Learning as a function of territory-related behavior patterns in the blue gourami (*Trichopterus trichopterus*)*

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Five groups of 20 adult male Three-Spot Gouramis (*Trichopterus trichopterus*) were used to test the hypothesis that territorial familiarity and preference for a particular territory served to enhance the learning of an avoidance response. The five group conditions were occupation of one-half of a shuttlebox for a period of 0, 24, 48, 72, and 96 h, which established the operational definition of territorial familiarity. Crossed variables for the group conditions were the presence or absence of food and a sterile or enriched environment in the familiar half of the shuttlebox. The data indicated that the interaction of territorial familiarity with food significantly improved learning. Additionally, preference for a particular territory appeared to be related to availability of food but not to quality of environment.

Historically, territory-related behavior patterns in diverse animal species have been explained in terms of the availability of food, presence of mating partners, safety from predation, care of progeny, or preference for physiologically tolerable zones within the environment (Howard, 1920; Tinbergen, 1951; Willock, 1964; Wynne-Edwards, 1965). This multiplicity of presumed causal factors has stimulated research designed to explain an organism's preference for a particular territory in more general and, therefore, more widely applicable terms.

The general thesis of the literature in the field seems to indicate [as Barnett (1967) concludes] that territoriality, defined as affinity for, acquisition, and/or defense of a particular place, has some survival value. On the other hand, several studies have revealed territory-related behavior patterns which seem not to be related to the aforementioned causal factors (Barrou, 1955; Hinde, 1955; Carlisle, 1961). The diversity of research results suggests further work toward examining what may be a more general factor affected by an organism's preference for a particular place—the learning factor. Specifically, will an organism's familiarity with or affinity for a particular territory have any effect on a situation wherein the organism must change its behavior in order to survive? What will be the

magnitude of the effect, and how would it be mediated by other prevalent aspects of the organism's environment, such as availability of food and quality of environment? Additionally, if an organism becomes familiar with a territory which is initially tolerable but later assumes an aversive character, what effect will this change have on the organism's preference for remaining within the territory?

One hundred fresh-water tropical fish (*Trichopterus trichopterus*, Three-Spot Blue Gourami) were used in this research. All were 2-year-old adult males. Males of this species are highly territorial in the classical sense in that they reliably defend choice feeding locations against both sexes of the same species. Prior to each S's participation in the study, all were maintained in a 14.52-liter holding

tank where they were provided a constant supply of aerated water, daily feeding to satisfaction, and a controlled temperature of $25^{\circ} \pm 2^{\circ} \text{C}$.

PROCEDURE

With modifications, the shuttlebox and associated circuitry described by Horner, Longo, & Bitterman (1961) was used. Half the shuttlebox served as the territory to which the S was to become familiarized, while the other half represented an unfamiliar territory. The familiar half of the shuttlebox was fitted with shocking grids. The avoidance paradigm paired a CS (light) with a UCS (3.55-V ac shock). The required response was to avoid the shock by traversing a barrier to the other half of the shuttlebox during the period of the CS (10 sec). Criterion response was five consecutive avoidances. As shown in Fig. 1, each cell within the matrix consisted of five Ss. The order of experimentation was derived in a random fashion. Depending on order of experimentation, Ss were net-captured from the holding tank and placed in the shuttleboxes. Three shuttleboxes were used simultaneously. A five-channel event recorder provided data on CS initiation/termination, UCS initiation/termination, and S's response and location within the shuttlebox. This arrangement provided measures of whether the S escaped or avoided, when the response took place in relation to the CS/UCS, and how long the S remained in the unfamiliar half of the shuttlebox.

RESULTS

Study results were analyzed in terms of two dependent measures: trials to avoidance criterion and time spent outside the home half of the shuttlebox. The main effects show that the presence of food served to

		T ₀	T ₂₄	T ₄₈	T ₇₂	T ₉₆
S	F _N	T ₀ F _N E _S	T ₂₄ F _N E _S	T ₄₈ F _N E _S	T ₇₂ F _N E _S	T ₉₆ F _N E _S
	F _F	T ₀ F _F E _S	T ₂₄ F _F E _S	T ₄₈ F _F E _S	T ₇₂ F _F E _S	T ₉₆ F _F E _S
E	F _N	T ₀ F _N E _E	T ₂₄ F _N E _E	T ₄₈ F _N E _E	T ₇₂ F _N E _E	T ₉₆ F _N E _E
	F _F	T ₀ F _F E _E	T ₂₄ F _F E _E	T ₄₈ F _F E _E	T ₇₂ F _F E _E	T ₉₆ F _F E _E

Fig. 1. Data Matrix for Experimental Design: Each cell consisted of five Ss. F_N = no food, F_F = food available, E_S = sterile environment, E_E = enriched environment.

