

VISUAL IMAGERY PRODUCED BY RHYTHMIC PHOTIC STIMULATION: PERSONALITY CORRELATES AND PHENOMENOLOGY

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This study is concerned with relationships between descriptions of visual imagery produced by rhythmic photic stimulation and a number of personality tests. Individuals who manifested the ability to suspend their generalized reality-orientation described more imagery; imagination and suggestibility also seemed to be important. Subjects' expectations about what they would see influenced their reports, although comprehension of the experimental design, fatigue and motivation were not relevant. The correlated personality variables indicate a close relationship with other types of visual imagery; the phenomenology fits a synthesized description of sensory deprivation, mescaline, and hypnagogic imagery.

The photic stimulator has long been used in clinical electroencephalography. As a by-product of this work it has been found that rhythmic photic stimulation almost always produces a wide range of visual imagery. The principal object of the present study was to investigate the relationship between certain personality variables and the visual imagery obtained by rhythmic photic stimulation. Secondly, the experiment attempted to relate photic stimulation imagery to other types of imagery experience more difficult to study in the laboratory—specifically, hypnagogic imagery, sensory deprivation, hallucinations, and mescaline visions.

Previous work on these problems falls into two main categories: first, comparisons of the phenomenal qualities of the imagery occurring under different conditions; and, secondly, investigations of the personality variables related to imagery production.

(i) *Photic stimulation imagery compared with hypnagogic, sensory deprivation, and mescaline imagery*

Experimenters who have investigated photic stimulation imagery (Blum, 1956; Smythies, 1959; Walter, 1953; Walter & Walter, 1949) have described four central characteristics of the imagery: colour, movement, geometrical patterns, and meaningful images (the last reported by only very few subjects). Certain shapes such as circles, spirals, checkerboards, and waves have been mentioned with great regularity (Blum, 1956; Smythies, 1959). Smythies (1960) concluded that these characteristics of photic stimulation imagery are similar to the imagery occurring in the first stages of mescaline intoxication.

Klüver (1942) had also noted that 'some or all of the form constants found in mescaline hallucinations are also found in certain hypnagogic hallucinations' and in a rotating disk condition similar to photic flicker.

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Bexton, Heron & Scott (1954) were the first to report that sensory deprivation produced 'visual phenomena . . . quite similar to what have been described for mescal intoxication, and to what Grey Walter has . . . produced by exposure to flickering light' (p. 12). The range of phenomena they described was identical with that reported in the photic stimulation literature. Freedman, Grunebaum, Stare & Greenblatt (1962) concluded that sensory deprivation imagery is much closer to hypnagogic and hypnopompic imagery than to psychotic hallucinations.

Perhaps more convincing evidence of the similarity between the visual phenomena of hypnagogic, sensory deprivation, mescaline, and photic stimulation are the interactive and summative effects of the various conditions. For example, Smythies (1960) has found that photic stimulation potentiates the effect of mescaline and that 'hallucinations' can be induced by photic stimulation in combination with a smaller dose of mescaline than would otherwise be necessary to achieve the same effects.

Thus the literature contains evidence for phenomenological resemblances and functional relationships among hypnagogic, sensory deprivation, and mescaline imagery.

(ii) *Possible personality factors*

Smythies (1959) and Blum (1956) have reported that photic stimulation imagery patterns differ among subjects and that individual imagery patterns remain stable over long periods of time. But the photic stimulation literature is very sparse on the subject of personality factors associated with this imagery. However, since hypnagogic, sensory deprivation, mescaline, and photic stimulation imagery are, phenomenally, very much alike, it appeared that it might be fruitful to investigate the personality variables associated with imagery in these other situations in order to consider their relevance for photic stimulation imagery.

Goldberger and Holt have worked extensively with personality variables affecting the production of imagery during sensory deprivation (Holt & Goldberger, 1959, 1960; Goldberger & Holt, 1961*b*). They identified a syndrome which constituted an adaptive response to the isolation situation. This syndrome included imagery production and controlled and accepted primary process in the isolation situation. Its presence was positively correlated with an artistic, sensitive and creative self-concept. Imagery alone was found to be significantly correlated with controlled primary process during isolation. It was also highly related to vividness of imagery in everyday life in a student sample. Finally, the Rorschach colour sum measure was positively related to imagery in a group of actors, although not in the student group. McKellar (1957) pointed out that hypnagogic images and hallucinations have been used by artists as source material. Thus, sensory deprivation imagery and hypnagogic imagery have both been linked with aesthetic tendencies and creative imagination. Freedman *et al.* (1962) found a direct relationship between sensory deprivation and hypnagogic imagery. They reported a significant positive correlation between histories of hypnagogic imagery and reports of imagery from their sensory deprivation subjects. Ardis & McKellar (1956) came to a similar conclusion with respect to mescaline and hypnagogic imagery.

Camberari (1958) identified a syndrome adaptive to an isolation situation (im-

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mersion in a water tank); like Goldberger and Holt's syndrome, it included a greater frequency of 'hallucinations'. The adaptive syndrome also included greater production of and tolerance for all regressive phenomena; less concern with reality orientation, i.e. a greater ability to ignore external factors that reinforce reality; and more reported affective reaction to the situation. These characteristics are analogous to what Goldberger and Holt termed 'controlled primary process' in the adaptive syndrome which they identified.

The distinguishing feature of Camberari's study was that he was able to predict differences in reaction to the isolation situation by dividing his sample into a 'suggestible' and a 'non-suggestible' group on the basis of a battery of tests. The adaptive syndrome just described was typical of the suggestible group, while the maladaptive syndrome characterized the non-suggestible group. Thus, suggestibility was positively correlated with a greater number of reports of visual imagery during isolation.

