

Goldfish Group Choice: Tests of the Ideal Free Distribution and Matching Theory

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Introduction

The ideal free distribution theory has been used to explain group foraging behavior between two or more locations (Fretwell & Lucas, 1970). Group foraging behavior occurs when organisms move from one location to another to access some available resource (e.g., food patch). The theory has been expressed mathematically as: $N_1/N_2 = A_1/A_2$ where N is the amount of participants foraging at the resource sites, while A is the amount of the available resource at each site. Ideal matching occurs when twice as many foragers move to the resource location with twice the amount of resources available. That is, a group of organisms will distribute themselves proportionately to the amount of reinforcers available.

Several studies have examined ideal free distribution and the matching law in nonhuman animals. Baum and Kraft (1998) examined group foraging behavior in 30 pigeons. The pigeons were able to obtain food reinforcement from one of five phases: separated areas, troughs, bowls, adjacent areas, and areas with a visual barrier. Dried green peas in two different resource sites at different rates according to VI schedules of reinforcement. The pigeons were allowed to either remain in one resource site, move to a different site, or engage in other activities. Baum and Kraft found that the pigeons undermatched. That is, there was tendency towards indifference between the resource sites.

Similarly, Farmer-Dougan and Dougan (2005) conducted two experiments investigating group foraging behavior in rats. Farmer-Dougan and Dougan delivered food pellets to different feeding stations according to multiple schedules of reinforcement. Farmer-Dougan and Dougan's findings indicate the relative distribution of behavior (between the two sites) roughly matched the relative rate of food delivery every at each of the sites.

The purpose of the present study was to investigate a group of common goldfish would also demonstrate undermatching, like other animals and humans have, when using three different variable time schedules of reinforcement.

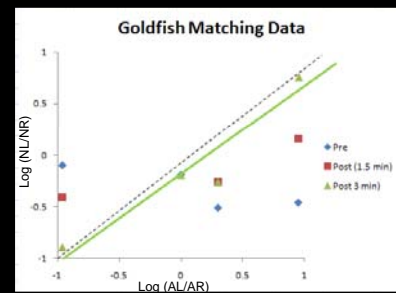
Method

Subjects: 13 common comet goldfish

Materials: 20 gallon fish tank, a screen with a hole in the middle (for the fish to pass through), and pelletized fish food

Procedure: The goldfish were fed according to the amount of fish in the tank. During the different conditions the goldfish were fed every other day, to ensure they did not become satiated with the reinforcers. The goldfish were able to freely swim to and from either patch at any time during the experiment, although they would have to pass through the hole cut in the screen to get to either side.

The first schedule of reinforcement used was a VI 5-5 where five reinforcers were placed into the water on the left side of the tank; while five reinforcers were placed on the right side of the tank. The next schedule of reinforcement used was a VI 9-1 where nine reinforcers were disbursed to left side of the tank, and one reinforcer was disbursed to the right side of the tank. The third schedule of reinforcement used was a VI 1-9, where one reinforcer was delivered to the left side, and nine reinforcers were delivered to the right side. The last schedule of reinforcement used was a VI 4-2, where four reinforcers were delivered to the left side, and two were delivered to the right side.



Schedule	Log (AL/AR)	Pre	Post (1.5 min)	Post (3 min)
VI 5/5	0	-0.19	0.16	-0.19
VI 9/1	0.95	-0.46	-0.41	0.76
VI 1/9	-0.96	-0.1	-0.41	-0.89
VI 4-2	0.3	-0.51	-0.26	-0.26

Filter

Left Food Patch



Test Environment

The goldfish were kept in a 20 gallon standard fish tank, and able to swim from either side (food patch) at any time during the experiment.

Right Food Patch



Screen with a hole in the middle

Results

The number of fish located in each patch were averaged from the last 3 days of each condition.

The graph shows, for each condition, where the goldfish were located before the food pieces were distributed (blue triangles), where the goldfish were located 1.5 minutes following food distribution (red squares) and 3 minutes following food distribution (green triangles). The dashed line represents what would be perfect matching. We calculated and plotted the log values of the ratio of the amount (log (AL/AR)) and ratio of the number of goldfish (log (NL/NR)) for each condition.

By calculating and plotting the logs we were then able to measure the overall sensitivity (slope) to changes in food distribution as well as bias (intercept at 0,0 coordinate) the goldfish may have had towards one side or the other.

As a group, the goldfish were sensitive to changes in food distribution ($slope = 0.81$), but not as sensitive as was predicted by the matching law.

There was some bias demonstrated toward the left side of the aquarium ($b = -0.20$).

The table shows the numerical data for each condition.

Discussion

This study investigated the effects of changing resource availability in two locations on the group foraging behavior of goldfish. At question was whether the group of goldfish would distribute themselves in a manner in accordance with what the Ideal Free Distribution would predict.

Did the goldfish match?

- Yes, but there was a tendency towards undermatching. That is, the goldfish changed their relative distribution to each side of the aquarium as the resources changed but the distribution tended slightly towards indifference.

The undermatching that was observed is consistent with what has been found in humans and other animals.

Was there bias?

-Yes, there was some bias towards the left side of the aquarium. That is, regardless of the resource distribution there was a slight preference for the left side. The bias could be due to any number of factors but a likely contributor may have been the location of the water filter. Placing the water filtration system equidistant from the resource sites should be considered for future research.