# Reports and Letters

## Exposure Duration as a Variable in Perceptual Constancy

The perception of the size, shape, brightness, and color of objects may be considered a compromise between the constant physical characteristics and the continually varying retinal image properties of the objects. The usual tendency to emphasize the constant properties of objects is known as perceptual constancy. A major problem in the study of these phenomena is the explanation of the mechanism by which this perceptual stability is mediated. To gain some insight into the nature of this process, experiments were performed to determine the effect of reduced exposure duration on the perception of shape, size, and brightness (*1*).

In the first study (*2*), matches were made between a circular object that was rotated at various angles to the subjects' line of vision and a series of ellipses. The results obtained at a 1.0-sec exposure duration were typical of data obtained in constancy studies in that the matched ellipses were rounder than would be predicted from geometric optics, tending in varying degrees to approach the circularity of the object. With a decrease in exposure duration to 0.01 sec, this tendency toward constancy was destroyed, and the resulting matches were in good agreement with retinal image theory. Thus, in the perception of shape, reduced exposure duration eliminates the tendency toward perceptual constancy.

In order to determine the generality of this finding with respect to the perception of size and brightness, two additional experiments were performed in both of which a major variable was a comparison of data obtained at a long and at a short exposure duration. To determine the effect of reduced exposure duration on the perception of size, we had the subjects view one of a series of circular disks presented at distances from 12 to 192 ft and adjusted in size so that, regardless of distance, the visual angle subtended at the eye was constant at 1.07 deg of arc. A spot of light 65 ft distant in a dark corridor was matched to equal these disks in size for both continuous illumination of the disks and, for a different group of subjects, while viewed by the 0.0005-sec flash from a "strobotron" lamp.

The data are plotted in Fig. 1. On this graph, the horizontal line represents a prediction in terms of geometric optics.

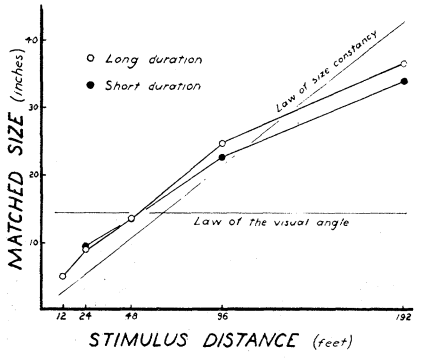


Fig. 1. Matched size as a function of distance at a long and a short duration of exposure for stimuli subtending the same visual angle.

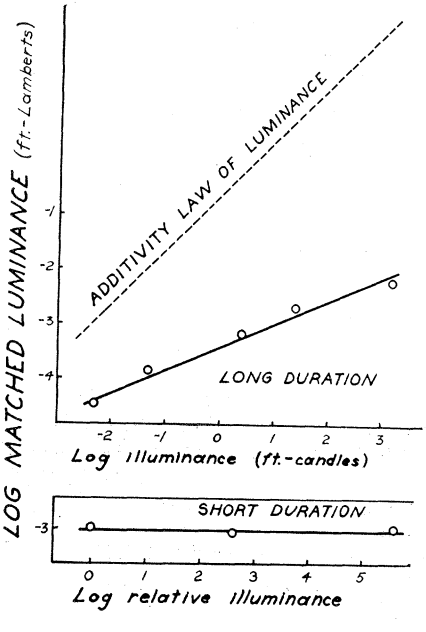


Fig. 2. Matched luminance as a function of field illuminance for a gray paper on a white background at a long and a short exposure duration.

The line labeled "law of size constancy" represents prediction in terms of constancy. The data for the long duration are in agreement with the results of previous investigators, especially those of Holway and Boring (*3*), after which this experimental arrangement was modeled. Perceptual constancy is good up to 96 ft, but it falls off slightly at longer distances. The data for the short duration are essentially identical with those obtained under continuous illumination, demonstrating that reduced exposure time has little effect on the perception of size.

In the third study on the perception of brightness, a square piece of gray paper mounted on a white background was viewed over an ambient illumination range of more than 100,000 to 1 and matched with a photometric field (*4*). The data obtained for continuous illumination and with a strobe lamp that provided flashes of 0.0005-sec duration are plotted in Fig. 2. On this graph, a line of unit slope represents an expectation based on energy relationships, and a line of zero slope represents a prediction in terms of brightness constancy. It can be seen that the effect of reducing the exposure time is to reduce the slope of this function so that it is brought more nearly in line with the law of brightness constancy.