Suggestibility, as the term is used by Camberari, seems to be equated with hypnotizability. But Orne (1959) distinguished two quite different subjective components of the hypnotic state: one is a compulsion to follow cues given by the hypnotist; the other is perceived discontinuity from the normal waking state. Shor (1959) described the discontinuity from waking experience typical of the trance state by his conception of a temporary fading of the 'generalized reality orientation', defined as 'a structured frame of reference in the background of attention which supports, interprets, and gives meaning to all experiences' (p. 585). He then defined a good hypnotic subject as 'a person who has the ability to give up voluntarily his usual reality orientation to a considerable extent' (p. 598). Considering this ability as a component of Camberari's suggestibility provides an explanation of why the suggestible subjects were also less concerned with reality-orientation and more willing to ignore external factors which would reinforce reality.

A sensory deprivation study by Leiderman (1960) produced data which may possibly confirm the association between imagery and an ability to ignore external features of the environment. With six subjects, he found imagery production to be significantly correlated with field-independence as measured by the Gottschaldt test. He interpreted this result to mean that imagery is related to independence of the external environment.

In Freudian terms, Shor's 'generalized reality orientation' performs many of the functions of secondary process thinking. Similarly, the ability temporarily to give up this reality orientation corresponds to a temporary regression to primary-process functioning (Shor, 1959). Thus, it is understandable that Camberari's suggestible subjects were more productive of regressive phenomena, including 'hallucinations', and that 'controlled primary process' was associated with the occurrence of visual imagery in Goldberger and Holt's samples.

Moreover, one can also connect primary process thinking with emotional reactivity (as opposed to the dominance of logical thought processes). This interpretation could explain why a Rorschach colour response, which represents an emotional responsiveness to the environment, might also be correlated with imagery production (Holt & Goldberger, 1959; Goldberger & Holt, 1961*a, b*). If one takes ability to suspend the 'generalized reality orientation' as a component of hypnotizability and a factor in the production of visual imagery in the sensory deprivation situation, as

the literature suggests, then Sutcliffe's (1958) work relating hypnotizability to imagery activities is of interest. He found that hypnotizable subjects scored significantly more highly on several imagery tests, including one devoted to visual imagery exclusively.

In the light of these findings, it is interesting to see references in the literature to similarity between photic stimulation effects and the hypnotic trance state. Blum (1956) stated that a few of his eleven subjects reported trance effects from the flickering light, while Kahn (1954) found that simultaneous visual, auditory and tactile rhythmic stimulation could produce 'in a relatively short time, a hypnotic-type stupor' (p. 103). Kroger & Schneider (1959) used photic stimulation for the specific purpose of hypnotic trance induction.

Thus the concept of the 'generalized reality orientation', developed for hypnotic phenomena, seemed to explain and give unity to diverse experimental findings on the relationship between imagery and personality. Evidence concerning a similarity between the effects of photic stimulation and hypnotic trance states indicated further that this construct might furnish a useful theoretical framework for the present experiment.

In summary, the literature indicates that:

- (1) There are similarities among the visual phenomena of hypnagogic states, sensory deprivation, mescaline, and photic stimulation.
- (2) Photic stimulation can produce an effect similar to a hypnotic trance state.
- (3) There are stable individual differences in photic stimulation imagery patterns among subjects.
- (4) Sensory deprivation imagery is related to the following personality variables:
 - (a) controlled and accepted primary process; emotional responsiveness;
 - (b) vividness of imagery in everyday life;
 - (c) history of hypnagogic experience;
 - (d) artistic and imaginative self-concept;
 - (e) suggestibility, hypnotizability;
 - (f) field independence.
- (5) The concept of suspension of the 'generalized reality orientation' brings these variables into a unified frame of reference, and provides a theoretical basis for extending their relevance to photic stimulation imagery.

THEORY AND HYPOTHESES

The 'generalized reality-orientation' is conceived as a cognitive frame of reference which constitutes a person's ordinary 'reality'. From this most general structure 'are derived various concepts and functions, some of which are reality-testing... cognition of world...logic...various inhibitions, conscious fears and defenses' (Shor, 1959, p. 589). In relation to Freudian theory, these functions are 'roughly equivalent to the cognitive components of the ego or the secondary process orientation' (*ibid.*).

The fading of this generalized reality-orientation into a more distant background of awareness defines what Shor calls 'trance' (Shor, Orne & O'Connell, 1962). In Freudian terms, it refers to many of the same phenomena covered by the concept of

primary process functioning and 'regression in the service of ego'. These phenomena are viewed as having a 'trance' component in so far as they occur in relative isolation from ordinary reality. Hypnosis is one such phenomenon. Other states which Shor feels may fit into this category are hallucinogenic drug experiences, sensory deprivation, and the inspirational phase of creativity (Shor *et al.* 1962).

From the hypothesis that the hypnotic state contains a 'trance' component, 'an important deduction... is the prediction that most individuals who can readily become profound hypnotic subjects have had many profound "hypnotic-like" experiences which have occurred naturally in the normal course of living. The theory supposes that these individuals have the ability to suspend their usual generalized reality-orientation so that "hypnotic-like" experiences can occur' (Shor *et al.* 1962, p. 55). This deduction can also be extended to include other phenomena which have a 'trance' component. The present experiment sought to demonstrate that individuals with an ability to suspend their generalized reality orientations, that is, individuals who have had many naturally occurring 'hypnotic-like' experiences are more productive of photic stimulation imagery.