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significantly increase the required trials to criterion ($F = 5.2468$, $df = 1/80$, $p < .05$). Similarly, an enriched environment resulted in significantly increased trials to avoidance criterion ($F = 9.1986$, $df = 1/80$, $p < .05$). The significant Time by Food interaction ($F = 3.1904$, $df = 4/80$, $p < .05$) was further analyzed for the simple effects. This analysis shows that simple effects were significant when the food was available. Further, as a function of time, trials to avoidance criterion significantly decreased at the 48-h level. A trend analysis was performed for the simple effects of time at the food-available (F_T) level. This showed a significant quartic relationship ($F = 10.8046$, $df = 1/80$, $p < .05$). The significant time, food, environment triple interaction ($F = 3.1520$, $df = 1/80$, $p < .05$) implied simple interaction effects of food and environment at some level of time. This significant relationship ($F = 12.4183$, $df = 1/80$, $p < .05$) occurred at the T_0 level. An analysis of variance was also performed for the second dependent measure, time spent outside the familiar half of the shuttlebox. Results clearly indicated that time and the combination of food and environment were the only variables significantly related to Ss' preference for the home half of the shuttlebox. Dunnett's t test was used to determine which of the time group performances were significantly different from the T_0 group, which was considered a control. Results indicated that both the $T_{7,2}$ and $T_{9,6}$ groups showed a significantly greater preference for the home half of the shuttlebox. Trend analysis revealed a significant linear and quartic trend over the five levels of time. The simple effects of the food environment interaction were analyzed. In this case, the availability of food at the sterile environment level was significantly related to Ss' performance.

DISCUSSION

The most important hypothesis under investigation in this study was that organisms considered to be more familiar with a specified territory would perform better in a learning situation. Although the main effects (degree of familiarity or time) were not significant, the interaction of time and food resulted in significantly

decreased trials to criterion. This relationship assumes a quartic function and is, therefore, quite complex. Generally, as food was made available or the environment was enriched, Ss required more trials to criterion. Presumably, these aspects of the environment establish the territory in a fashion which interferes with avoidance learning. The significance of the interaction between time and food lends support to the inference that time is indeed a factor in territorial behavior in that there may be some minimum time necessary for the organism to establish a territorial preference, after which behavior patterns may show some consolidation and stability.

In relation to the second dependent measure (time spent outside the familiar territory), group differences clearly showed that more familiarized Ss spent less time in the unfamiliar half of the shuttlebox. It appears that these group differences demonstrate that an organism will less readily leave an area which it perceives as its territory as a function of degree of familiarity with that territory. In no case was the quality of environment related to Ss' preference for territory. This infers the prepotency of availability of food as the major determinant of territorial adequacy as compared to quality of environment.

Of particular interest is the significant preference of the $T_{7,2}$ and $T_{9,6}$ groups for the home environment. A tentative explanation of this may be found in the relation of the results of this research to a similar study by Agranoff (1967). Working on memory fixation with a similar shuttlebox technique, Agranoff concluded that memory fixation in the goldfish is blocked when the fish is in an environment associated with high levels of stimulation and that, while memory formation takes time, it appears to depend on the prevailing environmental surrounding. Level of stimulation would seem to be a relative quantity, and it is plausible to assume that as long as the stimulation was not debilitating, the organism may, in fact, become desensitized and adapt to the total stimulating pattern. If this is true, then an organism may, because of no other alternatives,

occupy a particular environment, even though initially it presents a "high" level of stimulation (shock). This line of reasoning suggests further research, using time variables in excess of 96 h. A supportive line of reasoning is advanced by Andrewartha (1961), wherein he suggests that organisms search the immediately available environment for tolerable physiological zones and that the acclimatization or habituation to the limits of these tolerable zones may be valuable for survival. Further, he suggests that there is an upper and lower limit to these zones, beyond which the organism cannot survive. For this reason, then, natural selection would favor those organisms and species which happen to evolve special behavioral patterns which enable acclimatization to unfamiliar zones or territories. It is suggested that these may, in fact, be the behavioral patterns which are categorized as territorial behavior.

REFERENCES

- AGRANOFF, B. Research on memory. University of Michigan Research News, 1967, 18, (12).
- ANDREWARTHA, H. G. *Introduction to the study of animal populations*. Chicago: The University of Chicago Press, 1961.
- BARNETT, S. A. *Instinct and intelligence: Behavior of animals and men*. Englewood Cliffs, N.J.: Prentice-Hall, 1967.
- BARROUD, E. M. Notes on the territorial behavior of the Ten-Spined Stickleback (*Pygosteus pungitius*). *British Journal of Animal Behaviour*, 1955, 3, 134-136.
- CARLISLE, D. B. Intertidal territory in fish. *Animal Behaviour*, 1961, 9, 106-107.
- HINDE, E. A. A comparative study of the courtship of certain finches (*Fringillidae*). *Ibis*, 1955, in press. Cited by Barroud, E. M. Notes on the territorial behavior of the Ten-Spined Stickleback (*Pygosteus pungitius*). *British Journal of Animal Behaviour*, 1955, 3, 134-136.
- HORNER, J. L., LONGO, N., & BITTERMAN, M. E. A shuttle box for the fish and a control circuitry of general applicability. *American Journal of Psychology*, 1961, 74, 114-120.
- HOWARD, E. *Territory in bird life*. London: Murray, 1920. (Reprinted—London: William Collins, 1948.)
- TINBERGEN, N. *The study of instinct*. London: Oxford University Press, Amen House, 1951.
- WILLOCK, C. Deer's friend with a gun. *London Observer*, April 19, 1964.
- WYNNE-EDWARDS, V. C. Self regulatory systems in populations of animals. *Science*, 1965, 147, 1543-1548.