Thus it can be seen how reduction of exposure duration differentially affects the tendencies toward shape, size, and brightness constancy. Shape constancy is reduced, size constancy is unaffected, and brightness constancy is improved. A possible interpretation from the results of previous experiments is that perceptual constancies depend on the presence in the visual field of stimuli in addition to the discriminative stimulus (*5*). If the same experimental procedure—for example, reduction of exposure time—affects the three types of measures differently, it follows that the additional stimuli and the process of interaction between these additional stimuli and the discriminative stimulus must, to some extent, be different, depending on the visual measure under consideration.

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### References and Notes

1. This research was sponsored by a grant from the research committee of the University of Wisconsin and by research grant M-1090 from the National Institute of Mental Health, National Institutes of Health, U.S. Public Health Service.
2. H. Leibowitz, E. Mitchell, N. Angrist, *Science* 120, 400 (1954); H. Leibowitz and L. Bourne, *J. Exptl. Psychol.* in press.
3. A. H. Holway and E. G. Boring, *Am. J. Psychol.* 54, 21 (1941).

4. For details of the apparatus see H. Leibowitz, N. Myers, and P. Chinetti, *J. Exptl. Psychol.* 50, 15 (1955).
5. C. H. Graham, in *Handbook of Experimental Psychology*, S. S. Stevens, Ed. (Wiley, New York, 1951), Chap. 23; for a review of the literature see also R. S. Woodworth and H. Schlosberg, *Experimental Psychology* (Holt, New York, rev. ed., 1954), Chaps. 15 and 16.

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## Studies on Tryptophan and Serotonin in Patients with Malignant Carcinoid

This is a report of an abnormality of tryptophan metabolism in patients with metastatic malignant carcinoid, a relatively rare disease that Thorson *et al.* showed to be associated with an unusual syndrome consisting of intestinal hypermotility, bronchospasm, vasomotor disturbances, and cardiac lesions (*1*). The demonstration of the presence of the pharmacologically active agent, serotonin (5-hydroxytryptamine), in carcinoid tumors (*2*) implicated it in the pathogenesis of this disorder. Since Thorson's report many additional patients with this disease have been reported.

A preliminary report from this laboratory indicated that the urinary excretion of 5-hydroxyindoleacetic acid (5HIAA), the major metabolite of serotonin, was greatly increased in patients with malignant carcinoid (*3*). Since previous animal studies had shown tryptophan to be the dietary precursor of serotonin (*4*), an investigation of tryptophan metabolism was undertaken in patients with this disorder (*5*).

Blood levels of serotonin were found to range from 0.6 to 3.0 μg/ml in carcinoid patients as compared with 0.1 to 0.3 μg/ml in normals. A tremendously elevated excretion of urinary 5HIAA, 70 to 800 mg/day in carcinoid patients as compared with 2 to 9 mg/day in controls, was found to be diagnostic of this condition (*3*).

The excretion of labeled 5HIAA following the administration of 2-$C^{14}$ DL-tryptophan to three of the patients demonstrated that in human beings tryptophan is the precursor of serotonin and its metabolites. A quantitative estimate of the defect in tryptophan metabolism in this disorder was shown in the following experiment. One patient was fed a diet that gave a basic daily intake of 500 mg of tryptophan, and at various intervals the tryptophan intake was increased. The daily excretion of total 5-hydroxyindoles and of 5HIAA was measured and nitrogen balance was determined, as shown in Fig. 1. The urinary excretion of 5-hydroxyindoles increased when the tryptophan intake was increased and returned to control levels when the original intake was resumed. At a daily intake of 500 mg, as much as 60 percent of the dietary trytophan was converted to 5-hydroxyindoles. In normals only about 1 percent is metabolized in this way. The normal requirement of tryptophan has been estimated by Rose to be 150 to 200 mg/day (*6*). If this is correct, then this patient was just maintained in nitrogen balance at an intake of 500 mg.