If visual imagery in general demands an ability to suspend one's generalized reality-orientation, then the occurrence of visual imagery experiences in a person's ordinary life should be related to his imagery production under photic stimulation. This was another hypothesis of the present study. Shor indicates that suggestibility in everyday life situations and artistic experiences (the latter a phenomenon included in 'regression in the service of the ego') also have a 'trance' component. To this extent then, they should relate to photic stimulation imagery, and such relationships constituted additional hypotheses of the present experiment.

Another hypothesis based on the assumption that imagery under photic stimulation involves the ability to suspend one's generalized reality-orientation was that people who, under ordinary circumstances, are relatively independent of their environment as a cognitive frame of reference (field-independent) are more able to let this frame of reference slip away; and, therefore, such people are likely to be more productive of photic stimulation imagery.

Shor suggests that freedom in emotional expression is related to the suspension of the generalized reality-orientation (Shor *et al.* 1962). Emotion can also be considered a primary process activity. The variable of emotional responsiveness, as an instance of controlled primary process or voluntary suspension of the generalized reality-orientation, was therefore of interest in the present experiment.

The implication throughout the preceding discussion has been that the relevant imagery dimension is quantitative rather than qualitative. One reason for the choice of quantity rather than quality was that Blum (1956) found reports of meaningful images under photic stimulation to be associated with abnormality. Since the present experiment employed a supposedly normal sample and since the personality variables used did not have a normal-abnormal dimension, the particular content or meaning of the images was not considered relevant. Moreover, previous experimental work which provided the starting point for this study used quantity rather than quality in relating imagery to other variables.

Finally, it should be made clear that the above hypotheses apply to the formal rather than the chromatic aspect of photic stimulation imagery. Both in the

literature and in common sense thinking, the minimum criterion for an image is that it should have a shape. Since the word imagery seemed to imply form as a minimum criterion, it was possible to formulate hypotheses about this aspect of the imagery on the basis of previous experimental work. This was not the case with the colour aspect of the imagery. Although no predictions could therefore be made, the relationship between colour reports under photic stimulation and the personality variables was also investigated.

EXPERIMENTAL DESIGN

Each subject was tested once over a range of flicker frequencies to obtain a sample of the formal and chromatic aspects of his imagery. The results of a pilot study had indicated that one series of exposures to the flashing light over an adequate range of frequencies would be sufficient to obtain a representative sample of the variety and amount of imagery for a given subject. After this series of exposures, a form suggestion procedure was used in order to test hypotheses about suggestibility.

One problem of design was that if imagery was responsive to explicit suggestions, as had been indicated in the pilot study, it seemed likely that it would also be affected by the implicit clues offered by the experimental procedure itself—what Orne has termed the 'demand characteristics' of the experiment. Thus, the degree to which suggestibility affected imagery reports might depend upon the way in which the subject perceived the experimental situation. Consequently, it seemed necessary to assess and control for 'demand characteristics'. The strategy used for this purpose was Orne's (1959): subjects were intensively questioned concerning their expectations before the experiment, and their ideas about the purpose of the photic stimulation procedure after it was over. It was assumed that subjects who perceived the experiment in a certain way would manifest similar experimental behaviour if 'demand characteristics' were a determining factor.

Another methodological problem was that imagery reports might be influenced by verbal ability as much as, or more than, by the visual experience itself. The influence of verbal ability was assessed by asking subjects how adequately they felt they had been able to describe their visual experience. It was assumed that if this rating was positively correlated with the amount of imagery reported, verbal ability had contributed significantly to the supposedly visual results.

METHOD AND PROCEDURE

(i) *Subjects*

Twenty paid subjects, ten male and ten female, were recruited through the student employment offices of three nearby colleges. Ages ranged from 18 to 25, with a mean of 20.3 years.

(ii) *Photic stimulation sessions*

The experiment involved two sessions one or two days apart. At the start of the first session the subjects were told only that the experiment would involve an electroencephalogram, a flashing light, and a description of what they saw while the light was on. Before photic stimulation began, subjects were questioned about their motivation for participating and their expectations concerning the experiment. They were then given a clinical EEG by a hospital technician in order to screen out those who exhibited adverse reactions to the light. The clinical EEG and the experiment took place in a dark room with the subject recumbent on a bed, eyes closed. After the clinical EEG, the subject was instructed that while the light was on he was to describe everything he saw as carefully and accurately as possible. He was also told to look straight ahead with his eyes closed, not to move, and to relax as much as possible. A Grass PS-2 Stimulator was placed about 1 in. from the subject's nose so as to cover the visual field; relative intensity was set at 16. In this part of the photic stimulation procedure, called the 'spontaneous reporting condition', the duration of each exposure to the light was 10 sec. The first exposure was at a frequency of 1 f.p.s. (flash per second) with later exposures progressing successively up to a frequency of 20 f.p.s. The amount of time between exposures was determined

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primarily by the length of the subject's description, which was allowed to continue after the light went off, if necessary.

In the second session of the photic stimulation procedure, the 'suggestion condition', subjects again described everything they saw, but in addition were asked to watch particularly for a specific form on successive 30 sec. exposures. The suggested forms were: (1) circles, (2) squares, (3) spirals, (4) stars, (5) flowers, (6) animals and (7) people. The flicker frequency was 15 f.p.s. When a subject reported having seen a suggested form, he was asked whether it had been in motion, whether he had ever seen it before, and how he had described it (if he had seen it previously). The subject was asked to rate himself on a 5-point scale for fatigue, at the beginning and the end, and in the middle of the photic stimulation procedure.

