

ASSESSMENT OF MOTIVATION IN THE LIZARD, *CHALCIDES OCELLATUS*

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Abstract

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The purpose of this study was to assess whether running an alleyway can be used to measure the motivation of lizards. Six, eyed skinks, Chalcides ocellatus, were trained to run an alleyway to reach sand in which to hide. Each skink was deprived of sand for 0, 1, 5 or 15 minutes on four occasions and the times to run the alleyway and the latencies to move were recorded. When the sand was 38cm from the start, the three deprivation periods resulted in decreased latencies and increased speed ($P < 0.01$), but there was no difference between the speeds or latencies for any of the deprivation periods. In a second experiment, the sand was moved to 94cm from the start. Latencies to move did decrease ($P < 0.05$) as in the first experiment, but speed did not increase. Within certain constraints, this methodology appears to be a good way of assessing motivation of reptiles.

Keywords: animal welfare, eyed skink, lizard, motivation, substrate deprivation.

Introduction

To improve animal welfare, it is important to know what matters to an animal. To a certain degree this will remain a subjective judgement, but it is possible to measure an animal's motivation for a reinforcer using operant behaviour. By conditioning an animal to peck a key, press a lever or run an alleyway to obtain a reward and then varying the amount of work required, it is possible to assess the importance of that reward to the animal (Dawkins 1990). If the animal is willing to work increasingly harder (ie make more operant responses) for the reward, it is said to show inelastic demand and the reward can be deemed a 'necessity' (Dawkins 1983). Conversely, if the response rate declines with increasing work load, the animal is showing elastic demand and that reward is deemed a 'luxury'.

It is important to measure a response that may be part of the species-specific behaviour since, not all operant responses may be equally learned (Roper 1983). Extensive training of the animals is often needed for them to make the correct response (Petherick & Rutter 1990) and in some cases, the response may not be learned at all (Dawkins & Beardsley 1986). If a manipulandum is used, one that accommodates species-specific behaviour patterns will be more useful and give a more accurate measure of motivation (Young 1993; Young *et al* 1994). In the past, many different ways of measuring motivation have been tried with varying degrees of success. The 'Skinner box', developed by Skinner in 1932, required a rat to press a lever in, to receive a reward. This methodology has been adopted and modified in numerous more recent studies (eg Roper 1973; Abramson & Feinman 1990). Animals have been conditioned to press panels (Lawrence *et al* 1988), peck keys (Faure 1994), break

a photo beam (Baldwin & Meese 1977) or root and chew on a paddle (Young *et al* 1994). Petherick and Rutter (1990) trained hens to push a computer-controlled door to gain access to food. Petherick *et al* 1992 trained hens to run an alleyway for a food reward. There are many other published studies using operant conditioning with farm animals (for a review, see Kilgour *et al* 1991).

The only two studies that we are aware of using operant conditioning techniques with lizards, were to measure their thermoregulatory abilities (Kemp 1969; Kingsbury 1993). We are unaware of any motivational studies being carried out with lizards. In the majority of studies with birds and mammals, food is the commodity showing the most inelastic demand (Dawkins 1990). It has therefore been suggested as a baseline commodity, to which other reinforcers should be compared (Dawkins 1990; Hogan & Roper 1978). Food is an inappropriate baseline for reptiles since their metabolism is largely environmentally controlled and they can survive extended periods without it (Mattison 1987). Other factors such as security from predation are of more immediate importance, especially for small, vulnerable lizards. In this experiment we investigate motivation of a small skink, *Chalcides ocellatus*, for sand. These lizards live in arid, often sandy regions of south-eastern Europe and North Africa and often burrow beneath the surface to search for food, escape from predators or avoid overheating from the sun (Mattison 1987).

This experiment assesses motivation by measuring speed to run an alleyway (see Petherick *et al* 1992). Decreased latencies to move and increased speed along the alleyway, with increasing deprivation periods, would indicate increased motivation for the sand.

Material and methods

Animals

Six captive-bred eyed skinks, *Chalcides ocellatus*, served as subjects. They were maintained in a wooden vivarium (75cmx30cmx15cm) filled to a depth of 4cm with bird sand. Heat and light were provided by a 100W spotlight positioned at one end to give a temperature gradient of 25–35°C. This was maintained for a 12-hour period, (0800 to 2000), the vivarium cooling to room temperature (22°C) at night. Food, in the form of mealworm larvae, *Tenebrio molitor*, and black crickets, *Gryllus bimaculatus*, was provided twice a week. Water was available *ad libitum*. Each lizard was assigned a number and their physical details recorded (Table 1).

Table 1 Individual lizard details.

