

PSYCHEDELIC REVIEW

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MOIRÉ PATTERNS AND VISUAL HALLUCINATIONS¹

GERALD OSTER

DURING THE PAST FEW YEARS I have been concerned with the scientific² as well as the aesthetic³ aspects of moiré patterns. Moiré patterns are the figures produced by the overlapping of two or more families of lines; the locus of points of intersection form the moiré pattern. My interest in visual hallucinations as evoked by psychedelic drugs was stimulated by the writings of Aldous Huxley.⁴ I was particularly struck by his reference to the fact that under the influence of mescaline, patterned structures (*i.e.*, repetitive structures) such as a garden trellis, a striped beach chair, and wood grain appeared to be particularly exciting. It is as if mescaline brings to the fore some screen in the eye which, when superposed on the visual scene, produces a moiré pattern. On the basis of this tentative hypothesis I proceeded to devise experiments, the results of which are reported herein.

My plan was to view in detail *single* highly-structured figures while under the influence of LSD. I also wished to ascertain the possible optical origin of reports that under the influence of psychedelic drugs objects appear "alive," that space appears full, and that colors are enhanced.

I was cognizant of the fact (as reported by Henri Michaux, among others) that the psychedelic experience can be achieved with the eyes closed. In order to proceed in an orderly manner, I decided that throughout my experiments I would be concerned mainly with visual impressions (*i.e.*, eyes opened) but a few experiments were devoted to impressions with my eyes closed.

In attendance during the session was a trained clinical psychologist who administered the drug (75 micrograms of LSD-25 intravenously) and my wife, a physicist who is knowledgeable about moiré phenomena. They report that throughout the session (of six hours' duration) I was coherent and logical in my speech patterns. I recall an extraordinary amount of detail of that session which I rechecked with my wife. Most of the session was devoted

to repetitive viewing of the projection of the figures (transparencies) from my moiré kit² on to a smooth white wall.⁵ The projector used was of the overhead type (Bessler Vu-Graph) which allows one to move the transparencies about in a horizontal plane. A complication arose because of the choice of this projector in that it contains a Fresnel lens which introduced a further patterned structure. The projected image was about three feet square and was viewed at a distance of about seven feet. The viewing took place in a small country cottage free from external noises and all extraneous objects were removed from the room and the windows were curtained with plain paper. During the session I also examined under strong illumination (a 150-watt GE spotlamp) the illustrations in my moiré article,⁶ and various household objects as well as effects (for a short period) with my eyes closed. The session took place in the afternoon (between the hours of one and seven, preceded, by the way, by a very light lunch) in which the first four hours were devoted to the viewing of the projected images.

During the first few hours after the administration of the drug and especially between the first and second hour there was superposed on my vision a pleasant undulatory movement which I timed to be about 0.5 cycles per second (that is, one wave of two seconds' duration) which could conceivably be associated with the delta rhythm in electroencephalography.⁷ During the waning hour (between the fifth and sixth hour) of the session I found I could command myself, so to speak, to revert from the normal state to the drugged state.

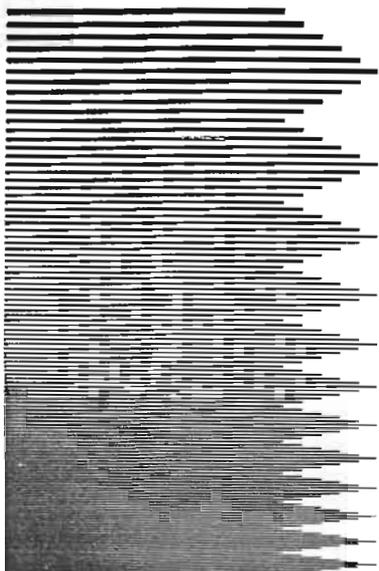
The feeble concentric ring structure of the projected image of the Fresnel lens of the projector, although barely perceptible to others, (*i.e.*, the psychologist and my wife) was clearly visible to me and seemed to be moving in and out of the projection screen. In addition I was acutely aware of specks on the image (arising from dust motes and scratches on the lens of the projector) which seemed to acquire a three-dimensional character. Those specks which were defocused appeared further away than the ones which were sharply in focus. With a little effort I was able to disregard these background images and to concentrate on the high contrast transparencies of the moiré kit. The figures were examined in no particular sequence. In fact, throughout the first four hours of the session all the transparencies were re-examined several times. There was no indication that the appearance of a figure was influenced by being preceded by another figure. In this article the number designation for a figure is that given in my book.²

