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A new technique for testing the eliciting effects of fish color patterns

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This new technique provides an alternative to the use of stimulus fish with paint applied to their body surfaces or fish dummies for testing the eliciting effects of different color patterns. The stimulus fish are fitted with thin plastic suits, with the pattern to be tested painted on each suit. Small numbers of stimulus fish are required. They adjust readily to the suit and rarely show agitated movements during testing. Suited-up stimulus fish may better simulate the appearance of free-living conspecifics than dummy fish that show no breathing activity or unassisted swimming movements. At the same time, suited-up fish provide some variation in stimulus characteristics particularly relative to swimming movement.

In order to provide convincing tests of the eliciting effects of different color patterns, it is necessary to present them in a stimulus situation that is relatively constant except for the change in color patterns. Models of fish with color patterns painted on them have been successfully used in such testing, for example, in cichlids (Heiligenberg, Kramer, & Schulz, 1972; Leong, 1969; Rowland, 1975), centrarchids (Colgan & Gross, 1977; Keenleyside, 1971; Stacey & Chiszar, 1978), and anabantids (Picciolo, 1964). The use of models allows a consistent manner of presentation from test to test, but there are some potential disadvantages. Models may be unnatural in that they lack vital signs other than experimentally induced and often crude movement. Also, models do not respond to behaviors directed toward them. Such lack of natural characteristics may not be important in all situations. Robertson and Sale (1975) have found that male Siamese fighting fish (*Betta splendens*) respond to lifelike models in some circumstances in a manner indistinguishable from typical response to live fish. Brockmann (1973) and Zaret (1977) painted color patterns on live fish. Subsequent unpredictable behavioral responses of the stimulus fish may limit the use of this technique, and toxic effects may restrict repeated alterations of the same individual, so large stimulus stocks may be necessary.

The technique described here has been successfully used to test the eliciting effects of fish color patterns (Townsend, 1980). In this, as in the other techniques, the eliciting effects of different color patterns are determined by comparing the responses elicited by each pattern when the stimulus fish showing the patterns are presented in a randomized sequence to a series of test fish. This technique differs from those previously described in the manner by which the different color patterns are presented to the test fish. Stimulus fish are not required in large numbers. Treatment stress appears small, and stimulus fish show some natural activity in the form of slow swimming and regular breathing. This technique, useful in its own right, could be particularly valuable when fish species not responsive to models are to be tested and artificial alteration of the stimulus fish's own color pattern is not feasible.

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TECHNIQUE

The stimulus fish are fitted with .1-mm polyethylene suits on which the various color patterns to be tested are painted. A stimulus fish with suit in place is depicted in Figure 1. The suits are constructed in the following manner. The body dimensions of a stimulus fish to be used are measured, and a wooden replica (not including fins) is constructed from soft wood. The replica is cut roughly to shape with a band saw and then is filed and sanded to final dimensions. The components of the various color patterns to be tested are then added to the replica at locations determined from measurements taken directly from the stimulus fish and from photographs. Two sheets of plastic are then pulled over the wooden stimulus fish replica and heat fused with a soldering iron from the tip of the head posteriorly along the dorsal and ventral midlines to the level of the caudal peduncle. The surface of the polyethylene is then lightly abraded with fine sandpaper to facilitate good

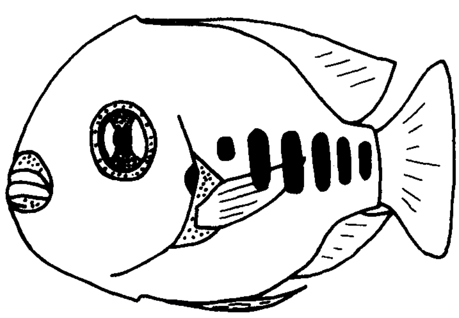

Figure 1. A suited-up stimulus fish.