After the suggestion procedure, the experimenter asked the subject a series of questions (the photic stimulation inquiry). These questions were concerned with the phenomenal qualities of the imagery, the subject's affective reaction to the experience, and his conception of the nature of the experiment.

(iii) *Coding the imagery*

Visual imagery reports during the 'spontaneous' condition were coded for form and colour. A form response was defined as any mention of shape which implied at least two dimensions, that is, dots and lines were excluded. This definition included objects of the real world (e.g. rocket, pinwheel) as well as geometric figures (e.g., square, circle). The imagery scores were:

(a) *Variety of form*—the number of *different* form responses given over all twenty of the 10 sec. trials in the spontaneous reporting condition. For example, the response 'circle' would be counted only once even if it were repeated several times. Actual form scores ranged from 1 to 19.

(b) *Variety of objects*—the number of different forms reported over the same twenty trials which referred to objects of the external world; i.e. geometric figures were excluded.

(c) *Frequency of colour*—the *total number* of colour responses given over all twenty of the 10 sec. exposures. If a given colour response was repeated on the same trial it was counted only once. Actual colour scores ranged from 0 to 45.

Imagery during the 'suggestion condition' was scored for positive responses to suggestion. A positive response was defined as any mention of the suggested form during the following exposure. The following measures were used:

(a) *Form suggestibility*—the sum of all positive responses to suggestion. Each form was assigned a weight in accordance with the empirically determined 'difficulty' of seeing it.

(b) *New forms under suggestion*. This measure was based on the same scoring system. However, scores for those suggested forms which subjects reported having seen before the suggestion condition were subtracted.

(iv) *Testing session*

All personality tests were individually administered by a single experimenter. All subjects were given the following tests in the order listed:

(a) *A modification of the Gottschaldt embedded figures test*—(Witkin, 1950)

This test, which involves extracting a simple geometric figure from a complex context of lines and colour, was employed as a measure of field-independence to test the hypothesis that this variable is positively related to amount of photic stimulation imagery. According to Gardner *et al.* (1959), one group of figures (cluster I) sets a more purely perceptual task than the other group of figures (cluster II), which demands conceptual activity as well. Consequently, scores were computed separately for each cluster. Scores consisted of the total amount of time taken to find all the embedded figures.

(b) *Memory for positions test*

This test, one of those used by Camberari (1958), was employed as a measure of suggestibility to test the hypothesis that visual imagery is positively related to suggestibility. It involved remembering how many letters on one card were in the same position as on another card seen immediately before. The correct answer in each case was none. Suggestibility was measured by the number of letters guessed.

(c) *Rorschach test*

Three Rorschach cards (II, IX, X), containing varying amounts of chromatic colour, were presented to each subject. The protocols were scored by an experienced clinical psychologist and a colour sum ratio was computed according to the formula $(0.5FC + CF + 1.5C)/\text{total } R$. This score was taken as a measure of the subject's ability to respond spontaneously to the environment in emotional terms and was used to test whether or not more emotionally responsive subjects would see more imagery. (Rorschach results are based on nineteen out of the twenty subjects.)

(d) *Barron-Welsh art scale* (Welsh, 1959)

This scale was employed as an objective measure of artistic ability, sensitivity and creativity (Barron, 1953; Welsh, 1959) to test the hypothesis that these traits are associated with high imagery production. The scale consists of sixty-two out of the 400 black and white drawings contained in the Welsh Figure Preference Test. Subjects rate each drawing 'like' or 'dislike'. The scale was scored according to the key provided by Welsh (1959).

(e) *Shor 'Hypnotic-like' experiences questionnaire* (Shor, 1959)

This questionnaire was conceived as a measure of 'the ability to lose temporarily or to suspend voluntarily the relative functioning of the generalized reality-orientation' (Shor, 1960, p. 162). Scores have been found to correlate with hypnotizability, and it was hypothesized that they would also correlate with the amount of photic stimulation imagery. In general, the questions ask whether the subject has ever had various mystical-type experiences not induced by special conditions such as drugs or hypnosis; for example, 'Have you ever been able to quiet down your mind, construct a new imaginary world and feel for the time that it was real?' In accordance with Shor's methods, scores consisted of the number of hypnotic-like experiences the subject reported having had at least once.

(f) *Imagery and creativity questionnaire*

This questionnaire includes nineteen items about past imagery experience (hypnagogic imagery and dreams), artistic inclinations, self-ratings of imaginative and creative abilities, and empathy experience. On the basis of interviews conducted during the pilot study, these items seemed most promising as predictors of photic stimulation imagery.

Subjects responded to each item on a three-point rating scale. An overall questionnaire score was based on eleven of the nineteen items. The selected items are all concerned with visual imagery and creativity, and they constitute a scale referred to as 'imagery and creativity'. In addition, each of the nineteen items was considered separately in an item-by-item analysis.

RESULTS

(i) *The relation between personality variables and photic stimulation imagery*

The main body of results relating photic stimulation imagery to the personality variables is presented in Table 1.

(a) *Interrelation among imagery variables*

The colour and form aspects of imagery were independent, i.e. the correlations between form and colour responses did not approach statistical significance.

