RESPONSE ACQUISITION BY SIAMESE FIGHTING FISH (BETTA SPLENDENS) WITH DELAYED VISUAL REINFORCEMENT

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Male Siamese fighting fish, *Betta splendens,* swam through a ring in an aquarium, breaking a photocell beam and initiating an unsignaled, resetting delay interval. Following delays of 0 s, 10 s, or 25 s, a 15-s mirror presentation released an aggressive display by the fish. Swimming through the ring increased in the absence of either a period of acclimatization to the reinforcer (analogous to magazine training when appetitive reinforcers are used) or explicit training of the response by the experimenters. Response rates were a decreasing function of delay duration. Other fish exposed to a schedule of response-independent mirror presentations failed to acquire and maintain the response. The results demonstrate the robustness and generality of the phenomenon of response acquisition with delayed reinforcement. They further qualify earlier observations about behavioral mechanisms involved in the phenomenon.

Key words: response acquisition, delay of reinforcement, visual reinforcers, mirror image, swimming, Siamese fighting fish

Neither explicit training nor immediate reinforcement is necessary to establish operant behavior of rats and pigeons. For example, immediately after training experimentally naive pigeons and rats to eat from a food-delivery device, Lattal and Gleeson (1990) implemented a procedure wherein the first response on an operandum initiated and an unsignaled delay that terminated with food delivery. Despite the absence of any training of the response, almost all subjects responded within a relatively short period after magazine training was completed. Responding under the delayed reinforcement contingency continued at a low but steady rate for the duration of the experiment. The effect has been replicated by several investigators (e.g., Dickinson, Watt, & Griffiths, 1992; van Haaren, 1992; Wilkenfield, Nickel, Blakely, & Poling, 1992), with both resetting and nonresetting delay intervals (Lattal & Gleeson, 1990; Wilkenfield et al., 1992) and with different responses (Critchfield & Lattal, 1993; Lattal & Gleeson, 1990).

Response establishment and maintenance under the conditions described above also may be common in nonlaboratory settings. For example, a pet dog that is routinely admitted to the house only after some delay following a bark may come to emit barks at a low but steady rate when subsequently placed outside. Critchfield and Lattal (1993) noted how some instances of complex behavior by animals in natural settings, such as the food-gathering response of the fishing wren, might involve contingencies similar to those under discussion here.

Despite speculations about the species and situational generality of the phenomenon of response acquisition with delayed reinforcement, experimental analyses of the phenomenon have been conducted using only standard laboratory preparations. For example, the extant experiments all have used rats or pigeons as subjects, appetitive reinforcers (Dickinson et al. 1992; Lattal & Gleeson, 1990; van Haaren, 1992; Wilkenfield et al., 1992), and, with the exception of Critchfield and Lattal (1993), conventional responses involving mechanical action to operate a switch. Critchfield and Lattal defined the operant response by the disruption of a photocell beam near the top rear of an operant conditioning chamber. The photocell-beam-break response by rats was established with delayed reinforcement in a manner similar to more topographically conventional responses.

Access to visual stimulation has been shown

to reinforce responses of a number of species, including human infants (Rovee-Collier & Capatides, 1979) and rhesus monkeys (Moon, 1961; Tolman & Mueller, 1964). Visual stimulation via a model or mirror image of the subject evokes aggressive displays by primates (Gallup, 1968), male fighting cocks (Thompson, 1964), pigeons under some conditions (Ator, 1980; Azrin, Hutchinson, & Hake, 1966; Cohen & Looney, 1973), and male Siamese fighting fish (*Betta splendens*) (e.g., Thompson, 1963).

Male Siamese fighting fish have been trained to swim through a small ring, thereby breaking a photocell beam and immediately activating a timed access to a mirror image (e.g., Thompson, 1963), model (e.g., Thompson & Sturm, 1965), or motion picture (Turnbough & Lloyd, 1973) of a *Betta splendens*. On presentation of the mirror image or model, a species-typical response is characterized by erection of the dorsal and ventral fins, extension of the gill cover, a deepening of body color, the appearance of vertical lines on the torso, and stereotyped undulating swimming movements parallel to the "opponent" (see Lissman, 1933; Simpson, 1968).

The present experiment employed a similar procedure of response-dependent visual stimulation to *Betta splendens* to explore further the generality of the phenomenon of response acquisition with delayed reinforcement. Male *Betta splendens* initiated an unsignaled delay by interrupting a photocell beam. Following the delay, brief access to a mirror occurred.

METHOD

Subjects

Experimentally naive male *Betta splendens* were obtained from a local pet store and were housed individually in visually isolated, 5-L tanks in a room with a 12:12 hr light/dark cycle. The tanks were filled with conditioned tap water maintained at a presession temperature of 80 to 82 °F (Hess, 1952). One third of the water was replaced every 2 to 3 days, and a filter was activated for 30 to 60 min at least twice a week; the filter was operated only following completion of a session. The fish were acclimated for a minimum of 7 days before exposure to the experimental conditions. At least 30 min after an experimental session, the fish were fed a combination of freeze-dried tubifex and blood worms once a day.

