EFFECT OF ENVIRONMENTAL LIGHTING ON IMPRESSION AND BEHAVIOR

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Abstract

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 arrangements. 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.

Premise

The overall purpose of this study[1] was simultaneous development of theories of the effect of environmental lighting on impressions and behavior of the participant in a 'behavior setting'[2,3] (as shown in Figure 1), and the methods of evaluating these theories.

The premise of this research begins with recognition of the fact that visual consciousness does not seem completely explainable with the simple notion of an optical image imposed on the retina of the eye and photographically interpreted by the brain. Instead, there are indications that there is considerable selectivity in the process of visual experience --- a search for meaningful information. This suggests that light can be discussed as a vehicle that facilitates the selective process and alters the information content of the visual field. It appears that lighting should be evaluated for its role in adequately establishing cues that facilitate or alter the user's understanding of his environment and the activities around him.

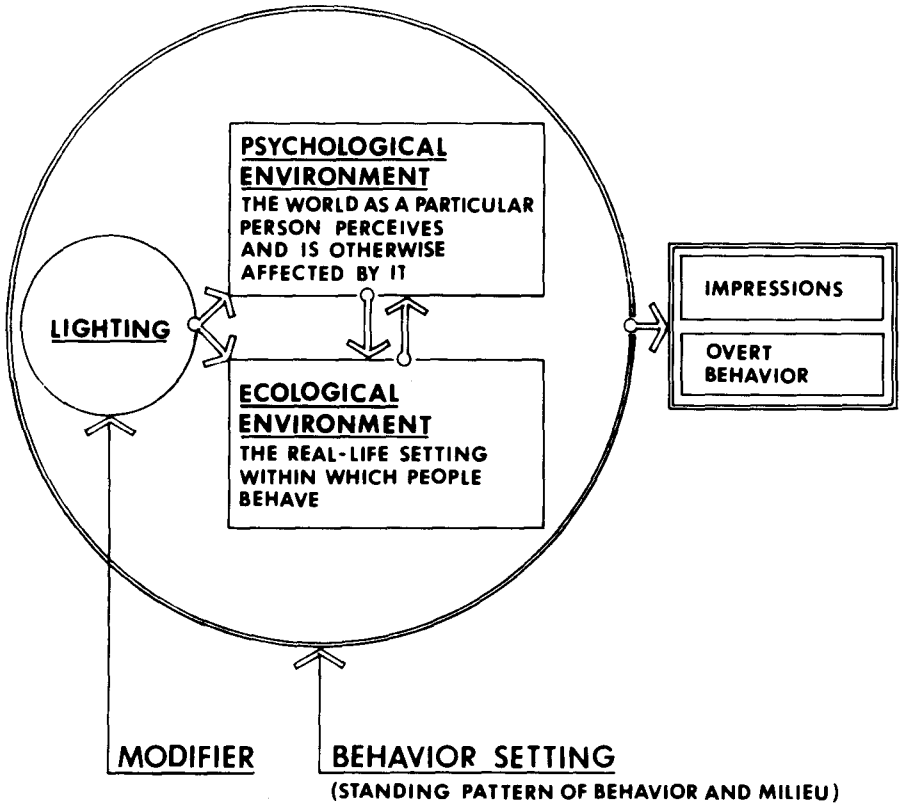


FIGURE 1. Behavior Setting

Concern

This research focuses on two aspects of concern: (1) does environmental lighting have effects on human behavior, and (2) can such effects be measured, and what kind of scientific techniques can be utilized in evaluation.

Study

The tests which were designed, supervised and evaluated by the Kent State University team, were conducted at the General Electric 'Lighting Institute', Nela Park, Cleveland. Description of setting, lighting arrangements, subjects, and methods of evaluation are shown in Figure 2.

