It is tempting to explain the qualitative similarity of behavior between our normal monkeys and Klüver's operated animals in terms of constancy phenomena. Klüver has suggested that exclusion of the geniculostriate system eliminates perceptual constancies of brightness, size, distance, shape, and so forth. Studies on humans have shown that constancies may be considerably decreased when background cues are reduced (*10*), and it might be argued that our normal animals tend to ignore the luminance of the stimuli in our situation where brightness constancy may be reduced (transilluminated figures with little background). However, experimental data to substantiate this interpretation are lacking at present.

Since this study was primarily designed to delineate the response determinants in the B-F problem, no clear conclusions can be drawn concerning the stimulus parameters used to solve the B/A task. The significant difference between the two sets of A-F trials indicate that the animals do not discriminate the same parameters on the B-F and B/A problems. In fact, the results on the A-F trials following this latter test suggest that various animals may solve the B/A problem in different ways.

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### References and Notes

1. F (lumens) = B (ft-lam) × 0.001076 A (where A is in square centimeters).
2. Brightness is the psychological correlate of retinal illumination, which in turn depends on the target's luminance as the psychophysical determinant. Intensity as a psychophysical dimension applies only to point sources (amount of light per unit solid angle) and consequently the use of this term is inappropriate for the kind of test under consideration [Optical Society of America, *J. Opt. Soc. Amer.* **34**, 244 (1944)].
3. M. P. Crawford, *Genet. Psychol. Monogr.* **17**, 77 (1935); H. Klüver, *Biol. Symposia* **7**, 253 (1942).
4. Report in preparation.
5. H. Klüver, *Behavior Mechanisms in Monkeys* (Univ. of Chicago Press, Chicago, 1933), pp. 19–25.
6. The B values were obtained by averaging 20 readings made with a Macbeth Illuminometer.
7. There is some indication that normal cats may exhibit this same type of behavior: P. Schilder, *J. Neurophysiol.* **29**, 888 (1966).
8. H. Klüver, *J. Psychol.* **11**, 23 (1941).
9. P. Pasik and T. Pasik, *Disturbances of the Occipital Lobe,* (Proc. 8th Intern. Congr. Neurol., Vienna, 1965), vol. 3, pp. 127–130.
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11. We thank Victor Rodriguez for assistance in training the monkeys. Supported by PHS grants MH-02261 and K3 NB-16,865.

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# Behavioral Thermoregulation in the Desert Iguana

McGinnis and Dickson (*1*) have stated that there is a close similarity between the mean body temperatures of desert iguanas (*Dipsosaurus dorsalis*) in experimental thermal gradients (39.0°C) and those of active desert iguanas in nature, as studied by Norris (42.1°C) (*2*). However, there is a considerable difference, amounting to abou 3°C, between these means, and to overlook this fact obscures an important feature of thermoregulatory behavior in this species. That this difference between laboratory and field records can be significant is demonstrated by statistical analysis of similar data (*3*), for which standard deviations are available, which show a similar difference of about 3°C and demonstrate (*4*) a highly significant difference [$P<$ .001 that the two means ($\mu_1$, $\mu_2$) are equal ($H_0 : \mu_1 = \mu_2$)]. Such a significant difference is frequently observed between laboratory records and records made under the extremely hot conditions which prevail especially during summer (*5*). Under more moderate thermal conditions, as are those prevalent during spring and fall, significant differences between field and laboratory animals often do not exist; this fact is demonstrated by McGinnis and Dickson in their statistical comparison of their field records of late spring and their laboratory records, both of which have means in the preferred level of 38° to 39°C.

The higher mean body temperatures of desert iguanas under hot environmental conditions of summer are due to the fact that they abandon regulation at the preferred level under these conditions. Under such conditions there are no areas available within their territories, exclusive of burrows, cool enough to permit attainment of body temperatures as low as the preferred level of 38° to 39°C. When these conditions prevail, desert iguanas do not immediately retreat to their burrows, but usually seek the coolest place in their territory, and, if these places gradually warm up, as is common during the earlier portion of the day, these lizards let their body temperatures rise as high as the temperature at which panting begins (43° to 44°C). Under severely hot conditions of summer, therefore, it is not unusual to record body temperatures whose mean may be 42° or even 43°C, a value which may be as much as 4°C above the preferred level of body temperature as determined in experimental thermal gradients (*3, 5*). The coolest places in the territory, exclusive of burrows, frequently are located in the heights of bushes as a consequence of the usual thermal inversion. It also is not unusual during these hot conditions to find that, of those desert iguanas outside burrows, most or all are in these coolest locations, particularly toward the end of the activity period (*2, 5*). But, as demonstrated by the observations reported by McGinnis and Dickson, desert iguanas under the more moderate thermal conditions of spring may not resort to climbing bushes since temperatures suitable for regulation near the preferred level are available elsewhere in the territory. When the threshold for panting is reached, desert iguanas usually do not pant, but retreat instead to burrows they have constructed to such depths that a temperature of 39°C or lower always is available (*3, 5*).

