within confined areas. Each is the dominant species within its habitat. Both habitats feature open grassland, permanent water, and low-lying areas subject to flooding. Both kob (9) and lechwe prefer to locate leks on high or exposed ground which is dry but adjacent to water. At Lochinvar, few sites fit all these requirements, a circumstance appropriate for the development of a type of territoriality in which numbers of territories are compressed together on a few suitable locations. A related finding is that lekking was never observed outside the main rutting season, when the frequency of mating was lower. Apparently, a necessary condition for lekking is a large number of adult males simultaneously rutting.

The ecology of the Kafue Flats may also be responsible for some unique features in the lekking behavior of lechwe. There are variations in flood levels from year to year and gradually rising flood levels during each lekking season. Two leks seen at the start of the season were empty a month later; a fourth lek was not seen until midway during the main rutting season when most lechwe had migrated off the floodplain. Reproduction seems to be organized around a succession of temporary leks as the lechwe migrate to higher ground. This could explain the almost continual chasing and fighting. On new leks, territories can only be marked by means of behavioral displays. There are no conspicuous areas of cropped grass, bare ground, or excrement to denote territorial areas. This should contribute to a more unstable situation in which neighbors are more likely to wander into each other's territory, precipitating territorial conflict.

It has been suggested that seasonal territoriality in antelope can be usefully subdivided into three stages corresponding to successive periods when territories are established, maintained, and dissolved (2). Aggression is supposedly most frequent and intense during the initial stage as contestants vie for possession, establish boundaries, and expel competitors. Lechwe lekking may be an example of a system that is perpetually in the early stages of territoriality.

RICHARD H. SCHUSTER
Department of Psychology, University of Zambia, Post Office Box 2379, Lusaka, Zambia, Africa

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7. A hydroelectric project under construction on the Kafue River is scheduled for completion in 1978. This includes dams up- and downriver from the lechwe habitat and could alter the ecology of the area by reducing the extent and increasing the duration of the annual flooding cycle. This, in turn, would reduce the amount of grass available for forage. Thus the lekking patterns described here may be affected by reduction in population density and by interference with the annual migrations across lekking areas. The future of the Kafue lechwe is therefore uncertain.
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10. I thank the Kafue Basin Research Program of the University of Zambia and the Fauna Preservation Society of the Zoological Society of London for continuing financial support and the Zambia Electricity Supply Corporation for donation of a land rover to the Kafue Basin Research Program. The Department of Wildlife and National Parks of the Ministry of Lands and Natural Resources gave permission for the study to be carried out at Lochinvar Park. My children, Ben and Ruth, and my student, S. P. T. Nyandiya, provided many observations contained in this report. The first draft was written while I was a visiting research fellow of the Laboratory of Experimental Psychology, University of Sussex, Falmer, Brighton, England.

25 November 1975; revised 30 March 1976

Evaluation of Transcendental Meditation as a Method of Reducing Stress

Abstract. *Transcendental meditation is said to induce in its practitioners an altered state of consciousness resulting in relief of stress, an increased sense of awareness, and a sense of well-being. Release of catecholamines has been associated widely with stress and lends itself to quantitation. Plasma epinephrine and norephinephrine, as well as lactate, were measured in 12 volunteers before, during, and after meditation. Values were compared with those obtained from controls matched for sex and age who rested instead of meditating. Essentially the same results were obtained for the two groups, which suggests that meditation does not induce a unique metabolic state but is seen biochemically as a resting state.*

Among the physiological and biochemical changes that accompany stress are increased concentrations of catecholamine in the blood (*1*). Exposing rats to brief, but repeated, stressful situations permanently raises concentrations of catecholamine in urine (*2*). Although some degree of stress appears to be essential for the success of both a society (*3*) and the individual (*4*), our society has become concerned with relieving stress. Some 900,000 persons in the United States (*5*) are reported to practice transcendental meditation (TM), a technique said to produce relief from stress, increased awareness and productivity, and a state of well-being.

Physiological changes characteristic of rapidly induced, wakeful hypometabolic states have been described during the practice of TM. These include changes in electrodermal activity (*6*), electroencephalographic waves (*7*), oxygen consumption, carbon dioxide elimination (*7, 8*), respiratory rate (*7, 8*), blood pressure, (*7*), and heart rate (*7*). Biochemical measurements reported to be altered during TM include blood pH and lactate concentrations (*7*). In most of these studies the meditating subjects served as their own controls.

