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Kim Bouradee

University of Southern Maine

Kim Boutavee

University of Southern Maine

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Meat, plants, or both?

A food preference study in Siamese fighting fish, *Betta splendens*

Bouradee Kim and Boutavee Kim, Department of Biology, University of Southern Maine, Portland, Maine, Advisor: Chris Maher, Ph. D

Abstract

Most animals choose food based on its nutrient content and time and energy involved consuming and digesting the food. We used a discrete food preference test to investigate if Siamese fighting fish (*Betta splendens*) preferred particular foods based on the food's nutritional value. Among foods that Siamese fighting fish commonly eat, freeze-dried brine shrimp consist of high amounts of protein, plus lipids and carbohydrates, and shrimp are easily digestible; pellet food is a mixture of plants and small crustaceans; and flake food contains meat, yeast, and gluten. With this knowledge, we predicted that Siamese fighting fish consume freeze-dried brine shrimp first, followed by pellet food, and then flake food. We offered pairs of food choices consisting of pellets, flake food, or freeze-dried brine shrimp to male Siamese fighting fish. We recorded latency for fish to consume food, recording preference as the first food chosen. We found no significant difference in mean latency to choose food, but significant difference in food preference where the fish chose pellet food first most frequently, followed by freeze-dried brine shrimp, then flake food. The results of this study helped us determine if Siamese fighting fish display food preferences and whether nutritional value is a factor when choosing which type of foods to consume.

A. Introduction

Background

The consumption of food is needed for survival and reproduction in animals (Emlen, 1966). Fitness of an animal is maximized by their efficiency in foraging, known as the optimal foraging theory (Pyke, Pulliam, & Charnov, 1977). Optimal foraging theory can be summarized as the following: choice of food and time spent searching and consuming food (Pyke, Pulliam, & Charnov, 1977). Animals aim towards food choices that give the highest energy output (Emlen, 1966). In their natural habitat, Siamese fighting fish (*Betta splendens*) favor live prey, such as bloodworms, daphnia, and brine shrimp (Monvises et al., 2009). Siamese fighting fish are easily attainable and sustainable and their food choice availability is more broad compared to common household pet fish. When Siamese fighting fish are kept as pets, their owners choose what types of food they consume, not giving fish an option (Driscoll, Macdonald, & O'Brien, 2009). Three common foods that Siamese fighting fish consume as pets are freeze-dried brine shrimp, which consists of high amounts of protein and vitamins (Leger et al., 1987); pellet food, a mixture of fish meal, wheat flour, and plants; and flake food, a mixture of fish meal, dried yeast, and wheat gluten. Although in captivity, food preference is just as prevalent in individual fish compared to in the wild (Rofe & Anderson, 1970). In our study, we will determine if Siamese fighting fish display food preference based on nutritional value and the latency to choose preferred food.

Objective

In this study, we performed a discrete food preference test to determine if Siamese fighting fish (*Betta splendens*) preferred specific foods based on the food's nutritional value.

Predictions

1. Latency for Siamese fighting fish to choose food would not differ.
2. Siamese fighting fish consume freeze-dried brine shrimp first, holding the highest vitamin concentration and nutrition value due to being freeze-dried; followed by pellet food, holding the highest amount of fiber and minerals; and lastly flake food (Table 1).

B. Methods

Housing

This study occurred in 160 Science at the University of Southern Maine. We kept ten male Siamese fighting fish in 5 2-L water tanks, each holding 2 fish separated by a divider. We placed handmade cardboard dividers between each tank to prevent the fish from seeing each other as this could cause unnecessary aggression (Bronstein, 1998).

Collection

We conducted preference tests normally as we fed fish. Every weekday for 3 weeks, fish underwent trials once every 12 hours. We gave the fish 10 mg of random pairs of food choices consisting of pellets (Zoo Med), flake food (Tetra BettaMin), or freeze-dried brine shrimp (Hikari). We introduced food at the same time and recorded latency with a stopwatch to the nearest tenth of a second for fish to choose food, recording preference as the first food chosen.

Data Analysis

We used repeated measures ANOVA to analyze data, followed by pairwise comparisons, using JMP 12.2 (SAS Institute, Inc. 2015). We used chi-squared testing to analyze choice data. Significance level at $P < 0.05$.

Table 1. Nutritional values of freeze-dried brine shrimp, pellet, and flake food used to feed Siamese fighting fish over 3 weeks.