Lizard	Age (years)	Sex	Weight (g)	S-v length (mm)
1	5	F	48	135
2	5	M	36	130
3	5	F	30	130
4	1	NK	38	135
5	1	NK	19	100
6	1	NK	12	95

F = female, M = male, NK = not known, S-v length = snout to vent length

Apparatus

A cardboard alleyway 150cm long, 20cm wide and 24cm high was constructed (Figure 1). A raised floor of height 4cm was inserted so that a 4cm deep sand pit (23x20cm) could be installed without presenting a raised barrier. Both ends of the alleyway were sealed and vertically sliding partitions were installed in order to form separate areas for substrate deprivation (18x20cm), a start zone (10x20cm) and to allow the sand pit to be moved to vary the running distance. The raised floor allowed a low wattage heat cable to be inserted beneath it to maintain the floor and sand temperature at 29°C ($\pm 1^\circ\text{C}$). A small piece of bark was placed on top of the sand in a central position and a sheet of white card placed behind it. Thus, the lizards were always moving towards the white card (the rest of the apparatus being made of brown card).

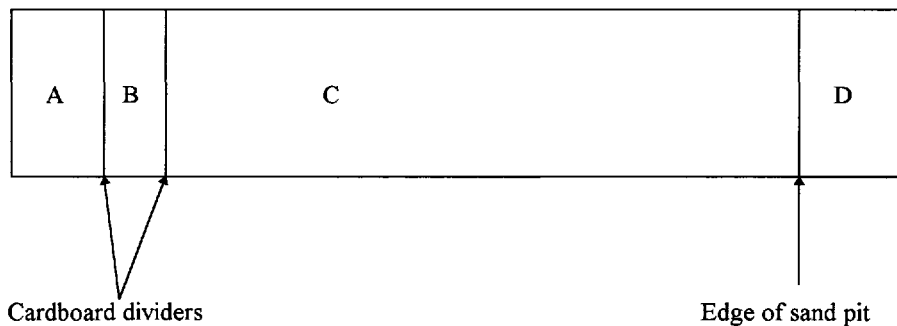


Figure 1 Cardboard alleyway (A = deprivation area, B = start zone, C = running alleyway and D = sand pit).

Training

All the animals were habituated to being handled by regular handling sessions for several weeks before the experiment. In addition, each lizard was placed in the test apparatus twice a day for two days to reduce fear of the novel environment.

Experiment 1

The sand pit was placed 38cm from the start zone. Each lizard was placed in the deprivation chamber (A, Figure 1) for 0, 1, 5 or 15 minutes. The order of animal testing was completely randomized and the deprivation level assigned to each individual was done using a Latin Square design. After the deprivation time had elapsed, the first cardboard divider was raised and the lizard gently moved on to the start zone (B, Figure 1). After 10 seconds, the second divider was removed and the stopwatch started.

The following variables were recorded:

- 1 Latency (in seconds) to move off the start zone.
- 2 Time taken (in seconds) to reach the sand pit (head over).
- 3 Time (in seconds) for the whole body to enter the sand pit (total time) (D, Figure 1).

After testing, the animal was allowed to remain in the sand for at least one minute so that it did not associate the sand with being caught and immediately returned to the vivarium. All animals were tested twice a day; once in each of two sessions separated by four hours; the

six animals were tested consecutively within one session. This procedure was done four times (ie four replicates at each deprivation level for each lizard).

Experiment 2

Experiment 1 was repeated exactly, except that the sand pit was positioned 94cm from the start zone.

Results

The variables recorded are mentioned in the material and methods (Experiment 1). In addition, the 'latency' times were subtracted from the 'head over' times and the results divided into the distance covered (38 or 94cm) to give a 'speed of running the alleyway' variable for both experiments 1 and 2. A preliminary analysis of the data showed that there was no difference between the four replicates. Therefore, mean values at each deprivation level for each lizard were subsequently used. Latency variables were square-root transformed, total time and speed variables were \log_{10} transformed to ensure that the variables were as close to a normal distribution as possible. Each variable was subjected to analysis of variance using a within lizard analysis and one factor with four deprivation levels (Ryan *et al* 1992). Results showing a significant effect of treatments are displayed in Table 2. Post-hoc comparisons of treatment effects were determined by paired *t* tests (see Table 3). The results demonstrate a significant effect of any deprivation level of substrate when compared to no deprivation, but there is no discrimination by the lizards between the different levels of deprivation. The mean values for these variables at each deprivation level are shown in Table 4.

Table 2 ANOVA results showing significant treatment (deprivation) effect.

Variable	<i>F</i> value
L38 - latency to move when the alleyway was 38cm long (sec)	11.11**
L94 - latency to move when the alleyway was 94cm long (sec)	3.47*
S38 - speed when running an alleyway 38cm long (cm sec ⁻¹)	6.42**
S94 - speed when running an alleyway 94cm long (cm sec ⁻¹)	1.25

All *df* = 3, 15; **P* < 0.05; ***P* < 0.01

Table 3 Post-hoc (paired *t* test) comparison of treatments (*t* values are given).