The coarse grating (No. 1) with straight lines (equispaced parallel black and white bars) vertical showed nothing particularly unusual except that the lines wobbled slightly, the wobbling being

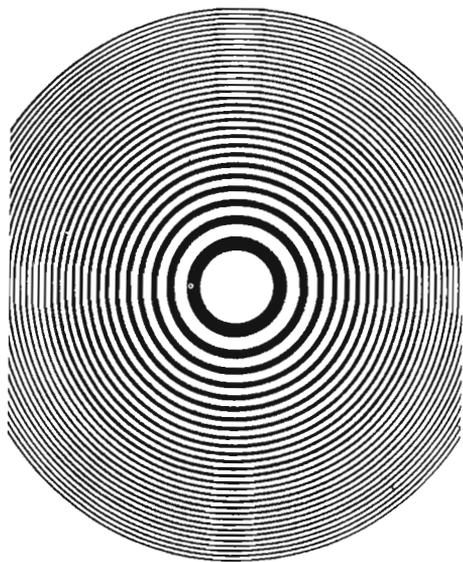
of the usual two-second period. The faintly-colored blue and yellow diamonds which are seen under ordinary conditions (see ref. 2, p. 24) are not enhanced by LSD. In contrast, the variable spaced grating (logarithmic spaced grating No. 3) appeared rich in detail, especially in the finer portions of the figure. The vertical lines appeared buckled (again in two-second waves) and were colored, purple being particularly prominent. Of considerable interest were the step markings of this figure.⁸ These markings (as individual lines) undergo slow successive rises and falls. The intensity of the effect (*i.e.*, the amplitude of the displacement in the vertical direction) was measured at various times. One-and-a-half hours after the drug was administered, the intensity was the greatest; was a minimum one hour later, rose slightly again after still another hour, and then trailed off. In other words, the intensity of the effect followed the same time-course curve⁹ as those obtained for large numbers of persons under LSD who were asked, "Do you feel dizzy?" Hence by the viewer actually measuring the displacement of the markings one has a convenient and reasonably quantitative measure of describing the extent of effect of one or another psychedelic drug. It should further follow that the counter-effects of tranquilizers could be evaluated in this manner.

The figure consisting of equispaced concentric circles (No. 5) showed rapid movement in the center rings which appeared to whirl at about ten cycles per second. Further from the center the circles appeared stationary. The zone plate (No. 6) which consists of concentric circles of equal areas between the circles (and hence become closer together as one goes out from the center) exhibited interesting activity in the center portion. In particular, the coarse center circle exhibited a slow eccentric gyration which imparted a rather gelatinous (or highly viscous) quality to the figure.

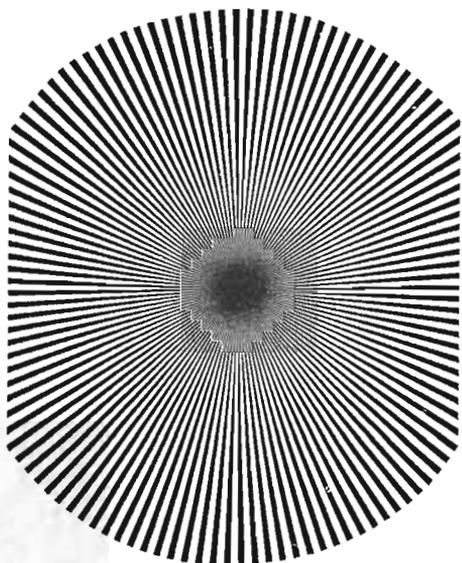
The radial figure (No. 4) consisting of radiating lines of equal angles is normally a very exciting figure. Staring at it reveals a swirling moiré pattern produced by the figure with its superposed displaced after-image, the movements being due to the saccadic (involuntary) movements of the eyeball. Under LSD this figure revealed no more features than are seen under normal conditions. This lack of feature with LSD provides a clue as to the nature of the screen which seems to be brought to the fore under the influence of the drug. The moiré phenomenon is most pronounced when the lines of the two superposed figures make a small angle. Conversely, when the lines are at right angles no moiré pattern is observed. Since the radial figure produced no special effect under LSD I conclude that the screen of the eye is a circular figure (and hence orthogonal to the radial figure). Histological studies of the human fovea¹⁰ (the point of fixation on the retina) reveals that it