Food Option	Crude Protein	Crude Fat	Crude Fiber	Moisture	Phosphorus	Ascorbic Acid (mg/kg)	Riboflavin (mg/kg)	Vitamin B12 (µg/kg)	Ash	Omega-3 Fatty Acids (mg/kg)
Brine Shrimp (Hikari)	min. 47.0%	min. 5.5%	max. 0.5%	max. 6.0%	max. 0.1%	min. 60	min. 20	min. 2000	0%	0
Pellet (Zoo Med)	min. 40.0%	min. 8.0%	max. 3.0%	max. 10.0%	max. 1.0%	0	0	0	max. 12%	0
Flake (Tetra)	min. 48.0%	min. 10%	max. 1.5%	max. 7.0%	min. 1.1%	min. 90	0	0	0%	6000

C. Results

Mean latency for each fish to choose their food option differed only by 0.4 s between the most chosen food choice and least chosen food choice (Fig. 1). Fish chose pellet first between the three food choices (Fig. 2).

Pairwise comparisons with t-tests of differing food options between pellet, freeze-dried brine shrimp, and flake food showed the mean latency for pellet vs. flake is not significant ($t = -0.05$; d.f. = 8; p-value = 0.9557) compared to flake vs. shrimp ($t = -0.74$; d.f. = 8; p-value = 0.4839) and shrimp vs. pellet ($t = -1.02$; d.f. = 9; p-value = 0.3360).

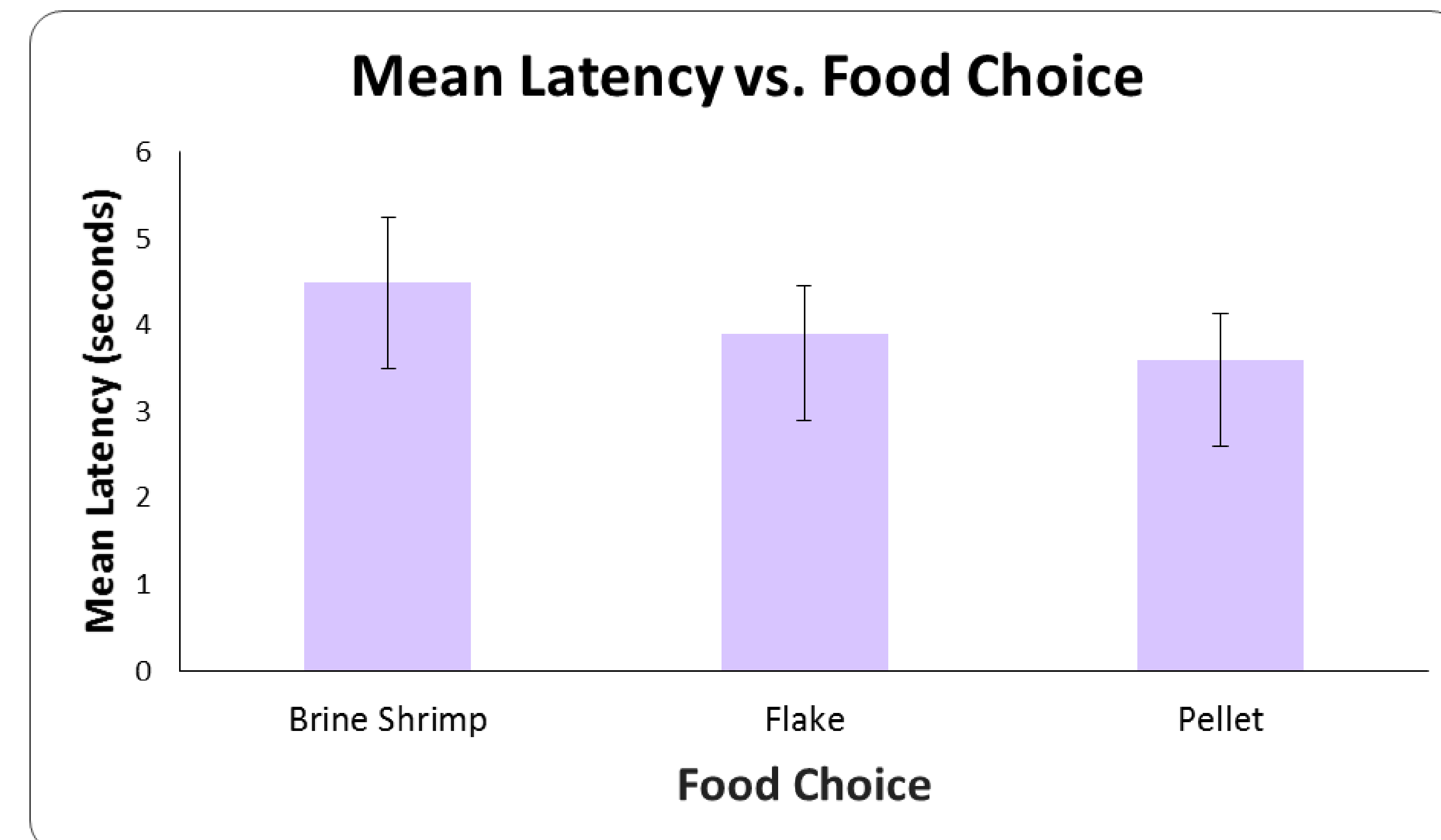


Figure 1. Mean latency (brine shrimp SE = 0.75, flake SE = 0.55, pellet SE = 0.53) for Siamese fighting fish (N = 11) to choose to consume freeze-dried brine shrimp, flake, and pellet food.