Apparatus

Experimental sessions occurred in the home tank (26 cm by 35 cm by 20 cm) of each fish. Prior to each session, the following components were moved to the tank: (a) A ring, 3.2 cm wide with an inner diameter of 4 cm, suspended from a clear Lucite holder, was placed in the center of the tank. The ring was supported on either side by aluminum tubing that terminated at a photocell and light source, attached outside the tank on either side of the Lucite holder. A response was recorded when the fish exited the ring, reestablishing the photocell beam that was broken on its entry into the ring. (b) A box (25.5 cm by 35.5 cm by 13.5 cm) containing two 40-W 110-V lightbulbs and a clear front panel was placed lengthwise along one long side of the tank. (c) A two-way mirror (35.5 cm by 25.5 cm) was inserted between the front panel of the box and the side of the tank. The mirror was made transparent and reflective, respectively, by turning the lights on the off in the box. A 15-s period, during which the mirror was reflective, served as the reinforcer. Electromechanical equipment located near the home tanks controlled the experiment and recorded data.

Procedure

No attempt was made to train the response of swimming through the ring or orienting towards the mirror. The ring apparatus simply was placed in the tank and the first session began. Sessions lasted about 1.5 hr each and occurred 7 days a week. Four fish were exposed to a fixed-ratio (FR) 1 schedule for 20 sessions in which each response was followed immediately by a 15-s presentation of the mirror. Hereafter, this condition will be described as the 0-s delay condition. Eight other fish were exposed to 20 sessions in which a tandem FR 1 differential-reinforcement-of-other-behavior (DRO) schedule was in effect. For each of 4 fish, the value of the DRO schedule was 10 s or 25 s, and these two conditions will be described hereafter as, respectively, the 10-s delay and 25-s delay conditions. The tandem schedule defined the delay of reinforcement such that swimming through the ring initiated an unsignaled delay, during which any further responses prior to the reinforcer presentation reset the delay interval. Thus, the reinforcer presentation required an absence of responding for either 10 or 25 s after the response that initiated the unsignaled delay. When the delay
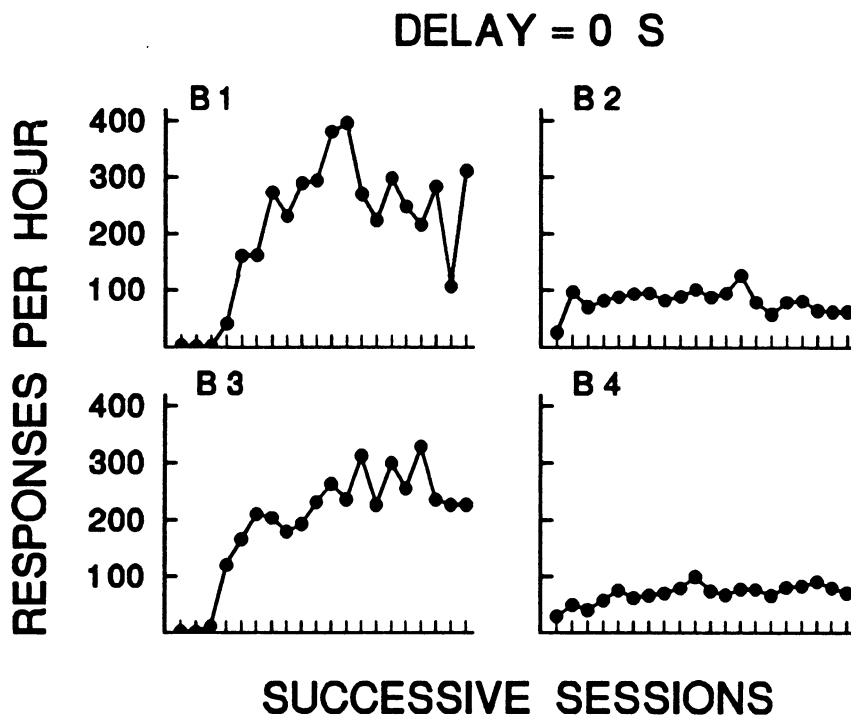
DELAY = 0 S

Fig. 1.   Responses per hour during each session of the experiment for each of the 4 Siamese fighting fish under an FR 1 schedule of visual reinforcement.

elapsed, the mirror was presented for 15 s; thereafter, another break of the photocell beam was required to initiate the next delay interval, and so forth. Responses that occurred during the reinforcement cycle were counted but did not initiate an additional mirror presentation. Such responses were rare.

Four other fish were first exposed to a variable-time (VT) 147-s schedule, then to a tandem FR 1 DRO 10-s schedule, and finally to a second VT 147-s schedule for 20 sessions each. Under the VT schedule, response-independent mirror presentations occurred at the same mean rate as did mirror presentations for the fish exposed to the 10-s delay (as described in the preceding paragraph). The value of the VT schedule was determined by calculating the mean rate of reinforcement across the last six sessions for each of the fish exposed to the 10-s delay and then calculating the group mean.