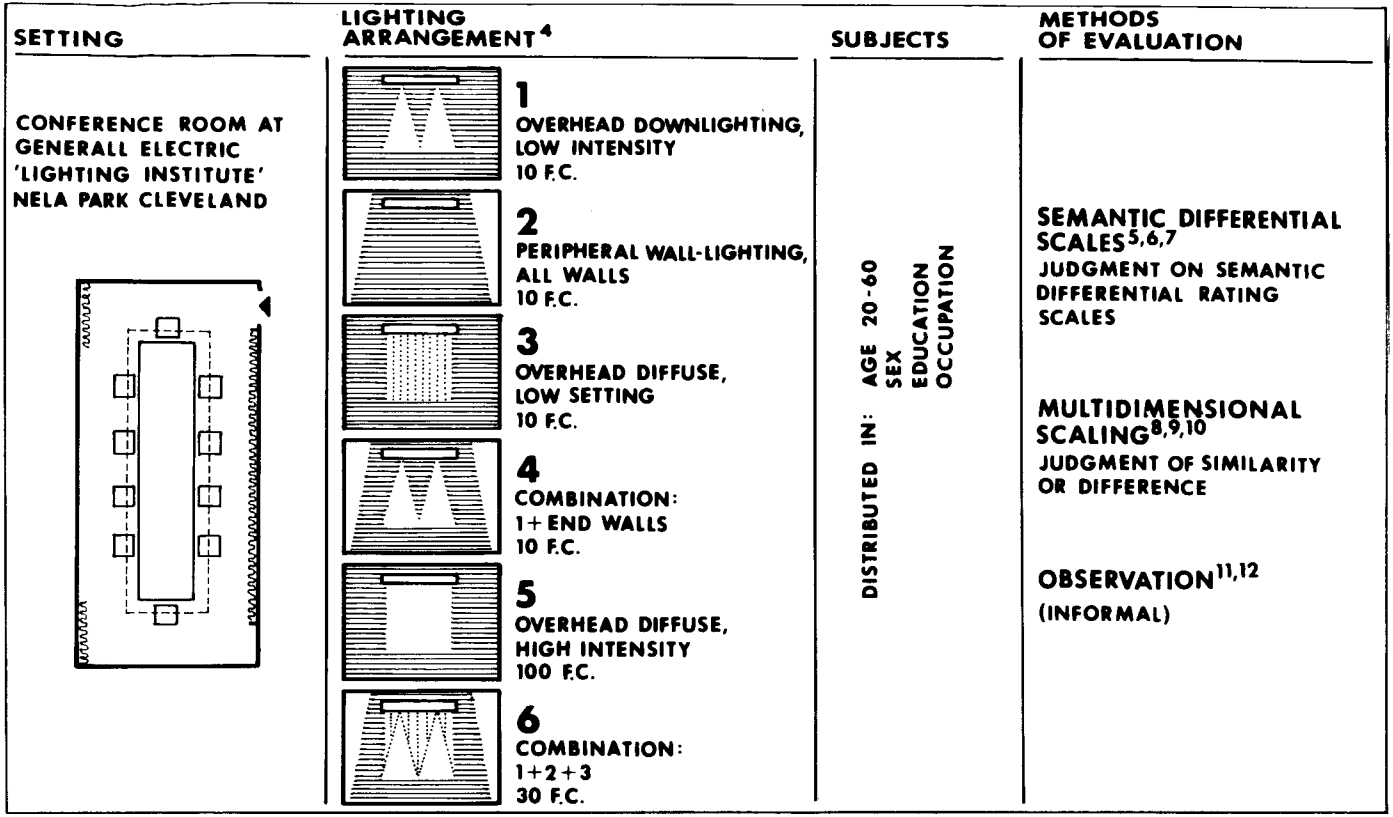


FIGURE 2. Description of setting, lighting arrangements, subjects, and methods of evaluation.

Semantic Differential Scales Procedure

1. Initial Ratings - Upon entering the room subjects (96 in 12 groups) were asked to rate the room. Participants were not initially informed that the lighting was the primary concern of the experiment and presumably rated the room with respect to all of its attributes. Each of six lighting arrangements was in effect for two of the twelve groups.