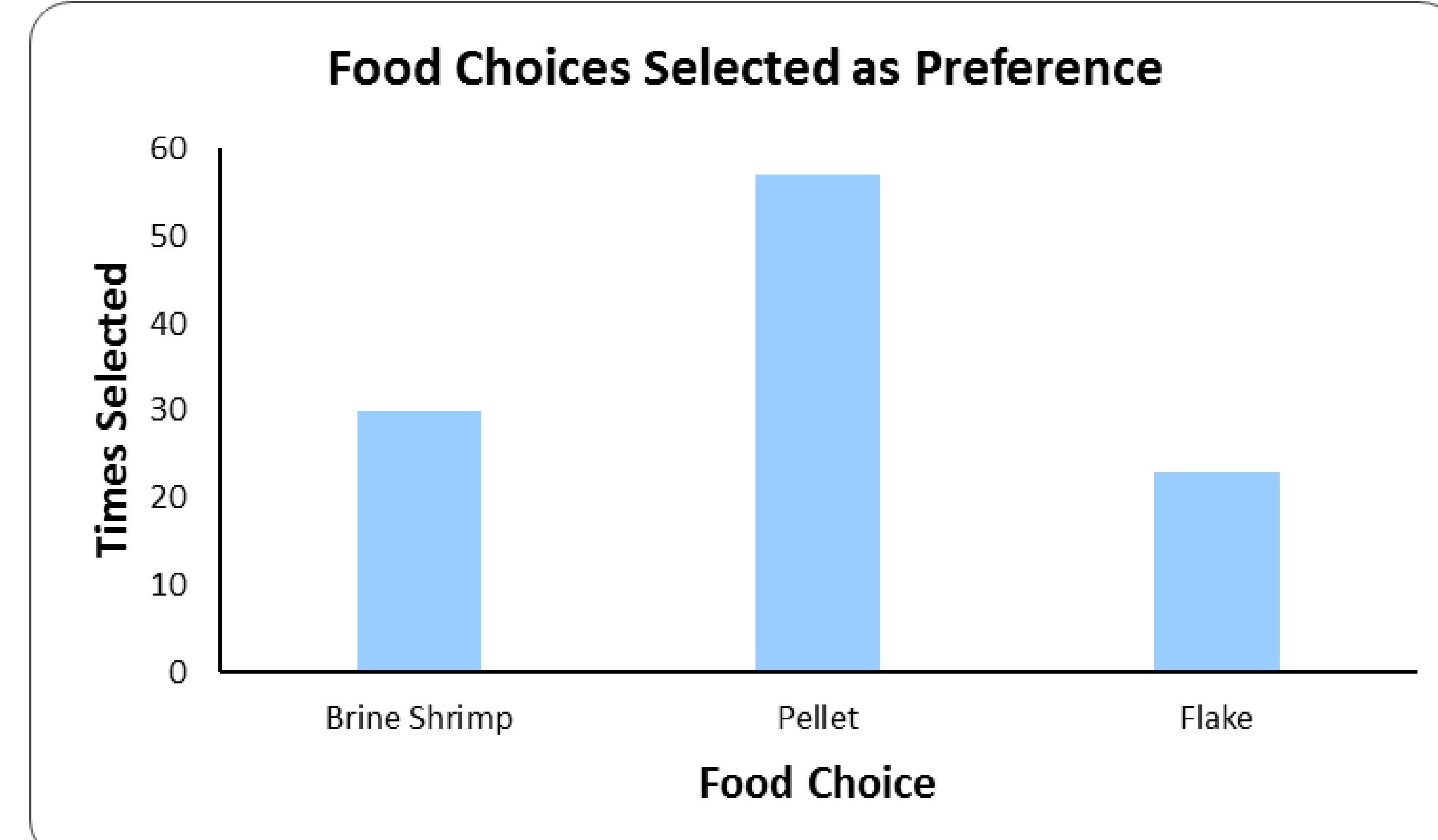


Figure 2. Number of times food options chosen first between freeze-dried brine shrimp, pellet, and flake food for Siamese fighting fish (N = 11). Pellet was chosen most frequently (DF = 2, P-value = 17.5818, critical value = 9.210 at $P < 0.01$, f ratio = 0.3556, Prob > F = 0.7057).