RESULTS

Figures 1 and 2 show the number of responses per hour for each of the fish exposed to the 0-s, 10-s, and 25-s delays to reinforce-

ment. Each of the fish swam through the ring in the absence of explicit training of the response. The number of sessions required for responding to develop varied. For fish with the 25-s delay, no consistent increase was observed. Response rates after 20 sessions of exposure to the delay conditions were a function of the delay duration, as shown in Figure 3, which provides the average response rates of each group for the last six sessions of each condition. Inspection of cumulative records indicated that, even though response rates were low, responding occurred at a steady rate throughout each session.

The mean rates of reinforcement, expressed as reinforcers per hour, during the last six sessions for each fish exposed to 0-s, 10-s, and 25-s delays are presented in Table 1. These reinforcement rates paralleled response rates in the respective conditions.

Figure 4 shows the responses per hour during each session for each of the fish exposed to response-independent mirror presentations arranged by the VT 147-s schedule, then to the 10-s delay condition, and finally to the VT 147-s schedule again. During the first exposure to the VT schedule, responding was in-

DELAY = 10 S

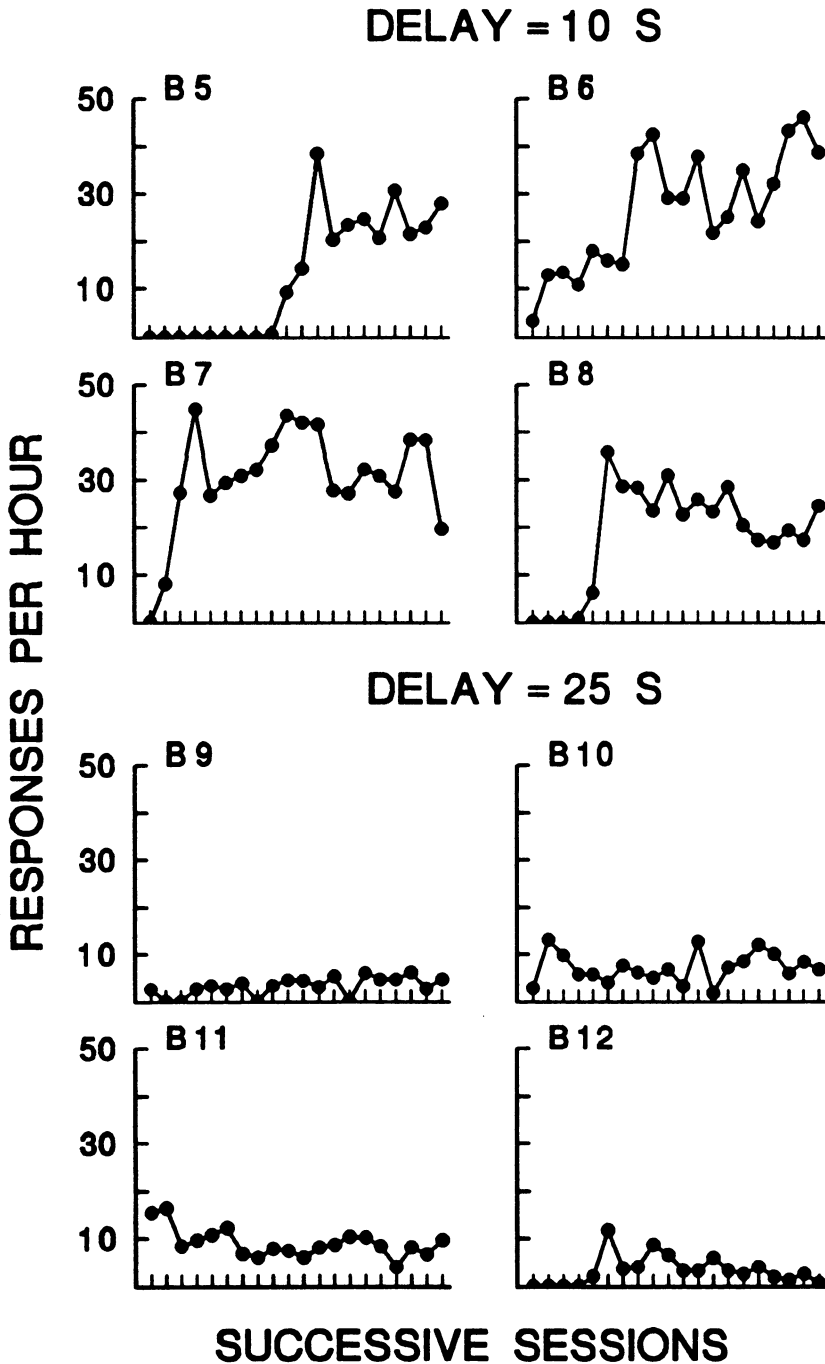## DELAY = 25 S

SUCCESSIVE SESSIONS

Fig. 2.   Responses per hour during each session of the experiment for each of the 4 fish under a 10-s unsignaled delay procedure (top graphs) and 4 fish under a 25-s unsignaled delay procedure (bottom graphs).

frequent and inconsistent. The low response rates concur with our informal observations that these fish do not consistently swim in the middle of the tank, even during mirror pre-

sentations, but rather tend to swim along the sides of the tank. In contrast, when mirror presentations were response dependent (albeit delayed from the response), response rates in-

creased and responding was more consistent both across and within sessions. Response rates of each fish systematically decreased when mirror presentations again were response independent. Table 2 shows that the mean mirror-presentation rates (per hour) during the VT schedule were similar to those for the fish in the 10-s delay condition (Table 1). During the 10-s delay condition, the mirror-presentation rates dropped, even though response rates increased.