2. Comparative Ratings - Following the initial ratings of the room each group was informed that it would be judging the room under a variety of lighting arrangements. All six lighting arrangements then were shown rapidly (15 sec. each) to provide a general frame of reference. The ratings proceeded using one of the six lighting arrangements at a time in a different order for each group. One minute was allowed for adaptation before rating each arrangement. The lighting arrangement for the initial rating was repeated as one of six comparative arrangements.

Semantic Differential Scales Results

Initial Ratings of the room showed significant differences in response to the room under the six lighting arrangements. Apparently the groups were evaluating the room differently according to the lighting system in effect.

Comparative Ratings were factor analyzed, resulting in identification of five factors or categories of impression: (Figure 3)

1. Evaluative

2. Perceptual Clarity - Although it might also have been named 'spatial brightness', since it seemed to relate to this physical variation.

3. Spatial Complexity - The terms 'visual noise' or 'visual clutter' might also be appropriate.

4. Spaciousness

5. Formality - It was not obvious what property of the two scales in this factor had in common, but 'formality' seemed tentatively appropriate.

Factors 1, 2, and 4 showed a significant difference in impression between two or more of the six lighting arrangements.

The rating scales that were loaded on Factors 3 and 5 did not

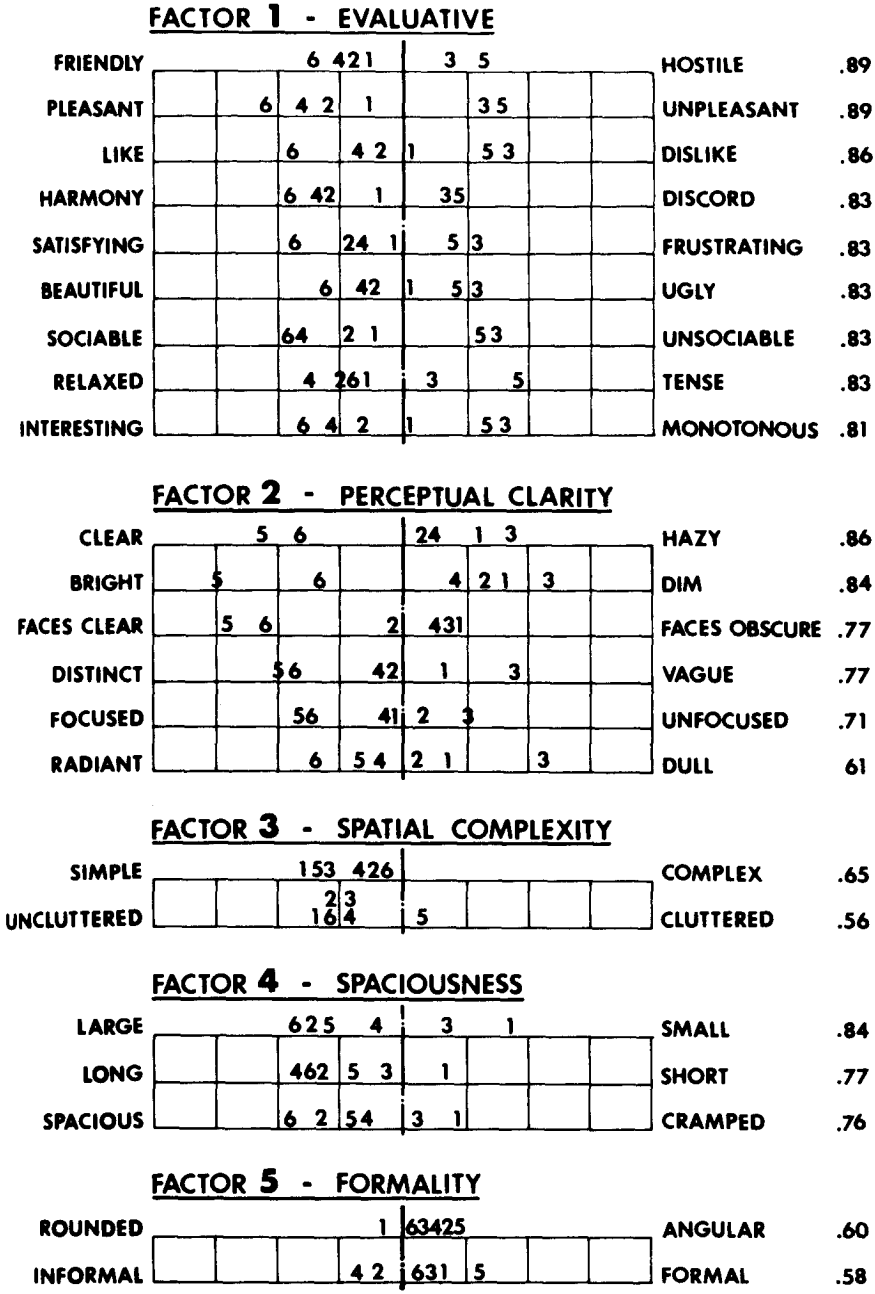


FIGURE 3. Factor Analysis.

strongly differentiate between the six lighting arrangements. However, these factors may serve to differentiate between rooms, and current research is investigating this possibility.

Semantic Differential Scales Analysis

An analysis of data from the initial ratings of the room showed that the groups were evaluating the room differently, according to the lighting system in effect as they entered the room. Data from comparative ratings of all six lighting arrangements were in good general agreement with initial ratings.

The test results for rating scales supported the two concerns of this research. First, they suggested that the lighting variables do induce some consistent and apparently shared impressions of the users (observers). Second, this tended to confirm that rating scales may be a useful technique for evaluation of the shared impressions of the users.

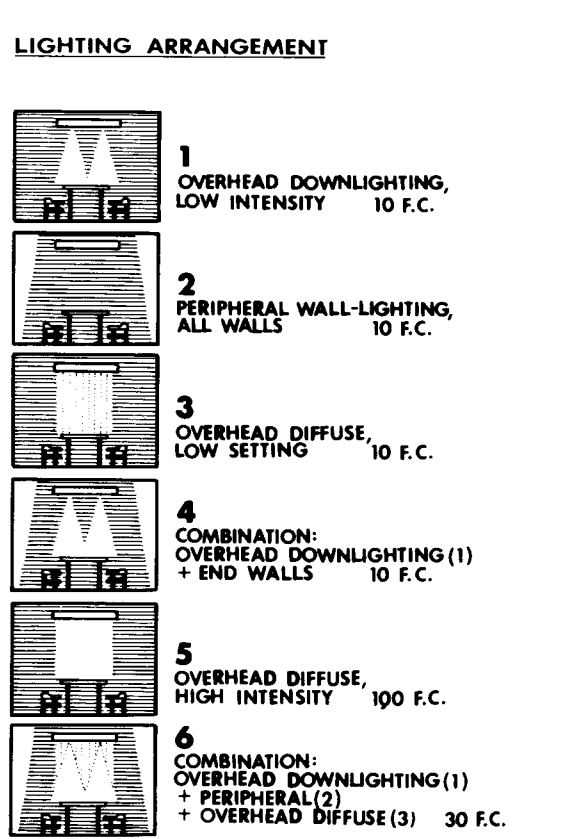
Several tentative but representative conclusions can be drawn concerning the evaluation of subjective spatial impressions associated with lighting design decisions.

1. Different intensities of lighting emission from overhead diffusing systems did affect impressions of 'perceptual clarity' and tended to increase perceived 'spaciousness', but had little impact on 'evaluative' impression, as shown by lighting arrangements 3 and 5, Figure 4.