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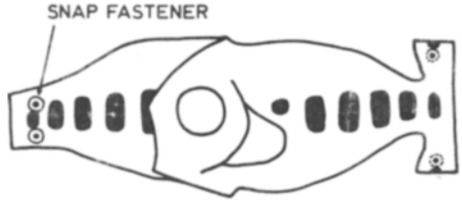

Figure 2. A plastic suit with opposite sides spread apart. The female halves of the two snap fasteners used to hold the suit together over the caudal peduncle of the stimulus fish are shown on the left-hand side of the suit. The two male halves, located under the tabs attached to the right-hand side of the suit, are indicated by dotted lines.

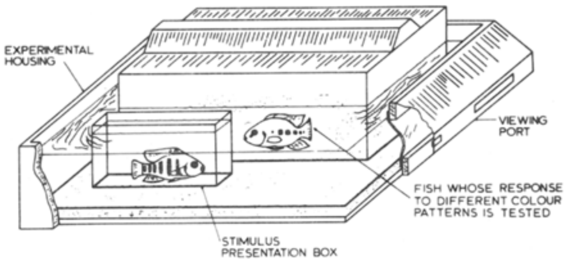

Figure 3. An experimental apparatus for testing the eliciting effects of color patterns shown by a suited-up stimulus fish (within the presentation box).

adhesion of the paint to the suit. Color-pattern components, visible on the replica, are then traced in ballpoint pen onto the polyethylene. The polyethylene is then cut posteriorly along the midline to the caudal peduncle dorsally from the origin of the dorsal fin and ventrally from the origin of the pelvic fins. Openings are also cut to provide clearance for the eyes, gill covers, and pectoral fins (Figure 1). At the caudal peduncle on one side, two tabs are left. After the suit is placed over the stimulus fish, these tabs are used to fasten the two sides of the suit together (Figure 2). Attachment of the tabs to the opposite side of the suit is achieved through the use of lightweight clothing snap fasteners (0 size, 7-mm diam). Color-pattern components, including background color, are painted on with Aeroglass airplane dope (Pactra Canada, Ltd.). The actual color pattern of the stimulus fish is not visible through the suit; the painted surface is opaque. The components bond well to the suits during tests; however, repainting is often necessary when suits dry out in storage between tests.

The "suited-up" stimulus fish are placed in a narrow, clear plastic box for presentation in tests (see Figure 3 for an example of testing apparatus in which, for an 18-cm stimulus fish, a 38.1 x 5.8 x 11.8 cm box was used). The presentation box serves several purposes. It facilitates standardization of stimulus location relative to the fish tested. Handling of the stimulus fish is reduced; the box is moved from test location to test location. Stimulus swimming activity is kept at a low level in the small space provided. Finally, the stimulus fish, when first suited up, appears to have equilibrium problems and tilts to one side. With the narrow box, the stimulus fish simply tilts over slightly before coming to rest on the side wall of the box. Within a few minutes, the fish regains its equilibrium and then maintains an upright posture for the duration of testing. If the stimulus fish is allowed to tip completely over on its side, it usually struggles violently to right itself and thereafter fails to consistently maintain an upright posture.

The removal of the stimulus fish from a holding tank and the "suiting up" and placement of the stimulus fish in the presentation box usually takes 50-60 sec. No anesthetic is needed; the fish are easy to handle if their eyes are covered (with the experimenter's hands).

DISCUSSION

The stimulus fish show some signs of stress when first suited up; however, they readily adjust. Within the presentation box, the stimulus fish show only slow swimming activity, rarely agitated activity. Stimulus fish used in over 100 presentations over a 3-month period showed no apparent cumulative stress effects.

This technique is most effective when stimulus fish larger than 12 cm are used. Small fish have considerable difficulty moving and maintaining an upright posture when suited up.

The stimulus fish may respond to test fish activities by changing their rate of swimming (Townsend, 1980). Depending on the responsiveness of a species to movement cues, differential stimulus movement may be a confounding factor, in which case model use might be most appropriate. For species that largely ignore nonmoving stimulus fish, the use of suited-up stimulus fish might be more effective.

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