Our investigation was undertaken to determine whether the relief from stress apparently achieved by practitioners of TM is translated biochemically in terms of plasma catecholamine or plasma lactate concentrations. (The latter can reflect alterations in availability of oxygen to tissues.)

Twelve volunteers, six males and six females, from the Students International Meditation Society served as subjects for the study. All 12 had received standardized instruction in TM. Nine were trained by the Society and were qualified as teachers by Maharishi Mahesh Yogi, the originator of the technique.

The selection of the meditators was essentially random. The only conditions placed on their acceptability were (i) that they had been active meditators for at least 12 months, (ii) that they were not routine users of drugs, and (iii) that, to the best of their knowledge, they were free of any acute or chronic disabilities. Their ages ranged from 21 to 50 years with a median of 25. All members of the group were Caucasian. Nine volunteers from the research unit who were unfamiliar with the technique of TM were chosen to approximate the age and sex distribution of the experimental group.

A spacious, pleasant, quiet room equipped with arm chair and hospital bed for the subjects and desk and chair for the technologist was set aside for the meditators. Only one subject was tested on any given afternoon. The subject came to the unit at 2:00 p.m., and one of the investigators reviewed the purpose and the design of the experiment with him or her.

The subject was allowed to sit comfortably in the chair or on the bed. A butterfly needle was inserted into the anticubital vein, and the zero time sample was obtained. (All blood samples were 7 ml.) During the next 20 minutes, a habituation period, the technician chatted with the subject and completed the details of the record, which included information about food and drink consumed that day, use of medications, and so forth. (Two of the subjects, one male and one female, were excluded from the study because they had been on medication during the preceding week.) A second blood sample was obtained at the end of the habituation period; a third was taken at the end of a further 15-minute control period during which the subjects sat with their eyes open but without talking. The subjects were then asked to start meditating or, in the case of the controls, to sit quietly with their eyes closed. Meditation periods ranged from 20 to 30 minutes, depending on the subject's usual habits. Blood samples were obtained after two equal intervals and at the end of the period. The subject remained seated for another 10 minutes with eyes open,,after which a seventh and terminal blood sample was drawn.

The butterfly needle was kept patent between samplings with a lock consisting of a solution containing 100 units of heparin per milliliter of physiological saline. Residual heparin solution in the tubes and the first 1 ml of blood were discarded in each instance before the actual sample was collected.

Blood for the catecholamine determination was placed in chilled heparinized tubes (Vacutainer) to which 10.5 mg of glutathione (Sigma) in 0.2 ml of water had been added. Immediately after the blood was drawn the tubes were mixed and returned to an ice bath. Blood to be analyzed for lactic acid was placed in heparinized tubes containing no other additives. The specimens were centrifuged in the cold within 90 minutes; the plasma was removed and stored at −70°C until it was assayed.

Plasma epinephrine and norepinephrine were assayed by a modification of the single isotope derivative procedure of Passon and Peuler (*9*). Plasma lactate was determined by the method of Hohorst as modified by Henry *et al.* (*10*).

Table 1. Stabilization of catecholamine concentrations in the blood with time. These data were obtained from 18 normal control subjects. Venipuncture was performed immediately after the subject was seated. Table entries are means ± the standard errors of the means.

Time (min)	Norepinephrine (pg/ml)	Epinephrine (pg/ml)
Zero	370 ± 40	41 ± 5
20	320 ± 50	43 ± 6
35	310 ± 50	36 ± 6

Day-to-day reproducibility of the assay was monitored by including a plasma pool. The coefficient of variation for the plasma pool was ± 9.6 percent for norepinephrine and ± 32 percent for epinephrine. Although the coefficient of variation for epinephrine is extremely high, absolute values are low; that is, the pool for which this measurement was obtained was evaluated as 43 ± 5 pg/ml (*11*), whereas the norepinephrine on the same pool measured 342 ± 11 pg/ml. The importance of drawing blood samples for plasma catecholamine determinations under uniform conditions (for example, erect, sitting, or supine) has been emphasized (*12*).

In 20 minutes, plasma catecholamine concentrations become sufficiently stabilized to overcome variations due to position and venipuncture (*13*). This was verified prior to our study in a group of control subjects (Table 1). Zero time for the 19 subjects in our study was defined as the point at which the venipuncture was completed (a time by which the majority of subjects had been seated for 10 to 30 minutes).