2. Distribution characteristics from overhead lighting systems with equal horizontal illumination did significantly affect 'evaluative' response and yielded marginally significant differences in the impression of 'spaciousness'. However, such systems produced little effect on the impression of 'perceptual clarity', as illustrated by lighting arrangements 1 and 3, Figure 4.

3. Overhead lighting and limited wall-lighting in comparison to overhead downlighting used alone did enhance 'evaluative' and 'spaciousness' impressions, and marginally improved the impression of 'perceptual clarity'. See Figure 4, lighting arrangements 1 and 4.

These are very tentative conclusions. They are discussed here simply to demonstrate the potential value of comparative rating procedures as a research device for providing broader insight into questions of lighting quality.



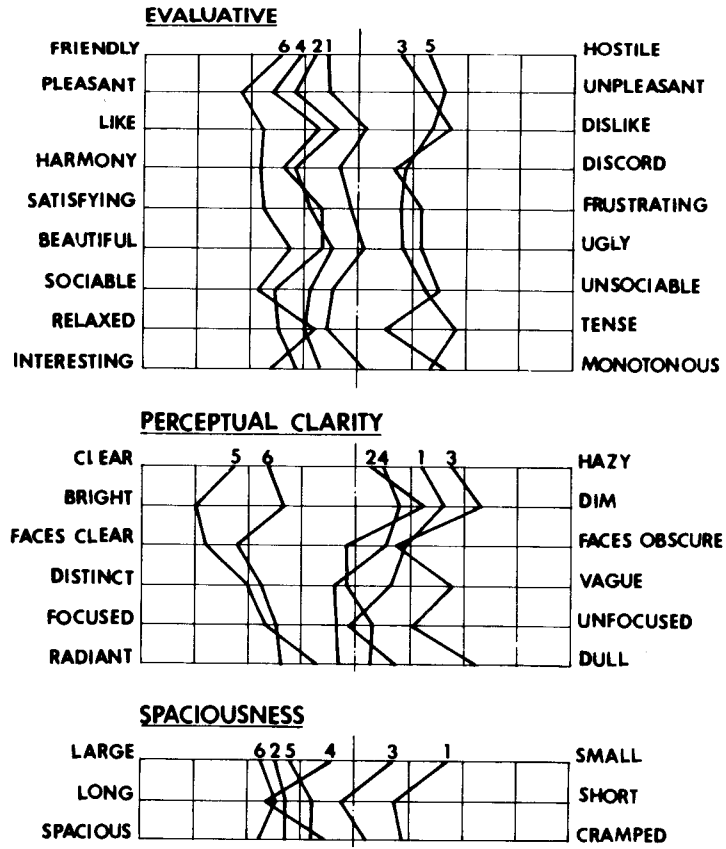


FIGURE 4. Lighting Arrangements Comparison.

Multidimensional Scaling Procedure

Subjects (46 in 5 groups- using a different set of subjects than were used in Semantic Differential Scaling) were asked for judgment of overall similarity or difference (degree of change) in going from one lighting arrangement to the next for 38 pairwise comparisons of the six lighting conditions. The participants were left to establish their own criteria for change. To facilitate these judgments, a scale was established where '0' represented 'no change'; '10' represented a 'very large change'; and for a medium change, numbers such as 4, 5, or 6 were assigned.

Multidimensional Scaling Results

In evaluating the 46 subjects involved, an 'INDSCAL' computer analysis indicated that the subjects used three dimensions (criteria) in judging the similarity or difference between lighting arrangements. Dimensions were tentatively labeled (See Figure 5):

1. Peripheral/Overhead: (lighting arrangements 2,4,6 vs. 1,3,5)

2. Uniform/Non-Uniform: (lighting arrangements 2,3,5,6 vs. 1,4) This dimension may also represent a 'warm/cool' variation in light tone, because this physical manipulation was confounded with the 'Uniform/Non-Uniform' variation.