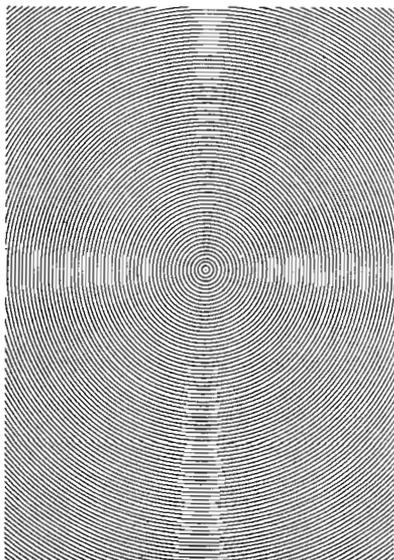
EDMUND SCIENTIFIC CO.
BARRINGTON, N. J. MOIRE PATTERN NO. 3



EDMUND SCIENTIFIC CO.
BARRINGTON, N. J. MOIRE PATTERN NO. 6



EDMUND SCIENTIFIC CO.
BARRINGTON, N. J. MOIRE PATTERN NO. 4



Negative of the circular figure used
as a transparency to simulate LSD effect

consists entirely of cones (the daylight illumination light receptors) each of which is connected by individual nerves which lead to the optic nerve via the "blind spot" of the eyeball. The nerves lie in front of the cones, *i.e.*, the light received is intercepted by a layer of nerve fibers (N.B. this region of the retina is free of capillaries). These nerve fibers would be expected to curve out and around the fovea to produce a screen consisting of curved lines which can be approximated as a figure consisting of concentric circles. I have made a screen (a photographic transparency) consisting of equispaced concentric circles of spacing 40 lines per inch with black regions twice that of the transparent lines. Under normal conditions this screen produces a view which simulates many of the effects of LSD. For this purpose the screen is held at a distance of about three inches from the eye and its center is slowly moved about while viewing a scene, the other eye being closed. The unfocused, and hence nearly imperceptible image of the screen, is superposed on the image of the object in question. I have viewed the projections of the transparencies described above while not under the influence of LSD and observed effects similar to those obtained while under the influence of the drug. Among the various LSD-like impressions one sees with the moving screen are the rotating moving of letters on a printed page and the ordering (a centering) of otherwise random structures (e.g., in the viewing of grass, sandpaper, etc.). When a flower having sharp pointed petals or leaves is viewed through the moving screen the flower takes on the appearance of underwater hydra-like movements. Edges of well-lit objects take on a lively appearance. Apropos of edges, I spent a considerable time under the influence of LSD trying to find out why objects looked "alive." A sharply defined edge has a visible pattern by virtue of the moiré pattern produced by the superposition of the diffraction image of the edge and its after-image.¹¹ LSD heightens this effect, possibly due to enhanced after-image production (but the duration of the after-images is normal). The wobbling of edges also has the appearance of emanations arising from the object. This may have, in the case of smell, the effect of making food seem more odoriferous.

Depth clues (or cues) are particularly effective under the influence of LSD even when the effects of the drug are waning. Thus, under the influence of LSD the cover of the May 1963 number of *Scientific American* which consists of red and blue lines on a white field appears three-dimensional, the red lines appear forward and the blue lines recede in the background. The black and orange circular patterns on the upper right hand corner of p. 61 of that same number of *Scientific American* appear as if the black circles are hovering far above the orange circles. The depth effects of the

scratches on the projector lens mentioned above are also due to this general phenomenon. Studies of the visual anomalies of persons judged to be suffering from schizophrenia show quite an opposite effect in this regard. These depth clues are not utilized in the normal manner¹² and the world appears as theatre backdrops (the "cardboard" world).¹³

Another demonstration of heightened perception of LSD was the fact that under the influence of the drug the circles of the figure on the lower right hand corner of p. 61 of the May 1963 number of *Scientific American* actually winked at me. That is, the circles (multiple zone plates produced by moiré) went in and out of phase. Closer examination of the figure after the LSD session revealed that the effect arose from subtle differences in projection effects or in reflectivity of the two inks used (black and orange) and the winking effect could be simulated, but to a much weaker degree, by varying the angle of observation of light from the page.

Another feature of the LSD experience is a heightening of colors. This effect can be duplicated by placing a screen over a multicolored patterned object (see ref. 2 pp. 24-25). The black portions of the screen isolate the colors from the white (and hence color-diluting background) to give an enrichment of the colors. This technique was used in my piece "Quadruple Colored Radial"³ which some viewers reported to simulate the color effects seen under the influence of LSD. If, as I have contended, LSD brings to the fore a screen in the eye one would expect to observe this color enrichment.