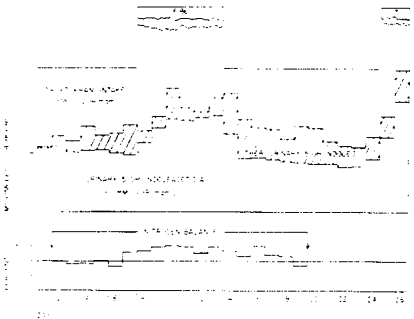

Fig. 1. The effect of variations in tryptophan intake on nitrogen balance and urinary excretion of 5-hydroxyindole compounds.

It is apparent that the carcinoid tumor is parasitic upon the tryptophan stores of the patient and, as a result, less of this amino acid may be available for formation of other metabolites, such as protein and niacin. Weight loss and hypoproteinemia are common features of the condition, and pellagra has been reported in several cases. The complex manifestations of this disorder may be related to both a serotonin excess and a tryptophan deficiency.

The conversion of what is normally a minor pathway of tryptophan metabolism into a predominant route of metabolism may make patients with malignant carcinoid useful in further studies on the biochemistry and physiology of serotonin.

Details of these studies will be published elsewhere (*7*).

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### References and Notes

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2. F. Lembeck, *Nature* 172, 910 (1953).
3. A. Sjoerdsma, H. Weissbach, S. Udenfriend, *J. Am. Med. Assoc.* 159, 397 (1955).
4. S. Udenfriend and E. O. Titus, *Amino Acid Metabolism* (Johns Hopkins Press, Baltimore, 1955).
5. Five patients with malignant carcinoid were studied at the National Heart Institute. Urine specimens were obtained from five additional patients at other institutions.
6. W. C. Rose, G. E. Lambert, M. J. Coon, *J. Biol. Chem.* 211, 815 (1954).
7. A. Sjoerdsma, H. Weissbach, S. Udenfriend, *Am. J. Med.*, in press.

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## Elastase Production in the Canine Pancreas

In 1950 Balo and Banga (*1*) reported the action of an extract of beef pancreas on pure elastin. The active substance, in view of its specificity, was termed "elastase." This work has been confirmed many times, and in addition these authors have reported that in human atherosclerosis the quantity of elastase extractable from the pancreas diminishes (*2*). Pepler and Brandt (*3*) demonstrated the action of elastase on the ground substance of aorta; the possibility of this enzyme's playing a part in the development of atherosclerosis has been noted further recently (*4*).

The following observations have been made concerning the production of elastase in dog pancreas. Pancreatic function in healthy mongrel dogs was modified by the following procedures.

1) Alloxan destruction of beta cells in the pancreatic islets. Two doses of alloxan (75 mg/kg. body weight) were given intravenously at 24-hour intervals. The animals were sacrificed 24 hours after the last dose. The loss of granules in the beta cells was demonstrated histologically.

2) Destruction of both alpha and beta cells in the pancreatic islets. Two doses of alloxan were given as before; following the last dose, 300 mg of cobalt chloride in 25 ml of water were given intravenously at hourly intervals for three doses. The animals were sacrificed 1 hour after the last dose. Complete lysis of both alpha and beta cells was demonstrated histologically.

3) Destruction of the pancreatic acinar tissue. Progressive destruction by fibrosis was produced by gradual occlusion of the pancreatic duct by a magnesium band placed about the duct. The technique, described elsewhere (*5*), provides both fibrosed and normal pancreatic tissue for assay in the same animal.

Elastase assays of residual pancreatic tissue were made by the method of Hall and Gardiner (*6*), over an incubation time of 18 to 20 hours, after preparation of the extracts by the method of Balo and Banga (*1*).

The elastolytic activity of pancreatic extracts varies a little with the elastin preparation and the results shown here in group 1 and groups 2a and 2b represent experiments carried out on three separate preparations of elastin.

*Group 1a* (control). Thirty-one assays of normal pancreatic tissue had an average elastolytic activity of 0.51 mg of elastin per hour (S.D. = 0.12).

*Group 1b* (experiment). Sixteen assays of pancreatic tissue modified by the administration of alloxan (method 1) showed an average elastolytic activity of 0.31 mg per hour (S.D. = 0.112).