Form suggestibility correlated significantly with the other form measures. Although form measures and form suggestibility are based on different observations, it was possible that people saw the same things under suggestion that they had

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already seen in the 'spontaneous' condition. However, the high correlation ($r_s = 0.86$) of form suggestibility with the number of new forms (i.e. forms reported as not seen in the spontaneous condition) shows that this relationship between forms reported spontaneously and those reported under suggestion is not based on a simple repetition of imagery from trial to trial (Table 2).

Table 1. *Matrix of rank order correlations: photic stimulation imagery and personality variables (N = 20)*

	2	3	4	5	6	7	8	9	10
1. Variety of form	0.56**	-0.08	0.71**	0.47*	0.39*	0.60**	-0.07	0.21	0.29
2. Variety of objects	—	0.05	0.45*	0.36	0.30	0.43*	-0.11	0.00	0.51*
3. Frequency of colour	—	—	0.12	0.22	-0.22	0.18	-0.19	0.63**	0.33
4. Form suggestibility	—	—	—	0.41*	0.45*	0.38	-0.25	0.37	0.21
5. Imagery and creativity	—	—	—	—	0.18	0.35	0.05	0.12	0.03
6. 'Hypnotic-like' experiences	—	—	—	—	—	0.15	0.01	0.22	0.12
7. Rorschach colour sum ratio (N = 19)	—	—	—	—	—	—	-0.05	0.03	0.03
8. Barron-Welsh art scale	—	—	—	—	—	—	—	-0.11	0.08
9. Embedded figures test, cluster I	—	—	—	—	—	—	—	—	0.38*
10. Embedded figures test, cluster II	—	—	—	—	—	—	—	—	—

* $P < 0.05$; ** $P < 0.01$ (one-tailed tests).

Table 2. *Rank order correlations: variety of form responses, form suggestibility, new forms under suggestion (N = 20)*

	2	3
1. Variety of form	0.71**	0.59**
2. Form suggestibility	—	0.86**
3. New forms under suggestion	—	—

** $P < 0.01$ (one-tailed tests).

(b) *Interrelation among personality variables*

From the lower right-hand segment of Table 1 it can be seen that there were no significant correlations among the personality measures (except between the two parts of the Gottschaldt test).

(c) *'Hypnotic-like' experiences*

A demonstrated ability to suspend temporarily one's 'generalized reality-orientation', as manifested in frequency of 'hypnotic-like' experiences reported in the Shor questionnaire, was significantly correlated with variety of form and form suggestibility. Thus, the hypothesis that individuals who have a general ability to suspend their generalized reality-orientation are more productive of photic stimulation imagery was confirmed with respect to the form aspect of the imagery. The fact that frequency of 'hypnotic-like' experiences correlated somewhat more strongly with form suggestibility than with form or colour is an indication that 'hypnotic-like' experiences are more closely related to phenomena occurring in a situation more like that of hypnosis. Assuming that a 'trance' component (as defined by Shor) is common to both hypnosis and imagery, this higher correlation

between 'hypnotic-like' experiences and form suggestibility suggests an additional component, suggestibility, which is called into play in both hypnosis and form suggestibility, but not in spontaneous reporting of imagery.

(d) Imagery and creativity

Self-ratings on the eleven imagery and creativity items selected from the questionnaire correlated significantly with variety of form and form suggestibility. Partial correlation, however, indicated that a large part of the correlation between 'imagery and creativity' and form suggestibility, could be attributed to a relationship between variety of form and form suggestibility. This result suggests that the 'imagery and creativity' items pertain to special imagery abilities distinct from 'trance ability' (although perhaps occurring in a trance state). These abilities would be more relevant to 'spontaneous' imagery than to imagery suggestibility. Artistic sensitivity and creativity, as measured by the Barron-Welsh Art Scale, was not significantly correlated with any of the photic stimulation measures, however.

(e) Field-independence

Field-independence, cluster I (the perceptual group of embedded figures) was significantly correlated with frequency of colour. Field independence, cluster II (the conceptual group of embedded figures) was significantly correlated with variety of objects.

The hypothesis that field-independent people see more imagery because they more readily abandon their generalized reality-orientation was not confirmed by the results if variety of form is taken as the criterion of imagery production. However, perceptual field-independence (cluster I) correlates significantly with the colour measures. There does not seem to be an obvious explanation for this result since attention to colour is detrimental to performance on the Embedded Figures Test.

(f) Emotional responsiveness

The Rorschach colour sum ratio, conceived as a measure of emotional responsiveness to external stimuli, was positively correlated with all the measures of photic stimulation imagery. The correlations of the colour sum ratio with variety of form and variety of objects were statistically significant.

The strong positive relationship between Rorschach colour sum ratio and photic stimulation imagery supports the hypothesis that emotional responsiveness to external stimuli is a factor in imagery experience. On the assumption that emotion is a primary process function, this result also supports the theoretical relationship between the suspension of the generalized reality-orientation and 'regression in the service of the ego', as well as giving evidence that such a process is linked with imagery production. However, partial correlation indicated that most of the relationship between variety of objects and the Rorschach seems to have been a result of the relationship between variety of objects and variety of form, for when variety of form was held constant by a partial correlation, the correlation between the Rorschach and variety of objects sank to 0.23. When variety of objects was held constant, on the other hand, the correlation between the Rorschach colour sum ratio and variety of form increased to 0.80.

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(g) *Suggestibility*

Although *t*-tests performed on the memory for positions scores did not yield statistical significance, the differences between the means of high and low suggestibility subjects were consistently in the predicted direction; that is, highly suggestible people tended to report a greater variety of form, a higher frequency of colour and tended to respond to form suggestion to a greater extent. These results are in accord with the finding that 'hypnotic-like' experiences are related to imagery production, and they support, to some extent, the hypothesis relating imagery and suggestibility.