Figure 5 compares response rates of the 8 fish exposed to the 10-s delay condition as a function of the absence (B5, B6, B7, and B8) or presence (B13, B14, B15, and B16) of a prior history of exposure to a VT schedule of mirror presentation. Response rates generally tended to be higher in the absence of a history of response-independent mirror presentations. This observation was supported by comparing the response rates during the first and the last six sessions for each subject in the two conditions using a Mann–Whitney U test. The group without a history of VT reinforcement responded significantly more during both the first ($U = 153$, $p < .05$) and last ($U = 117$, $p < .01$) six sessions than did the group with such a history.

DISCUSSION

Swimming through a ring by Siamese fighting fish was acquired and maintained when visual reinforcement occurred following unsignaled resetting delays. The response was acquired in the absence of response shaping or other experimenter-initiated attempts to train the response. These results lend further generality to the findings of response acquisition with delayed reinforcement by rats and pigeons (e.g., Dickinson et al., 1992; Lattal & Gleeson, 1990; van Haaren, 1992; Wilkenfield et al., 1992). Despite the similarity of the results to those obtained in other experiments,
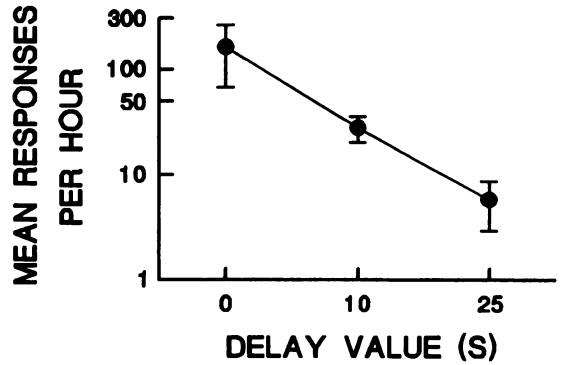

Fig. 3. Response rates, averaged over the last six sessions of each condition, for the 4 fish in each delay condition. The vertical lines through the data points indicate standard deviations.

there are a number of unique features of the present procedures that proffer further insights into the conditions needed to establish new behavior.

Perhaps the most unique feature of this analysis of response acquisition with delayed reinforcement was the use of visual reinforcement, as opposed to the typical appetitive reinforcers used in previous experiments. Deprivation of life-sustaining substances such as food and water is not necessary to establish and maintain consistent responding under the conditions described herein. Limiting visual access to a mirror might be considered "social" deprivation, but this conceptualization must be qualified by the fact that two fish of the same sex placed in a tank together will fight and possibly kill each other (Braddock & Braddock, 1955; Simpson, 1968). Furthermore, fish given constant exposure to a mirror image will respond to terminate the image after a period of time (Baenninger, 1970).

In previous studies of response acquisition with delayed appetitive reinforcers, magazine training preceded implementation of the delay condition. Magazine training in several earlier

Table 1

Mean rate of reinforcement (per hour) across the last six sessions of each condition.