Mean concentrations of norepinephrine, epinephrine, and lactate in the plasma for each interval studied were plotted as bar graphs and compared with corresponding data obtained from the control group (Fig. 1). The reproducibility and deviations obtained for each series of measurements suggest that the enzymatic, single-isotope derivative technique (*9*) is satisfactory for the study of plasma norepinephrine fluctuation under physiological and pathological conditions. Because normal concentrations of epinephrine in the plasma lie near the limit of sensitivity of the procedure, small physiological fluctuations cannot be followed by this assay. Only as variations approach ± 95 percent (3 standard deviations) of normal physiological levels can they be considered meaningful.

In our study the anticipated decrease of plasma norepinephrine concentrations between the 0 time and the 20-minute

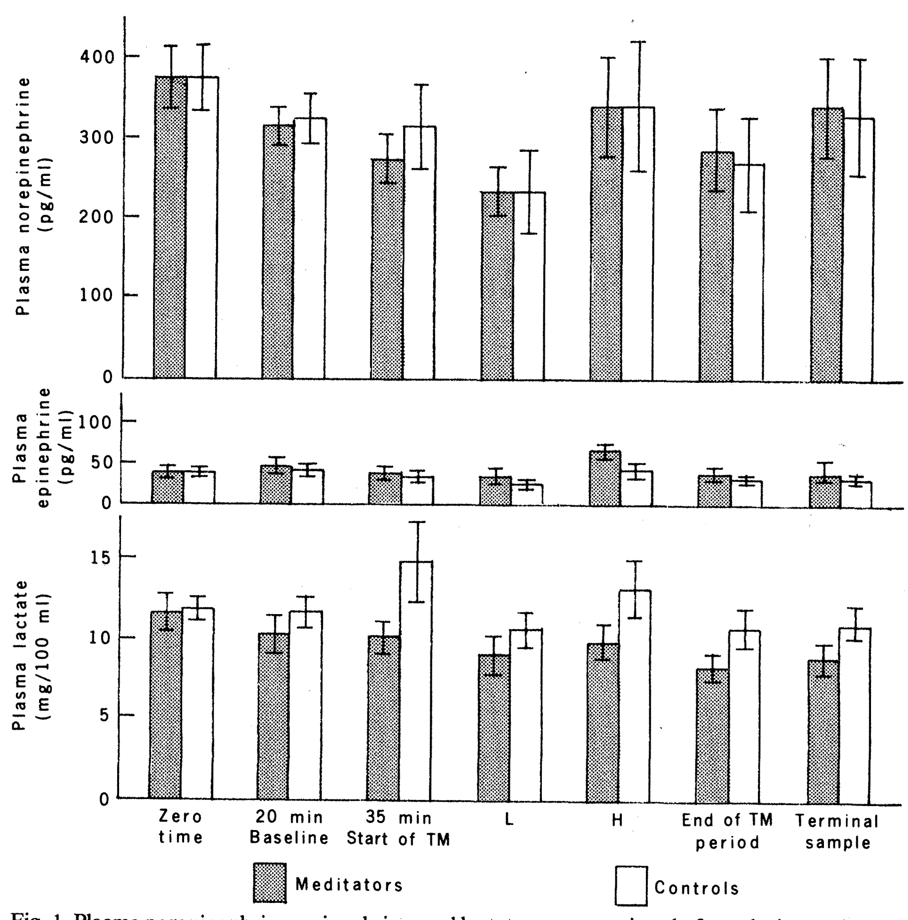

Fig. 1. Plasma norepinephrine, epinephrine, and lactate concentrations before, during (*L*, lowest; *H*, highest), and immediately after periods of transcendental meditation and rest.

"baseline" was noted. That latter averaged 307 ± 24 (*11*) and 290 ± 38 pg/ml for TM and control groups, respectively. Norepinephrine values for individual subjects fluctuated over the next 45 to 55 minutes, with mean coefficients of variation of ± 26 and ± 25 percent for the two groups, respectively.

A comparison of average norepinephrine levels during the actual meditation period (303 ± 38 pg/ml for the TM group, 270 ± 45 pg/ml for the control group) with the averages obtained from the 20-minute, 35-minute and terminal measurements (328 ± 39 and 302 ± 43 pg/ml respectively) indicates perhaps that rest, rather than TM, decreases plasma norepinephrine concentrations. A high correlation (r = .81) between the norepinephrine measurements of the two groups in those periods indicates constancy of ranking of individual subjects. Thus the physical situation, that is, being seated (resting in this instance) appears to modify but not override characteristic individual plasma norepinephrine levels.