This feature of thermoregulatory behavior which permits abandonment of the preferred body temperature and conformance to the coolest available environmental conditions is of real importance to the success of desert iguanas in severely hot environments since it serves to prolong the period during which their various necessary activities may be conducted. On extremely hot days, for example, the period during which desert iguanas have environmental thermal conditions available which permit regulation at or near the preferred level is very brief, sometimes only about 30 minutes, thus severely restricting activities outside of burrows. By permitting body temperatures to rise above the preferred level, however, desert iguanas may increase this period to as much as 3 hours under these same conditions. This feature, which apparently is not restricted to desert iguanas, may not only permit increased activity periods, but, as a consequence, may also permit colonization of habitats which otherwise might be too hot. This feature of behavioral thermoregulation may very well be a major contributing factor to the success of diurnal lizards in hot desert environments (*3, 5*).

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2. K. S. Norris, *Ecology* **34**, 265 (1953).
3. C. B. DeWitt, *Amer. Zool.* **2**, 403 (1962).
4. The means with their corresponding standard deviations are: for desert iguanas under laboratory conditions, 38.9° ± 0.9°C; under summer field conditions, 41.9° ± 1.2°C. Student's *t*-test for these populations has a value of 9.
5. C. B. DeWitt, thesis, University of Michigan, Ann Arbor (1963); ———, *Physiol. Zool.* **40**, 49 (1967).

4 August 1967

DeWitt's comments are a valuable postscript to our paper. What appears to be a rather loose statement concerning the close similarity of body temperatures (means) obtained in the field with mercury thermometers and those acquired in a laboratory thermal gradient from lizards implanted with miniature thermal transmitters stems from an unfortunate omission of a second reference (*1*) which appeared in the first manuscript but which was evidently lost in the revision. The fact that the plural noun "means" was followed by only a singular reference was overlooked by both the reviewers and the authors. The omitted mean of Cowles and Bogert (37.4°C) places the mean in the laboratory near the midpoint of means in field experiments reported for this species. This was the intended implication of the statement. We certainly did not intend to imply that there are no statistical differences between reported means. Indeed, the major point of an earlier paper (*2*) concerning the preferred body temperature of the western fence lizard is based on a 3°C difference in means.

As to the statement that the desert iguana abandons temperature regulation at preferred levels under hot environmental conditions, we feel that this hypothesis requires some further study and consideration. Such an abandoning of preferred mean body temperature for a higher mean implies acclimation to higher environmental temperatures, a phenomena which has not been demonstrated in heliothermic lizards. Indeed, a reverse condition has been shown for two species (*3*).

There is also the question of how the burrow and the lower temperatures which it offers should be viewed in the regulatory scheme. In our spring study, the burrow appeared to be a permanent retreat area. Once lizards emerged in midmorning they remained above ground until midafternoon. Norris (*4*), however, reports a bimodal picture of surface activity in which the burrow was not only an evening retreat but also an area to which to escape during excessive midday temperatures. If one acknowledges the burrow as a substitute for shaded surface areas which on summer days offer no suitable thermal relief, then body temperatures acquired in these burrows between morning emergence and evening retreat should contribute to the preferred daily mean. With such an interpretation, the resulting summer mean may deviate only slightly if at all from means obtained in spring or in the laboratory.

Finally, one may expect to see consistently lower means obtained through biotelemetry compared to those obtained by capturing a lizard and taking its cloacal temperature with a mercury thermometer. The "grab and jab" method appears rather bias to those lizards in full sun and plain view as opposed to sequestered individuals in deeply shaded surface areas.

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## Stability of Biogenetic Opal

Wilding (*1*) described the isolation of 75 g of biogenetic opal from 45 kg of soil and the dating of the occluded carbon within opal phytoliths at 13,300 ± 450 years before the present. He concluded, therefore, that biogenetic opal is stable for relatively long periods and may be useful for radiocarbon dating. With respect to the stability of biogenetic opal, there is also paleontologic evidence that is relevant.

Smithson (*2*) described phytoliths from the fine sand and certain fractions of British soils. He recognized that these opaline bodies came from plants, especially grasses. In the same year Baker and Leeper (*3*) recognized phytoliths in Australian soils, but concluded that "the mean life of these phytoliths in soil may not exceed the order of a thousand years, otherwise they would have accumulated to a greater extent than the one or two percent commonly found." Baker (*4*) stated that the term phytoliths could be used for both recent and fossil microscopic bodies of this nature "if fossil examples are subsequently shown to exist"; later (*5*) he reported success in discovering fossil opal phytoliths. Baker (*6, 7*) also referred to the phytoliths that appear in diatomaceous earth and similar deposits in the Tertiary and Quaternary sediments of Victoria. Being involved at that time with large numbers of slides of fossil diatoms prepared by B. Tindale, and anticipating that phytoliths would occur in the same conditions that had preserved the diatoms (since they are of similar chemical composition), I examined the slides and discovered that phytoliths were indeed present. I began with Holocene deposits, and then examined slides of still older floras extending back to Upper Pliocene age; the latter were found to contain opal phytoliths. The Upper Pliocene deposit referred to occurs on the Grange Burn, 6 km (4 miles) west of Hamilton, Western Victoria. It is overlain by a basalt flow which has been dated by the potassium-argon method as 4.35 million years old (*8*).

Thus, to the evidence of Wilding there can be added the paleontologic evidence from Australia which indicates that biogenetic opal is indeed stable for long periods of time under certain chemical conditions. It should be noted that while Wilding's date of 13,300 years is for biogenetic opal in soils, the paleontologic evidence quoted here is for phytoliths that have been preserved in deposits in a condition of chemical reduction.

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