D. Discussion

We predicted that Siamese fighting fish would choose to consume freeze-dried brine shrimp first, followed by pellet food, and lastly, flake food. Our results do not support our predictions. In our experiment, pellet food consumption varied with that of freeze-dried brine shrimp and flake food. Fish chose to consume pellet first, freeze-dried brine shrimp second, and flake food third.

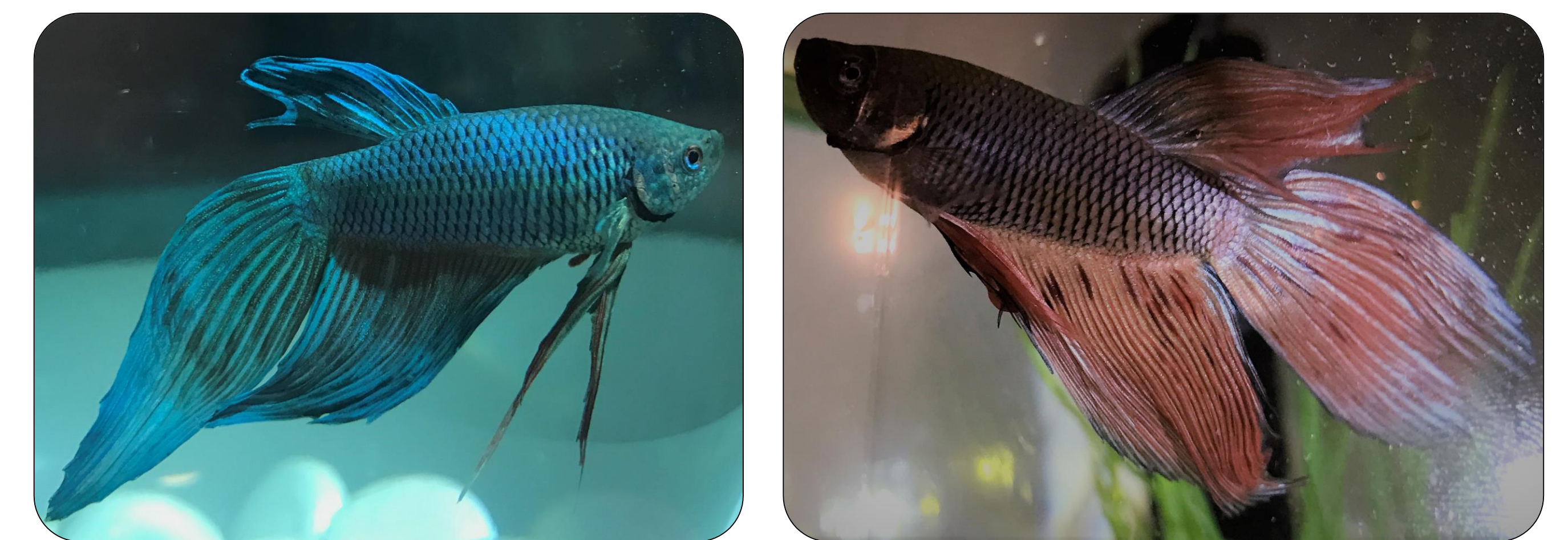
During the experiment, food items contained equal masses, but food particle shape and size differed, with some pieces larger than others. Pellet food could have been chosen more frequently due to its larger and rounder size compared to freeze-dried brine shrimp and flake food. Further testing on varying food sizes and shapes would need to be performed to test this hypothesis.

From our results, latency to choose food does not differ between the three food choices. Therefore, latency to choose food does not affect food preference. The difference in time to choose food is very small, which could be due to the time separation between each trial.

Fish displayed food preference while consuming foods varying in nutritional value. Although freeze-dried brine shrimp is high in protein and fatty lipids (Leger et al., 1987), and pellet food is low in protein, but high in fiber and fat content (Table 1), fish chose to consume pellet food first more frequently. The results supported our predictions for flake food, which was chosen lastly with its content consisting of meat, yeast, and gluten.

Optimal foraging theory states that an animal's fitness is maximized by food choice, energy intake, and time spent gathering and eating food (Pyke, Pulliam, & Charnov, 1977). Our results supported the theory subject to food selection and energy intake, but not subject to time spent gathering and consuming food.

We can conclude that food choice in Siamese fighting fish is more complex than high amounts of protein or vitamin content. Animals incorporate multiple factors into their food preference. Although we do not know all the reasons behind food preference, we examine food choice behavior and attempt to understand how these behaviors can maximize animal fitness and survival.



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