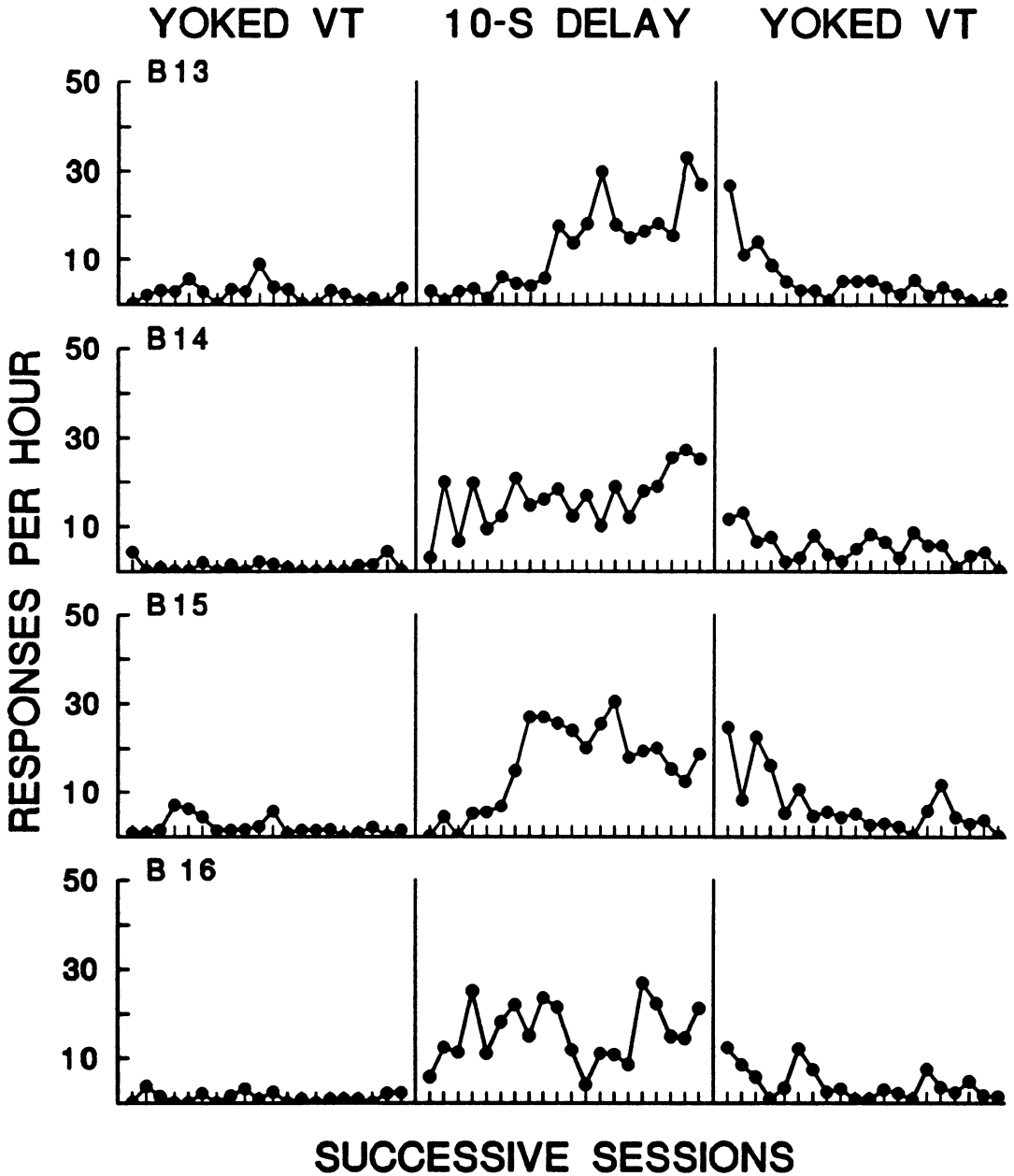|	Delay = 0 s			Delay = 10 s			Delay = 25 s	
Fish	M	Range	Fish	M	Range	Fish	M	Range
B1	201.23	85.34–296.08	B5	25.23	20.70–29.91	B9	2.25	0.67–4.07
B2	60.21	51.20–69.53	B6	29.42	18.65–34.72	B10	6.50	4.76–9.42
B3	244.86	218.31–309.20	B7	27.82	16.74–32.92	B11	6.19	3.94–8.96
B4	61.00	51.91–67.24	B8	15.70	12.32–17.16	B12	2.08	0.63–4.00

Fig. 4. Responses per hour during each session of the experiment for 4 fish under schedules of response-independent visual reinforcement (yoked VT) and a 10-s unsignaled delay procedure. See text for procedural details of the different conditions.

experiments involved providing reinforcers delivered according to a VT schedule until a criterion of reliably approaching the magazine and eating was observed. In the present experiment, 12 subjects received no prior exposure to response-independent mirror presentations (i.e., "magazine training") before the experiment proper began. The first and all subsequent mirror presentations occurred only following a response that broke the photocell beam. Contacting the reinforcer, through such activities as consumption or display, is necessary to the reinforcement process; however, the present results suggest that experimenter-ini-

Table 2

Mean rate of reinforcement sessions of each condition.

Fish	Yoked VT		Delay = 10 s		Yoked VT	
	M	Range	*M*	Range	*M*	Range
B13	25.18	24.85–25.95	13.49	9.30–18.84	25.44	24.24–26.58
B14	24.62	23.78–25.57	14.94	9.96–19.44	24.95	24.24–25.50
B15	24.86	23.90–26.27	15.59	11.22–18.66	25.31	24.84–26.28
B16	26.93	25.45–28.80	13.82	4.05–22.94	26.69	25.17–28.54

tiated or -induced contact with the reinforcer by the organism through magazine training is not essential for the establishment of new behavior.