The space-filling aspects of LSD are very reminiscent of the effects one achieves with moiré patterns produced by a screen placed a certain distance from another screen. This floating quality of moiré has been discussed in my book² and many of my moiré constructions³ have this quality. Essentially, it arises from the shifting of points of intersection as one views the object from slightly different angles.

What I have tried to do in this essay is to attempt some rationalization of the remarkable visual effects one obtains with LSD. My experiments demonstrate that the primary effects of LSD are a tremendously heightened awareness of optical phenomena which are present but which are only vaguely (if at all) seen under normal conditions. I further conclude that all vision has a circular pattern superposed on it and LSD reveals the presence of this screen *via* the moiré effect. It may be a misnomer to regard visual hallucinations with LSD as being "hallucinations" (*i.e.*, perceptions with no external cause). In fact, LSD has, it seems to me, quite the opposite effect in that it makes us more aware of the

visual world without the usual rejection of "useless" information.

Following these lines along a little further, a few remarks are in order about the figures seen under LSD when the eyes are closed. It is well known (e.g., Paul Valery's *Monsieur Teste*) that in a restful mood prior to sleep and when the eyes are closed, visions of geometric patterns are seen. Children seem to "see" them clearly. The literature on these "visions" (phosphenes, as they are called) is quite extensive.¹⁴ Under LSD I found that phosphenes (notably a checkerboard figure) could be evoked particularly easily, apparently again a manifestation of heightened perception due to the drug, and was even more striking if I applied mild pressure on the temporal side of both eyes while closed. Phosphenes can also be produced by applying electrical current to the temples, especially if the voltage is in the form of a square-wave pulse of about 20 cycles per second. The type of figures obtained depends on the frequency.¹⁵ It is not unexpected, therefore, that electrically-produced phosphenes are enhanced by LSD.¹⁶ Here again, LSD may prove to be an important aid in revealing the structure and orderliness, judging from the highly geometric nature of the phosphenes, of the nervous system.

REFERENCES

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2. G. Oster, *The Science of Moiré Patterns*, Edmund Scientific Company, Barrington, N.J. This book is accompanied by a kit with which the reader may perform the experiments described in the book.
3. As exemplified by the one-man show "Oster's Magic Moirés," Howard Wise Gallery, 50 W. 57th Street, New York City, Feb. 5-27, 1965. Accounts of the show were given in, for example, the Village Voice (Feb. 18, 1965, p. 9), the New York Times (Sunday, Feb. 14, 1965, p. X17), and the New Yorker magazine (Feb. 25, 1965, pp. 24-26). Two more of my pieces appear in the Museum of Modern Art Show, "The Responsive Eye," Spring, 1965.
4. Aldous Huxley a) *The Doors of Perception* and b) *Heaven and Hell*, printed together as a paperback book by Harper and Row, New York and Evanston, 1963. See also c) *Island*, reprinted by Bantam Books, New York, 1963.
5. Some of the newer projection screens consist of a fine patterned structure. For the present experiments it is preferable to use some unstructured projection screen such as white cardboard or, in my case, the wall of the room which was of white painted composition board.
6. G. Oster and Y. Nishijima, "Moiré Patterns," *Scientific American*, May 1963.
7. See, for example, Chapter 3 of W. G. Walter, *The Living Brain*, W. W. Norton and Co., New York 1953.
8. Stephen Durkee has pointed out to me that these step markings are reminiscent of the ziggurat motif in Hindu art.
9. See, for example, F. Barron, M. E. Jarvick, and S. Bunnell, Jr., "The Hallucinogenic Drugs," *Scientific American*, April 1964.
10. S. L. Polyak, *The Retina*, Univ. of Chicago Press, Chicago, 1941. Especially Chapter 15.

11. This interesting optical phenomenon, which may be the origin of one of Cezanne's techniques, has been considered in detail, G. Oster, "Optical Art," *Applied Optics* 4, 1359, 1965.
12. See, for example, pp. 98-100 of C. Landis (edited by F. A. Mettler) *Varieties of Psychopathological Experience*, Holt, Rinehart and Winston, New York 1964.
13. P. Hackett, *The Cardboard Giants*, Putnam, New York 1952.
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15. M. Knoll and J. Kugler, "Subjective Light-Pattern Spectroscopy in the Electroencephalographic Frequency Range," *Nature*, 184, p. 1823, 1959.
16. M. Knoll, J. Kugler and O. Hofer, and S. D. Lawder, "Effects of Chemical Stimulation of Electrically-Induced Phosphenes on their Bandwidth, Shape, Number, and Intensity," *Confin. neurol.*, 23, p. 201, 1963.

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