Variable	Comparison of deprivation levels (0, 1, 5, 15minutes)					
	0 vs 1	0 vs 5	0 vs 15	1 vs 5	1 vs 15	5 vs 15
L38 (sec)	2.63*	8.28***	10.31***	1.59	0.9	1.51
L94 (sec)	1.93	2.47 [†]	2.48 [†]	0.03	0.09	0.06
S38 (cm sec ⁻¹)	2.16 [†]	3.37*	3.45*	1.02	1.22	1.31

All *df* = 5; [†]0.05 < *P* < 0.1; **P* < 0.05; ****P* < 0.001.

Table 4 Mean values (\pm SEM) at each deprivation level.

Variable	Deprivation levels (minutes)			
	0	1	5	15
L38 (sec)	61.67 \pm 7.05	28.50 \pm 11.0	10.83 \pm 2.41	17.00 \pm 5.09
L94 (sec)	74.20 \pm 13.7	32.50 \pm 13.5	32.2 \pm 10.5	31.5 \pm 8.80
S38(cmsec ⁻¹)	2.62 \pm 0.54	8.69 \pm 3.06	6.85 \pm 1.53	5.96 \pm 1.42
S94(cm sec ⁻¹)	3.80 \pm 0.47	5.85 \pm 0.92	4.69 \pm 0.53	4.75 \pm 0.98

Total time (ie time for the lizard to be completely in the sand) at both 38 and 94cm and speed at 94cm were not affected significantly by deprivation level, hence the results are not given.

Discussion

The results of these experiments show that any period of deprivation of a substrate in which to seek shelter, results in increased motivation to seek that substrate. This is clearly shown by the decreased latencies to move at any level of substrate deprivation and also by the increased speed of the lizard over the 38cm distance (Experiment 1). One would intuitively have expected the latencies to decrease and the speed to increase in proportion to the level of deprivation. Vestergaard (1982) showed that dust-bathing tendencies of domestic fowl increased gradually with increasing dust deprivation. This is in accordance with the psychohydraulic model of Lorenz (1950) which states that motivation to perform a behaviour will increase with time since that behaviour was last performed. However, in this study, there were no significant differences between any of the levels of deprivation other than between no deprivation and deprivation. A one-minute deprivation period was sufficient to increase the lizards' motivation for substrate. It is unlikely that they were physically unable to move any faster; extra speed could be useful if an additional causal factor (eg sudden appearance of a predator) became apparent and a more rapid escape was essential. These results parallel the findings of Petherick *et al* (1992) who found that hens running an alleyway for food showed an all or nothing response to deprivation. The results of this study and the study of Petherick *et al* (1992) provide evidence for a motivational model whereby a behaviour can be switched on or off when the motivation to perform that behaviour increases above a critical threshold. There will of course be modulation by environmental factors and the state of the individual animal (eg age, sex and previous experience). (For a critical review of various models of motivation, see Hughes & Duncan 1988.) In Experiment 2, where the sand was 94cm from the start zone, the latencies did decrease with deprivation as in Experiment 1, but speed to cover the distance did not increase. The lizards began to look for cover as quickly as when the sand was at 38cm, but being unable to reach the sand quickly, often changed direction or became stationary. This inability to make an operant response could be interpreted as having low motivation to reach the substrate (Beilharz & Zeeb 1981). It is more likely that this represents an approach-avoidance conflict (eg Koene & Vossen 1991), ie conflict between motivation to run for cover and motivation not to cross a relatively large, open and barren space. This may represent an interaction of the internal state of the animal and its assessment of the external environment (McFarland 1989 Ch 1),

where the internal state is the need to hide and the external factor is fear of the open space. For small animals such as these skinks, an open space in the wild would constitute a considerable predation risk from birds, mammals and larger reptiles.

Clearly, speed of alleyway running (Petherick *et al* 1992) and latency to move can be used to quantify motivation, however, sensory constraints (ie depth of vision) and changes in how an animal perceives an experimental paradigm need to be taken into consideration. The methodology employed in this study has the advantage of being cheap, easy, simple to use and adaptable for further motivational studies. In addition the operant response required (ie movement from a start box to a sand pit) can be easily learned. Petherick and Rutter (1990) expressed concern at the amount of training required to teach hens to use a push-door and the possible resultant 'habit-strength'. It appears from our results that assessing motivation for substrate may be a better baseline measure than food, when assessing the behavioural needs of lizards. The disadvantages are that the lizards need to be habituated to being handled, which can take many weeks depending upon the nature of the species used. Also, sensory constraints of the animals preclude the use of greater distances, as does the confounding effects of the experimental paradigm apparently changing from 'motivation measurement' to approach-avoidance conflict (at least with this species).

Animal welfare implications

If an accurate method of assessing motivation for lizards can be devised, it would be easier to provide better welfare for the multitude of lizard species currently kept in captivity. Whilst lizards might not have the general appeal of mammals and birds, we have no reason to believe that their requirements for good welfare differ significantly. If we are to keep lizards in captivity for any reason (eg conservation, education or as a pet) we must make an effort to assess their needs. We believe that the methodology described in this paper is a simple, reliable and accurate way of assessing motivation for some species of lizards.

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