(ii) *Imagery and creativity questionnaire*

(a) *Questionnaire and variety of form*

An item-by-item analysis of all nineteen of the questionnaire items showed that two of the items were able to predict variety of form scores significantly and were therefore presumably responsible for most of the correlation computed on the basis of the total score of eleven items. The first item in Table 3 shows that subjects who considered themselves quite imaginative, as opposed to those who thought of themselves as only a little imaginative, produced a significantly greater variety of imagery.

From the second item in Table 3, it can be seen that those who reported a previous

Table 3. *Average variety of form and frequency of colour in photic stimulation imagery as a function of self-ratings on imagery and creativity questionnaire*

Do you consider yourself to be an imaginative person?					
	(a) Yes, quite (<i>N</i> = 8)	(b) Yes, a little (<i>N</i> = 12)	(c) No (<i>N</i> = 0)	<i>F</i>	<i>P</i>
Form	10.75	5.33	0	2.58	< 0.01
Colour	16.38	25.17	0	0.14	N.S.
Many people see quite vivid images when falling asleep or waking up, usually (but not always) with their eyes closed. Has this happened to you?					
	(a) No (<i>N</i> = 8)	(b) Yes, once or twice (<i>N</i> = 3)	(c) Yes, more frequently (<i>N</i> = 9)	<i>F</i>	<i>P</i>
Form	3.88	11.67	9.33	4.75	< 0.05
Colour	24.75	19.67	19.89	—	N.S.
How frequently do you paint or draw?					
	(a) Often (<i>N</i> = 4)	(b) Infre- quently (<i>N</i> = 4)	(c) Never (<i>N</i> = 12)	<i>F</i>	<i>P</i>
Form	7.00	7.25	7.75	—	N.S.
Colour	34.25	20.25	17.83	22.43	< 0.005
Do you consider yourself to be a creative thinker?					
	(a) Yes, quite (<i>N</i> = 4)	(b) Yes, somewhat (<i>N</i> = 11)	(c) No (<i>N</i> = 5)	<i>F</i>	<i>P</i>
Form	9.25 4.7	6.73	7.80	—	N.S.
Colour	11.25 1.9	23.27	26.40	9.42	< 0.005

history of hypnagogic and hypnopompic imagery differed in variety of photic stimulation imagery. The discriminating factor seems to be whether or not subjects reported ever having had previous imagery. Subjects who reported never having had hypnagogic or hypnopompic imagery differed significantly from subjects who reported 'once or twice' and from those who reported having had it 'more frequently'. The difference between the means of 'once or twice' and 'more frequently' was not significant.

(b) *Questionnaire and frequency of colour*

Several items of the questionnaire significantly differentiated among subjects with regard to amount of colour in their photic stimulation imagery. These items are all different from those which predicted the form aspect of imagery, although their general nature is similar. It can be seen from the third item in Table 3 that subjects who painted or drew most frequently reported the greatest amounts of colour in their imagery ($P < 0.005$). The results of the fourth item in Table 3 indicate that self-ratings of creativity were also positively associated with frequency of colour in photic stimulation imagery.

(iii) *Situational and control variables*

The following situational and 'control' variables had no effect on imagery production: self-ratings of fatigue, perceived ability to verbalize the visual experience, perceived control over the imagery, and motivation for participating in the experiment. Motivation to see the desired forms, like motivation for the experiment, did not affect form suggestibility.

Table 4. *Average frequency of variety of form, frequency of colour, and form suggestibility as a function of whether subjects perceived or failed to perceive imagination as an experimental variable*

	Named imagination as variable		<i>t</i>	<i>P</i>
	Yes (<i>N</i> = 5)	No (<i>N</i> = 15)		
Variety of form	8.60	7.13	—	N.S.
Frequency of colour	31.80	18.90	1.87	< 0.05
Form suggestibility	7.14	6.33	—	N.S.

In addition, the 'demand characteristics of the experimental situation' did not appear to have a decisive influence on the results. Subjects succeeded in perceiving two variables which were, in fact, a concern of the experimenter: imagination and suggestibility.

This perception, however, did not significantly increase experimental imagery scores for variety of form and suggestibility (Table 4). Moreover, perception of imagination as a variable was not significantly associated with a higher self-rating of imaginativeness on the questionnaire. Colour, on the other hand, did seem to have been affected by the perception of imagination as an experimental variable. These results indicate that the present design was such as to make the effect of situational determinants negligible, thus emphasizing the personality variables. Specific

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expectations, on the other hand, seemed to exert a very strong influence on imagery (Table 5).

The one subject who expected to see 'things' under the light had the highest variety of form score, deviating from the mean by 12.11 ($P < 0.005$). The three subjects who expected to see colours under the light had mean colour scores significantly greater than those of subjects whose expectations did not refer to colour (Table 5).

Table 5. *Average frequency of form and colour in imagery of people with different expectations before experiment*

	Expectations		<i>Z</i>	<i>P</i> *
	Expected to see 'things' (<i>N</i> = 1)	No expectations related to seeing 'things' (<i>N</i> = 19)		
Variety of form	19.00	6.89	2.63	< 0.005
	Expected to see colours (<i>N</i> = 3)	No expectations related to colour (<i>N</i> = 17)	<i>t</i>	<i>P</i>
Frequency of colour	39.33	18.24	2.67	< 0.01

* One-tailed, for normal deviate.