Within the limits of the sensitivity of the assay, no significant fluctuations of the plasma epinephrine levels were recorded during meditation. Neither were significant differences (α = .05) observed between controls and meditators.

Plasma lactic acid concentrations were lowest during or 10 minutes after meditation. Again, observed differences among these measurements were not significant, either within a group or between the two groups.

The problem of whether or not our subjects were meditating "properly" is a difficult question to answer objectively, but eight of the ten subjects were qualified teachers of TM, and all the subjects reported having had a "good" meditation. It follows that, while a psychological benefit may be derived by its practitioners from the act of TM, it cannot be expressed in terms of the biochemical parameters measured by this study.

Woolfolk (*14*) pointed out that a thoroughly consistent, easily replicated pattern of responses to meditation remains to be demonstrated. Our results are consistent with those of a study of sleep during TM by Pagano *et al.* (*15*), which concluded that TM does not induce a "unique state of consciousness" such as the "wakeful hypometabolic state" described by Wallace *et al.* (*7*).

R. R. Michaels, M. J. Huber
D. S. McCann

Research and Education, Wayne County General Hospital, Eloise, Michigan 48132, and *University of Michigan, Ann Arbor 48104*

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23 February 1976

Retardation of Autoshaping: Control by Contextual Stimuli

Abstract. *Training pigeons with random presentations of a tone and food proactively interferes with the acquisition of autoshaped keypecking to a lighted key. The interference effect is context-specific (observed only when testing for autoshaping occurs in the initial training environment). An interpretation based on blocking by background cues is suggested by the data.*

Brown and Jenkins (*1*) have reported that hungry pigeons spontaneously begin pecking a lighted response key if illumination of the key signals that grain is forthcoming. Acquisition of such "autoshaping" has been shown to be governed by the Pavlovian relation between the lighted key (conditioned stimulus, CS) and the grain (unconditioned stimulus, US) rather than by the instrumental relation between the keypecking response and the food reinforcement (*2, 3*). Theoretical accounts of autoshaping subscribe, with various degrees of reservation, to a Pavlovian model of the phenomenon (*4*).

Despite the reliability with which autoshaping normally develops, some manipulations during initial training can interfere with the subsequent acquisition and maintenance of autoshaping. Uncorrelated presentations of the key-light and food (*2, 5–7*), of houselight and food (*8*), and unsignaled presentations of food (*9, 10*) all retard the acquisition (*6–9*) or maintenance (*2, 5*) of autoshaping in pigeons.

Several investigators have suggested cognitive mechanisms of "learned irrelevance" (*6*), "general attention" (*8*), and "learned laziness" (*9*) to account for the retardation of autoshaping that follows the manipulations. Although the particulars of these accounts differ, they share the premise that the retarded acquisition of autoshaping results from associative interference engendered by the initial training with an unpredictable US. That is, subjects exposed to a situation in which the occurrence of the US is unpredictable presumably learn that it is unpredictable. This learning transfers to the autoshaping situation, where it proactively interferes with the acquisition of autoshaping.

While such an interpretation is consistent with the data on autoshaping and is compatible with interpretations of related Pavlovian phenomena (*11*), alternative mechanisms of Pavlovian associative retardation could conceivably provide a unified account of the retardation effects. For example, Kamin (*12*) has demonstrated that conditioning to a novel CS can be retarded if that novel CS is compounded with another CS that had been previously conditioned to the US (CS_x). The magnitude of such "blocking" is directly related to the amount of CS_x conditioning that preceded the introduction of the novel CS. Therefore, a blocking interpretation can account for differences in the acquisition of autoshaping if CS_x is more highly conditioned in the groups that are retarded than in the groups that are not.

A blocking stimulus must be (i) present during initial training, (ii) associated with the US during initial training, and (iii) compounded with the lighted key CS during autoshaping. The static, situational, contextual stimuli of the conditioning environment become associated with the US (*13, 14*). Such stimuli can subsequently prevent the lighted key CS from controlling operant keypecking in pigeons (*14*). Furthermore, the procedures that retard autoshaping are also those