction that sets out to be general must give a description of man in terms of numerous functional systems, some of them seemingly related, others not.

Finally, the third stumbling-block concerns the description of light in relation to all the other characteristics of the human environment. Light, colour and visual patterns belong in a very concrete way to the daily environment of man, being either at the centre of attention or constituting the visual background. However, these factors are constantly interacting with the others, like sound and noise, temperature and humidity, air pollution etc. Allegedly, in some cases the effect of light itself is bound to be rather specific, but in most cases the situation is much more complicated, involving specific and general effects as well as interactions. Still most researchers as well as practitioners treat their data by means of simplistic formulas reminiscent of the psycho-physical laboratory a hundred years ago. To aggravate the matter further, light is usually regarded as a natural force, not only out of context but completely lacking in content, and man is made into a passive receiver, not wanting, or being able to do anything whatsoever about his own lighting situation.

The application gap

Today, a large proportion of the earth's population spends most of its lifetime screened off from daylight by glass filters under the influence of substitutes providing an artificial radiation. The illumination in a normally lighted room is less than 10% of the outdoor light under the shade of a tree on a sunny day. The spectral as well as the spatial distribution is radically different, and the natural diurnal and seasonal variations are more or less obviated.

We are using more light during a longer period of the 24 hour cycle. In the morning, we switch on the lights, at least in the winter, and travel to work on an illuminated road or subway. We use additional light not only in the office or factory space, but also for the specific task at hand. In the

afternoon, we switch on more light as soon as it begins to get dark outside. We then travel home from work, or go shopping in the highly illuminated urban space, ending up in front of the flickering rectangle of the television set. Finally, we might spend an additional hour in bed reading in the light of the night lamp. By shiftwork, some of us are even turned into nocturnal animals for lengthy periods of time. Thus, the lighting situation is very different from how it was only a hundred years ago. Perhaps the time has come when we should ask ourselves not whether there is enough light but, whether there is, at times, too much light.

During the course of this work it has become evident there is an enormous amount of facts and results that is almost never considered in practice and education. Thus, one finds a gap between research on one hand and practice on the other, the infamous application gap. In spite of the uncertainty that concerns theoretical issues it is now realized that light and colour are important factors in the human environment.

When planning, there is good reason to consider not only the total amount of light, but also its distribution during the 24 hours of day and night, and its spectral composition including the amount of infrared and ultraviolet radiation. New types of lamps are appearing at an increasing pace, many of them of an extremely high intensity, some with a spectral content that has very little to do with daylight and solar radiation. Some of these lamps are used for specific purposes supervised by specialists, others, however, are regularly used in our work places, schools and other everyday environments.

The fact that all existing artificial light sources differ considerably from natural daylight raises the question whether in the long run, such light sources might cause actual damage to man. By using artificial light which is more dominated by long wavelengths than daylight, the pineal balance might become disturbed. Glare and flicker, and the use of strong colours and patterns, might affect the arousal level of the nervous system. There is little doubt, artificial light might cause stress-like reactions, if it is intense, if the spectrum considerably deviates from that of natural daylight, or if it is flickering and glaring.

There exist certain groups of people who, especially during the winter season, run the risk of being exposed to low quality illumination during a large part of the day. These are persons, tied to one working place during long shifts, without the possibility to stay outdoors during the light hours of the day. These are persons, at the same time exposed to other stress factors. These groups should be made aware of the possible effects on their health and well-being as a result of bad illumination and generally poor visual environments. Examples of such effects might be general tiredness, headaches, vision trouble, difficulty to sleep, tenderness of neck and shoulders,

anxiety and restlessness, decrease in performance, and decreased resistance, amongst others, to infection of the respiratory passages.

Unfortunately, there exists very little research on the long term effects of light and colour. Being far from unanimous, the results at present do not seem to warrant any firm conclusions regarding which kind of illumination is the most preferable from the non-visual perspective. Until the everyday effects of light pollution are better understood, we should, however, be more careful about using all kinds of artificial light sources as freely as we do.

The present bibliography may be regarded as an attempt to widen the outlook on the importance of light and colour for man, by listing some of the main functional systems of influence. Including lengthy summaries as well as critical comments of many of the studies has made it possible to establish at least some facts which might be used directly in the design process. The lists of references might also be helpful to those who want to weigh the evidence for themselves. I have indicated some areas I see in urgent demand of further research. By discussing light and colour in relation to other aspects of the environment, it is hoped the impact on man will be neither underestimated nor unduly valued.