Table 6. *Average frequency of imagery for subjects with different expectations about suggestion procedure*

	Expected to see suggested forms			<i>F</i>	<i>P</i>
	Yes (<i>N</i> = 6)	Some of the forms (<i>N</i> = 7)	No (<i>N</i> = 7)		
Variety of form	10.50	8.14	4.27	2.87	N.S.
Form suggestibility	10.83	7.00	3.00	6.52	< 0.01

Expectations about seeing suggested forms, as assessed at the end of the photic stimulation procedure, seem to be a strong factor in form suggestibility. The difference between subjects who reported expecting to see the suggested forms and those who did not report such expectations is significant at the 0.01 level (Table 6). However, interpretation of these results must be tempered by the fact that this inquiry about expectation was made after the suggestion trials had occurred. Consequently, remembered expectations may have been affected by subjects' intervening experience. If, however, expectation did have an effect, it seems that such expectations were based in part on past form experience, for subjects who expected to see the suggested forms had seen a greater variety of form in the first place (Table 6), although this difference did not attain statistical significance.

(iv) *Phenomenology*

(a) *Affective reactions*

Subjects' affective reactions to the photic stimulation could be classified as positive, negative or neutral. Although affective reactions did not differentiate subjects

to a significant degree with regard to amount of form and colour in their imagery, it is at least interesting that the two different questions 'Did you enjoy your experience under the light?' and 'Did you find the light at all annoying?' produced results related in the same way with respect to form. That is, subjects who were most positive in their reactions reported the most form, the most negative reported the next greatest amount, and the most neutral reported the least. This result lends credibility to the link between emotional responsiveness (as measured with the Rorschach) and imagery, for subjects who had either positive or negative affective reactions to the experience reported a greater variety of form than those whose reactions were neutral.

(b) Perceived relationship with past experience

Subjects viewed the photic stimulation phenomena as related to a variety of past experiences. Eight subjects associated it with various previous exposures to lights. Four subjects related the photic stimulation experiment to drug experiences of various sorts (peyote, marijuana, mescaline, nitrous oxide). Two subjects mentioned visual experiences produced by closing their eyes tightly or pressing their eyes. One subject related his photic stimulation experience to hypnagogic images. Three subjects did not see any relationship between photic stimulation imagery and previous experience. These three subjects did not differ significantly from the rest of the sample in the amount of form or colour contained in their photic stimulation imagery.

(c) Qualitative description of the imagery

When asked to compare photic stimulation imagery with perceptions of ordinary 'reality', eleven of the twenty subjects said that none of the images was as realistic as things seen in ordinary life. Only one reported that all the images were as real as life. The most frequent reason given for knowing that the images were *not* real was their blurredness or indistinctness (seven subjects). Nevertheless, seventeen of the twenty subjects felt as if they were really seeing the photic stimulation images (as opposed to imagining them). Imagery content ranged from lines and dots to geometric figures to objects of the real world to integrated scenes (only one subject).

At the end of the photic stimulation session, subjects were asked to imagine specific forms and to compare these images with the remembered photic stimulation images of the same forms. Of the total number of comparisons, 65% of the imagined forms seemed less real than their photic stimulation counterparts; 88% seemed less vivid; and 77% of the images were not 'seen' in the same way as the photic stimulation images, that is, they seemed more 'thought' than 'seen'. Thus, while photic stimulation images were 'seen' rather than imagined, they lay somewhere between imagination and open-eyed perception in their 'reality' qualities. In general, they were often less distinct than reality, although the colours were frequently more vivid or picture-like than those seen in the everyday world. Here is evidence in favour of the assumption that photic stimulation demands suspension of one's usual reality-orientation, for the reporting of an image seemed to signify that subjects were actually admitting that they saw things which at the same time they knew were not 'real'. Such a contradiction would not be tolerated by the more logical reality-testing typical of secondary process function, one aspect of the generalized reality-orientation.

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In general, the phenomenal qualities of the imagery fit a synthesized description of sensory deprivation, mescaline and hypnagogic imagery offered by Freedman *et al.* (1962). However, the description is somewhat too simple to fit all the experience of all the photic stimulation subjects. The way in which photic stimulation imagery compared with these other types of imagery on five main points common to them all is presented below.

(1) *Autonomy*. Half the subjects felt they had some sort of control over the imagery, but this control was not perceived as complete. None mentioned being able to control occurrence of the images, as opposed to their content. On the whole, it seems that photic stimulation images appeared at least partially autonomous to all subjects.

(2) *Irrelevance to thoughts of subjects*. This quality could be inferred from the relatively small number of meaningful (i.e. non-geometric) images which were reported.

(3) *Originality*. Originality in the sense of unreproductiveness was a predominant quality of much of the imagery. Only one of the subjects felt that the images 'reproduced' the reality of the external world.

(4) *Unnaturally vivid colour*. Three subjects reported that the images were coloured more vividly than things seen in ordinary life. Nine other subjects perceived at least some of the colours as extraordinary, but in what way was uncertain. Only one subject thought all the colours were those of the real world. Thus, it can be concluded that the colours were on the whole 'unnatural', although whether always in the direction of extraordinary vividness is uncertain.

(5) *Brief duration*. This was an outstanding quality of the imagery as manifest in the inability of twelve subjects to describe accurately the imagery because of rapid changes.

Thus four of the five outstanding characteristics which have been reported for sensory deprivation, mescaline, and hypnagogic imagery held true for most of the images for most of the subjects. The fifth characteristic, unnatural vividness of colour, was typical of most of the subjects with regard to the unnatural aspect. In addition, ordinary vividness was noted by several subjects.