3. Bright/Dim: (lighting arrangements 5,6 vs. 1,2,3,4)

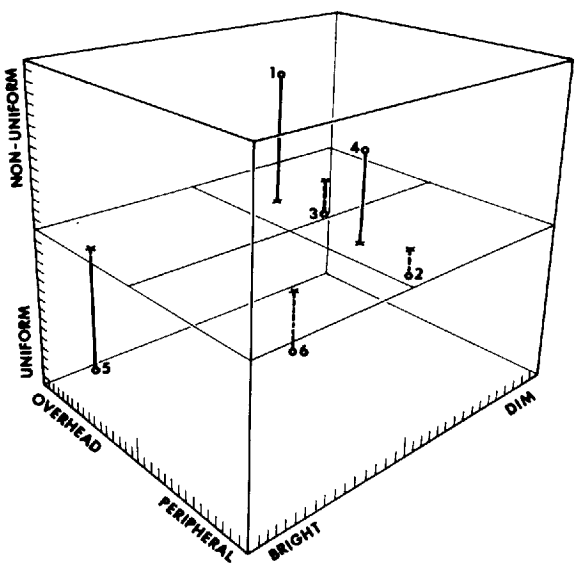


FIGURE 5. Group Stimulus Space: INDSCAL

Multidimensional Scaling Analysis

Although three dimensions were used by the group as a whole in judging the lighting arrangements, it was not necessarily true that each individual subject used all three dimensions. An inspection of the dimension weights for individuals provided by the INDSCAL program, indicated that the subjects could be classified into three categories: 1. one-dimensional perceivers (3), 2. two-dimensional perceivers (20), and 3. three-dimensional perceivers (23). All three-dimensional perceivers utilized each of the three dimensions of perceptual judgment to a significant extent. However, there were individual differences with respect to which dimension was given the greatest weight.

It appears that there were at least three primary dimensions of perceptual experience to which the subjects did or could respond: 1. peripheral/overhead, 2. uniform/non-uniform, and 3. bright/dim. However some individual differences in the response modes of the participants led the subjects to respond to either one, two or three of these dimensions.

These differences in response modes may reflect real differences in visual perception of the lighted space or they may be explained by a suggestion made by Arnold[13] that observers have a limited capacity for information processing --- and that this capacity may vary between individuals. He suggests that when subjects are asked to make comparisons of complex stimuli (such as lighting arrangements) in a multidimensional scaling situation where possible dimensions of experience are unspecified, some subjects may abstract out or isolate one or a few dimensions and submerge the others. If this is true, tests such as our multidimensional scaling plots (results) might give some significant insight into the internal priorities established by various groups of individuals in regard to lighting quality.

Observation Procedure

Some individual patterns were observed and recorded informally during the initial ratings when subjects made gestures, comments, or displayed overt behavior.

Observation Results and Analysis

In the present study certain behaviors were observed, as tabulated in Table 1. Although incomplete, these observations tend to support the previous findings. The lighting arrangements (such as arrangements 3 and 5) which were evaluated negatively on the rating scales also stimulated negative gestures and/or comments. Some of the arrangements stimulated descriptive com-

ments, which suggested that participants associated certain images with the lighting. This further suggests that some lighting conveys meaning, such as interrogation, task performance, meditation, reverence, and mysticism.

TABLE 1. Tabulation of Observation.

LIGHTING ARRANGEMENT	OBSERVED GESTURES	COMMENTS
1	drinking gestures	'Is this a seance?' 'Do we hold hands?' 'I am waiting for Norm to lead us in prayer.' 'Psychedelic lights.' 'Let us pray.'
2	quizzical looks	
3	thumbs down gestures	'Very unflattering.' 'Reminds me of an elevator.' 'Hazy.' 'Is this it?' 'What you see is what you get.'
4	affirmative nodding of heads; smiles	'That's nice.'
5	squinting; eye rubbing; removal of eyeglasses	'Too bright.' 'Good grief.' 'Ugh.' 'We have ways of making you talk.' 'Get out your typewriter, girls.'
6		

Comparison of the Factor Analysis and Multidimensional Scaling Results

In semantic differential ratings, the dimensions to be judged are specified for the subject by the experimenter. In multidimensional scaling, the dimensions are established by the subject himself. To what extent, if any, do these methods represent comparable qualities of perceptual experience?