Magazine training by means of a VT schedule may in fact be detrimental to subsequent response establishment and maintenance. For example, Engberg, Hansen, Welker, and Thomas (1972) found that previous exposure to a schedule of response-independent food delivery subsequently retarded key-peck response acquisition on an autoshaping procedure (cf. also van Haaren, 1992). Downing and Neuringer (1976) found a more complicated relation between the rapidity of autoshaping of chickens' key pecking and the number of food presentations during magazine training. Acquisition generally was more rapid when a single food presentation was given than when 10 or 100 presentations occurred, but was most

rapid after 1,000 food presentations during magazine training. Compared to intermediate numbers of magazine presentations, a large number of magazine presentations probably more strongly maintains the organism in proximity to the hopper and thus to the operandum, thereby reducing the time to a recorded response. On the other hand, the absence of magazine training may extinguish other, ineffective, responses before food is ever presented, with the result that the measured response is uniquely correlated with the reinforcer on the first occurrence of both. In the current experiment, Subjects B13, B14, B15, and B16 were exposed to response-independent mirror presentations at the same average as Subjects B5, B6, B7, and B8 received response-dependent mirror presentations. Although responding was established quickly in the first group, it is interesting to note that their response rates were
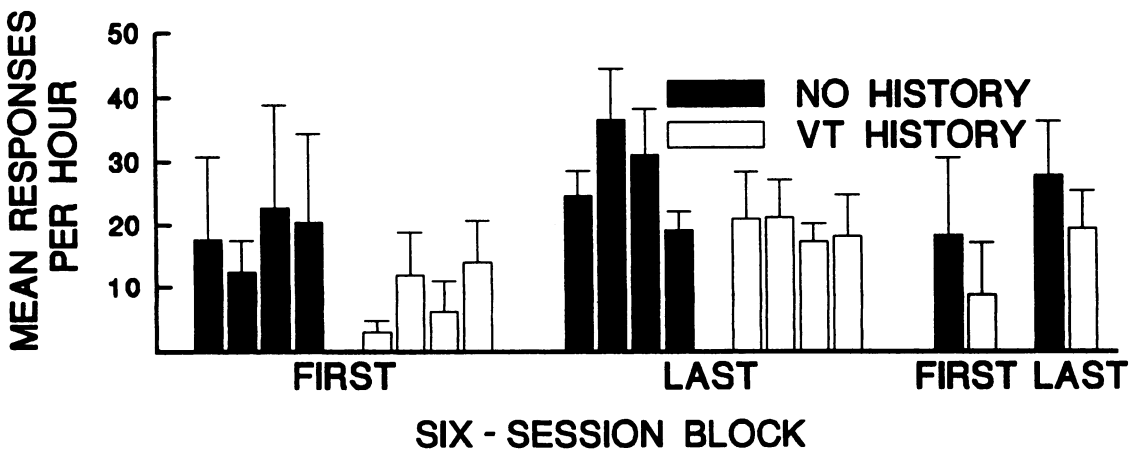

Fig. 5. Mean response per hour during the 10-s delay condition for the 4 fish (B5, B6, B7, and B8) that were exposed to the unsignaled delay condition without prior exposure to a VT schedule of mirror presentation (filled bars; No History) and for the 4 fish (B13, B14, B15, and B16) that had a prior history of exposure to a VT schedule of mirror presentation (open bars; VT History). Average data for the first and last six sessions of the conditions are presented in the left bar graphs for individual fish and are summarized as means for all fish in each group in the far right bar graphs. The vertical lines in each bar indicate standard deviations.

significantly lower than those of the second group that did not receive prior exposure to response-independent mirror presentations (see Figure 5).

The response in this experiment was not defined by the mechanical action of operating a lever or key but rather was a continuation of the locomotion of the organism through water. Critchfield and Lattal (1993) also used movement of rats to define the response established with delayed reinforcement. As in Critchfield and Lattal's procedure, the occurrence of a response did not produce auditory feedback in our study. Unlike their procedure, however, the visual feedback provided as a result of swimming through the ring, at least from our perspective, seems more salient, in that the ring is visually distinct from its surround.

The delay-of-reinforcement gradients obtained with *Betta splendens* were qualitatively similar to those obtained with other species and responses with the use of appetitive reinforcers (e.g., Sizemore & Lattal, 1978). Key pecking of pigeons and several topographically defined responses by rats have been established with nonresetting delays of 30 s (e.g., Lattal & Gleeson, 1990; Metzger & Lattal, unpublished; Wilkenfield et al., 1992). At some point, the delay is sufficiently long that behavior is not sustained (cf. Gleeson & Lattal, 1987). As in other delay-of-reinforcement studies, the parameters of reinforcement such as the delay duration (e.g., Mazur, 1985) and reinforcer-establishing variables such as water temperature (of which the strength of the visual display is a function; cf. Hess, 1952) are likely to affect response strength.

The response rates obtained in the present study on an FR 1 schedule generally were higher than those reported in several other investigations of visual reinforcement in Siamese fighting fish. These higher rates may relate to differences in session duration, responses, and the type of visual reinforcer. For example, Hogan, Kleist, and Hutchings (1970) and Thompson (1963) employed 12-hr and 24-hr sessions, respectively, with 20-s presentations of the mirror as the reinforcer. These longer sessions likely resulted in satiation or habituation to the mirror images (cf. Baenninger, 1966; Clayton & Hinde, 1968; Rhoad, Kalat, & Klopfer, 1975), a possibility lessened in the present experiment by the use of shorter sessions.

Hogan et al. (1970) studied reinforcement of a response of swimming through a short tunnel and reported response rates from about 4 to 63 per hour. Using a similar response, Turnbough and Lloyd (1973) reported rates of between 30 and 70 per hour. Thompson (1963) used a response similar to the one studied here and observed response rates of about 13 to 30 per hour.