DISCUSSION

On the whole, the results seem to confirm the usefulness of suspension of the generalized reality-orientation (or 'trance') as a theoretical framework within which to discuss the imagery produced by rhythmic photic stimulation. The relationships obtained using variety of form as the principal imagery measure indicated the importance of three clusters of variables which can be derived from this framework: 'hypnotic-like' experiences in ordinary life; imagination and past imagery experience (notably hypnagogic and hypnopompic imagery); and emotional responsiveness to external stimuli. The place of imagination is not so clear as the others; the Barron-Welsh Art Scale, which should theoretically have been related to self-rating of imaginative ability and hence to photic stimulation imagery, was not so related.

The colour aspect of photic stimulation imagery did not fit into such an orderly pattern. Except for some indication that colour may be related to creative thought

and artistic ability, the relationships found in this study do not have much order. The pilot study had indicated that colour reports were very much influenced by suggestion. One possible interpretation of the result regarding colour is that there is a kaleidoscope of colours generally present while the light is flickering and the particular colour attended to at a given moment can be a matter of a multitude of factors unless a specific set is induced. Perhaps such a set was induced by the 'demand characteristics' of the present experiment, for those subjects who perceived imagery as an experimental variable reported significantly more colour in their imagery than subjects who did not have such a perception.

The relationship between hypnotizability and imagery extends the generality of the reports of McBain (1954), Shor (personal communication, 1962), and Sutcliffe (1958) that waking imagery is related to hypnotizability. This relationship between 'hypnotic-like' experiences and imagery gains credibility from the observations of 'hypnotic-like' trances produced by rhythmic photic stimulation, sometimes in combination with rhythmic stimulation in other modalities (Blum, 1956; Kahn, 1954; Kroger & Schneider, 1959). This result also agrees with Camberari's (1958) finding that suggestible subjects have more visual experience in a sensory deprivation situation.

The relationship found between self-rating of imaginative ability and photic stimulation imagery agrees in a general way with Goldberger & Holt's (1961*b*) finding that an artistic, sensitive, and creative self-concept is related to a syndrome that includes imagery. However, self-ratings of artistic ability and creativity in particular did not relate significantly to imagery in the present study. Like that of Goldberger & Holt, the present experiment was not very successful in relating imagery to creativity on the Barron-Welsh Art Scale. In general, it appears that self-ratings of imaginative ability correlate with imagery whereas objective tests do not. The most parsimonious explanation is that self-ratings and objective tests of these variables have little to do with each other. This interpretation is supported by the lack of correlation between the imagery and creativity items of the questionnaire and the Barron-Welsh Art Scale.

The link between hypnagogic imagery experience and photic stimulation imagery supports the general notion of a relationship between the imagery occurring in various situations (Ardis & McKellar, 1956; Bexton *et al.* 1954; Freedman *et al.* 1962; Galton, 1883; Klüver, 1942; Smythies, 1960). In particular, it extends the generality of the finding of Freedman *et al.* (1962) that previous hypnagogic imagery experience is a determinant of imagery in a sensory deprivation situation.

The relationship found between emotional responsiveness to external stimuli and imagery supports Goldberger & Holt's (1961*b*) finding of a relationship between colour responses on the Rorschach and imagery in their actor sample. The relation between imagery and emotion also supports in a more general way their finding that 'controlled primary process' in the isolation situation is correlated with imagery production. Camberari (1958) also found imagery in sensory deprivation associated with other primary process or 'regressive' phenomena.

Finally, the positive relation between field-independence and imagery obtained by Leiderman (1962) in a sensory deprivation experiment was not supported in this photic stimulation situation. Two possible explanations of this discrepancy are readily

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apparent. One is that Leiderman's results, based on a very small sample of subjects may not represent a true relationship. The other is that the relationship is specific to conditions present in the sensory deprivation situation and absent in photic stimulation.

The success of the present study in relating photic stimulation imagery to personality variables which have been found relevant to imagery in other situations indicates the potential value of rhythmic photic stimulation as a laboratory method for studying phenomena which are similar to those found in areas of more practical interest. The fact that photic stimulation, unlike sensory deprivation or mescaline, produces visual imagery unaccompanied for the most part by complicated psychological and physiological reactions has implications for research whose primary interest is 'unreal' visual phenomena.

Moreover, the results of the present study have implications for the study of personality, as well as of imaginal processes. They can be viewed as belonging to the more general area of 'personality and perception' as represented, for example, by Blake & Ramsey (1951) and Witkin *et al.* (1954). The syndrome of abilities or traits identified in the present experiment is concerned with an extremely basic aspect of personality functioning, the question of what a person can accept as reality. As such, this syndrome may have relevance to a wide variety of situations which are conducive to 'unreal' experiences. For example, Klein, Gardner & Schlesinger (1962) have recently described a 'cognitive control' named 'tolerance for unrealistic experiences', which they have shown to account for individual differences in approach to unconfirmable or unrealistic stimulus material presented in situations such as apparent movement, distortion of the visual field by aniseikonic lenses and the Rorschach test. This 'tolerance for unrealistic experiences' is extremely similar to and should apply to the same phenomena as Shor's (1959) construct, the generalized reality-orientation.

If this is the case, then the personality syndrome identified in this photic stimulation experiment—imaginativeness, emotional responsiveness, and a tendency to mystical-type experiences—may have relevance for a wide variety of situations which are conducive to 'unreal' experience, as well as for imagery of all kinds.

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