Mean ratings on bright/dim, pleasant/unpleasant, and large/small rating scales were chosen to represent the perceptual clarity, evaluative, and spaciousness factors respectively. These were then subjected to a stepwise multiple regression with the three dimensions of the 'INDSCAL' group stimulus space, in order to determine which dimension and/or dimensions have the greatest predictive power.

For 'perceptual clarity', a correlation of 0.99 with the 'bright/dim' dimension was achieved in the first step (See Figure 6). Thus, both procedures yielded essentially equivalent results concerning this aspect of visual experience.

For the 'evaluative impression', a correlation of 0.83 with the 'overhead/peripheral' dimension was obtained in the first step, and a correlation of 0.92 was achieved in the second step, using both the 'overhead/peripheral' and 'uniform/non-uniform' dimensions (See Figure 6). The addition of the 'bright/dim' dimension contribution was negligible in increasing the correlation. Thus, evaluative impressions appear to be adequately represented as a linear combination of the 'overhead/peripheral' and 'uniform/non-uniform' dimensions.

For 'spaciousness', a correlation of 0.69 with the 'uniform/non-uniform' dimension was obtained in the first step, and a correlation of 0.94 was obtained in the second step, using both the 'uniform/non-uniform' and 'overhead/peripheral' dimensions as predictors (See Figure 6). The addition of the 'bright/dim' dimension increased the coefficient of correlation to 0.98.

Thus, the impression of spaciousness seems to be represented quite well as a linear combination of the 'uniform/non-uniform' and 'overhead/peripheral' dimensions -- but an even better fit is obtained using all three dimensions.

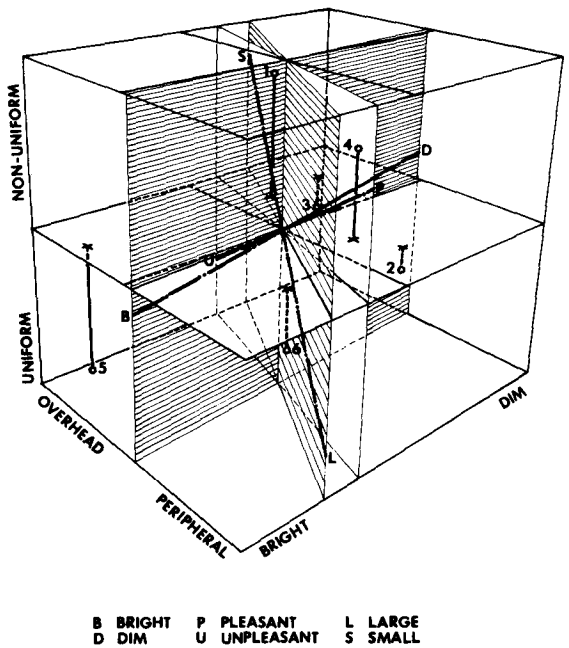


FIGURE 6. Perceptual clarity, evaluative, spaciousness factors plotted in INDSCAL group stimulus space

Conclusion

It is appropriate to conclude that the findings tend to sustain the two aspects of concern indicated at the outset of this study:

1. Lighting can be discussed as a vehicle that alters the information content of the visual field --- and that this intervention has some effect on behavior and on the sensations of well-being.

2. These lighting effects may be evaluated by psychological procedures for the rating and mapping of behavior.

Of course the interpretations in this paper are very tentative and must await additional data collection with a larger variety of lighting arrangements for confirmation. The purpose in noting such conclusions at this point is to suggest that semantic differential rating scales, multidimensional scaling, and observations may, in combination, become useful research devices for providing greater insight into the types of impressions that can be fostered or reinforced by various lighting systems in a 'behavior setting'.

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