Motion pictures (e.g., Turnbough & Lloyd, 1973), models (e.g., Rhoad et al., 1975), and mirror images (e.g., Thompson, 1963) all can function as visual reinforcers for operant behavior of Siamese fighting fish. Moving images are more effective as reinforcers than are stationary ones (e.g., Rhoad et al., 1975; Thompson, 1963). In the case of a mirror image, a perfect correlation exists between the behavior of the fish subject and the behavior of the image. The degree of color change, gill cover, and fin erection, as well as other components of the "opponent's" aggressive display, is a direct function of the subject's aggressive display (Gallup, 1968). Bronstein (1981) proposed that the intensity of the aggressive display of the Siamese fighting fish is directly related to the intensity and persistence of the aggressive display of the "opponent." Thus, mirror-image stimulation appears to substitute effectively for actual confrontation between two Siamese fighting fish. The use of a mirror-image reinforcer is therefore likely to contribute to the higher response rates observed here, compared to those in several other experiments using other types of visual reinforcement (e.g., Rhoad et al., 1975; Turnbough & Lloyd, 1973).

Visual reinforcers, like appetitive ones, may induce activity that may make the measured response more likely. Because the mirror presentation releases aggressive display, during which the fish swims rapidly in front of the mirror, the photocell-breaking responses might result from an increase in the general level of activity of the fish rather than the response-reinforcer dependency. Lattal and Gleeson (1990) discounted the possibility of activity induced by the appetitive reinforcer as the basis for changes in the measured response by showing that responding was established and maintained by an unsignaled delay procedure but not by a schedule of response-independent re-

inforcement, according to which reinforcers occurred at the same rate as those during the delay procedure. The present experiment employed a similar control condition that, unlike the Lattal and Gleeson procedure, was implemented within rather than between individual subjects. As in the study by Lattal and Gleeson, the failure of response-independent mirror presentations to control responding suggests that, as with appetitive stimuli, the photocell-breaking responses were a function of the response–reinforcer dependency and not the result of an increase in generalized activity or other inductive effects of the presentation of a mirror image (cf. also Goldstein, 1967). These data also concur with those of Turnbough and Lloyd (1973), who exposed Siamese fighting fish to an FR 1 schedule followed by exposure to a DRO schedule. In both conditions, the rate of reinforcement was similar, but response rates were higher when reinforcement was dependent on responding than when reinforcement was dependent on not responding. If increased activity resulting from mirror presentation alone were responsible for swimming through the ring, control of not swimming through the ring under the DRO contingency would have been precluded.

In previous investigations of response acquisition with delayed reinforcement, each subject first was exposed to a time in which reinforcers were frequent (i.e., during magazine training) and then to a period in which no reinforcers were forthcoming until responding began. The period of nonreinforcement following magazine training can be considerable. For example, some pigeons may go for several hours before emitting the first response (see Neuringer, 1970). Lattal and Gleeson (1990) suggested that a delay (e.g., 10 s) between the reinforced response and the reinforcer may be relatively contiguous in the context of a long session during which reinforcers are infrequent. That is, a 10-s delay may have more of a strengthening effect in the context of an 8-hr session than in one of shorter duration. The idea of relative contiguity is appealing, but in light of response acquisition with shorter session durations, such as the 90-min sessions employed in the present experiment, any relative contiguity effect does not appear to be a strong function of the session duration per se. It might be argued, however,

that relative contiguity may play a role in response establishment when a period of frequent reinforcement (as in magazine training) is followed by a period of nonreinforcement. However, in this experiment, responses developed in the absence of a period of frequent reinforcer presentation followed by a period of nonreinforcement.

These results suggest that response acquisition with delayed reinforcement is a robust, general phenomenon that occurs across a variety of species, topographically different responses, and reinforcers. The effect is not attributable to responding induced by access to either appetitive or visual reinforcers, but rather is a function of the relation between responding and its consequences.

REFERENCES

Ator, N. A. (1980). Mirror pecking and timeout under a multiple fixed-ratio schedule of food delivery. *Journal of the Experimental Analysis of Behavior, 34,* 319–328.

Azrin, N. H., Hutchinson, R. R., & Hake, D. F. (1966). Extinction induced aggression. *Journal of the Experimental Analysis of Behavior, 9,* 191–204.

Baenninger, R. (1966). Waning of aggressive motivation in *Betta splendens. Psychonomic Science, 4,* 241–242.

Baenninger, R. (1970). Visual reinforcement, habituation, and prior social experience of Siamese fighting fish. *Journal of Comparative and Physiological Psychology, 71,* 1–5.

Braddock, J. C., & Braddock, Z. I. (1955). Aggressive behavior among females of the Siamese fighting fish, *Betta splendens. Physiological Zoology, 28,* 152–172.

Bronstein, P. M. (1981). Commitments to aggression and nest sites in male *Betta splendens. Journal of Comparative and Physiological Psychology, 95,* 436–449.

Clayton, F. L., & Hinde, R. A. (1968). The habituation and recovery of aggressive display in *Betta splendens. Behavior, 30,* 96–106.

Cohen, P. S., & Looney, T. A. (1973). Schedule-induced mirror responding in the pigeon. *Journal of the Experimental Analysis of Behavior, 19,* 395–408.

Critchfield, T. S., & Lattal, K. A. (1993). Acquisition of a spatially defined operant with delayed reinforcement. *Journal of the Experimental Analysis of Behavior, 59,* 373–387.

Dickinson, A., Watt, A., & Griffiths, W. J. H. (1992). Free-operant acquisition with delayed reinforcement. *Quarterly Journal of Experimental Psychology, 45B,* 241–258.

Downing, K., & Neuringer, A. J. (1976). Autoshaping as a function of prior food presentation. *Journal of the Experimental Analysis of Behavior, 26,* 463–469.

Engberg, L. A., Hansen, G., Welker, R. L., & Thomas, D. R. (1972). Acquisition of key-pecking via autoshaping as a function of prior experience: "Learned laziness"? *Science, 178,* 1002–1004.

Gallup, G. G., Jr. (1968). Mirror-image stimulation. *Psychological Bulletin, 70,* 782–793.

Gleeson, S., & Lattal, K. A. (1987). Response–reinforcer relations and the maintenance of behavior. *Journal of the Experimental Analysis of Behavior, 48,* 383–393.

Goldstein, S. R. (1967). Mirror image as a reinforcer in Siamese fighting fish: A repetition with additional controls. *Psychonomic Science, 7,* 331–332.

Hess, E. H. (1952). Temperature as a regulator of the attack-response of *Betta splendens. Zeitschrift für Tierpsychologie, 9,* 379–382.

Hogan, J. A., Kleist, S., & Hutchings, C. S. L. (1970). Display and food as reinforcers in the Siamese fighting fish *(Betta splendens). Journal of Comparative and Physiological Psychology, 70,* 351–357.

Lattal, K. A., & Gleeson, S. (1990). Response acquisition with delayed reinforcement. *Journal of Experimental Psychology: Animal Behavior Processes, 16,* 27–39.

Lissman, H. W. (1933). Die Umwelt des Kampffisches *(Betta splendens* Regan). *Zeitschrift für Vergleichende Physiologie, 18,* 65–111.

Mazur, J. E. (1985). Probablity and delay of reinforcement as factors in discrete-trial choice. *Journal of the Experimental Analysis of Behavior, 43,* 341–351.

Moon, L. E. (1961). Visual exploration as reinforcement of conditioned bar-pressing responses of monkeys. *Journal of the Experimental Analysis of Behavior, 4,* 119–123.

Neuringer, A. J. (1970). Superstitious key pecking after three peck-produced reinforcements. *Journal of the Experimental Analysis of Behavior, 13,* 127–134.

Rhoad, K. D., Kalat, J. W., & Klopfer, P. H. (1975). Aggression and avoidance by *Betta splendens* toward natural and artificial stimuli. *Animal Learning & Behavior, 3,* 271–276.

Rovee-Collier, C., & Capatides, J. B. (1979). Positive behavioral contrast in 3-month-old infants on multiple conjugate reinforcement schedules. *Journal of the Experimental Analysis of Behavior, 32,* 15–27.

Simpson, M. J. A. (1968). The display of the Siamese fighting fish, *Betta splendens. Animal Behaviour Monographs, 1,* 1–73.

Sizemore, O. J., & Lattal, K. A. (1978). Unsignalled delay of reinforcement in variable-interval schedules. *Journal of the Experimental Analysis of Behavior, 30,* 169–175.

Thompson, T. I. (1963). Visual reinforcement in Siamese fighting fish. *Science, 141,* 55–57.

Thompson, T. I. (1964). Visual reinforcement in fighting cocks. *Journal of the Experimental Analysis of Behavior, 7,* 45–49.

Thompson, T. I., & Sturm, T. (1965). Visual reinforcer color and operant behavior in Siamese fighting fish. *Journal of the Experimental Analysis of Behavior, 8,* 341–346.

Tolman, C. W., & Mueller, M. (1964). Laboratory control of toe-sucking in a young rhesus monkey by two kinds of punishment. *Journal of the Experimental Analysis of Behavior, 7,* 323–325.

Turnbough, P. D., & Lloyd, K. E. (1973). Operant responding in Siamese fighting fish *(Betta splendens)* as a function of schedule of reinforcement and visual reinforcers. *Journal of the Experimental Analysis of Behavior, 20,* 355–362.

van Haaren, F. (1992). Response acquisition with fixed and variable resetting delays of reinforcement in male and female Wistar rats. *Physiology and Behavior, 52,* 767–772.

Wilkenfield, J., Nickel, M., Blakely, E., & Poling, A. (1992). Acquisition of lever-press responding in rats with delayed reinforcement: A comparison of three procedures. *Journal of the Experimental Analysis of Behavior, 58,* 431–443.