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Some methods of making realistic fish dummies for ethological research

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Several techniques for the construction of realistic dummies for use as stimulus objects in behavioral research are described. This paper details several alternative methods for making exact copies (castings) of a living or dead fish specimen. The methods described herein can be extended to construct castings of amphibians, reptiles, and certain invertebrates for use in ethological and psychological research.

The use of a dummy as a stimulus object in ethological research offers important advantages over the use of live animals. Both "behavioral" and physical characteristics of the dummy can be manipulated and controlled to a degree not usually possible with a live stimulus animal. While a very crude dummy is adequate to elicit a desired response in some animals, others appear to be more discriminating and will only respond reliably to a dummy that more closely simulates a real animal. Using such realistic dummies, we have been able to determine the effects of an opponent's size and color (Rowland, 1975), marking patterns (Slovin & Rowland, 1978), sound cues (Rowland, 1978), and body posture (Slovin, Note 1) on the behavior of territorial male cichlids.

We have developed several methods for making realistic dummies of fishes, newts, and lizards. The entire process consists of two phases: the making of a mold from a prototype animal (e.g., a fish), followed by the production of castings (dummies) from this mold.

METHOD

(I) Mold Construction

(A) Permanent silicone elastomer mold: Regular method. A flexible, sturdy, and extremely detailed two-piece mold can be made of silicone elastomer, such as Dow-Corning Silastic RTV. This material is the basic ingredient of the "silicloning" process used in our laboratory for several years, whereby many copies of a fish can be made.

(1) Select a preserved or, preferably, a freshly dead fish, clip off all nonmedial fins close to the body (the fins may be saved for copying), and pin opercula and mouth closed with straight pins, if necessary. In some cases it may be helpful to skewer the fish on a stiff wire through the long axis of the body in order to prevent it from bending. If glass eyes are to be added to the dummy, remove the fish's eyes from their sockets and discard. It may be useful to coat the fish with a parting agent (e.g., oil or petrolatum diluted with an appropriate solvent), especially if it is preserved and thus devoid of a mucus coating.

(2) Obtain or build a cardboard box somewhat longer, wider, and deeper than the fish's length, depth, and thickness, respectively (Figures 1a and 1b).

(3) Mix and pour enough dental plaster to fill the box about one-third full. Tap the box sharply several times on a table to drive air bubbles to the surface, where they can be removed by wiping a straightedge across the surface.

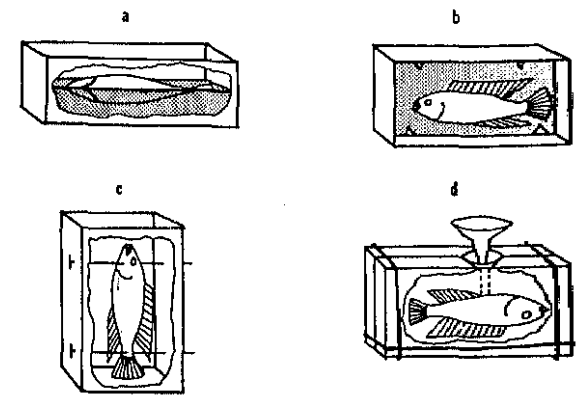

Figure 1. (a) Cutaway side view of Step IA4, showing fish positioned in semisolid plaster. (b) Face-on view of Steps IA4-5, showing extended fins of fish against plaster and alignment wedges cut into plaster. (c) Cutaway side view of Steps IC2-3, showing manner in which fish is held in box by pins. (d) Cutaway side view of Steps IIA2-3, showing how rubber bands are positioned to hold mold halves together during casting process.

(4) When the plaster reaches a semisolid consistency, usually after several minutes, carefully lay the prepared fish laterally onto the surface of the hardening plaster. (It is often helpful to first fill the empty eye socket that will contact the surface, i.e., the down-facing side, with plaster to avoid formation of an air pocket.) Slowly and evenly push the fish down into the plaster so that it lies just halfway submerged, with the surface of the plaster reaching the midline of the fish's sagittal plane (Figure 1a). Using forceps, spread out the medial fins to the desired degree of extension so that they too just contact the plaster surface; the surface tension of the plaster should hold the fins in position (Figure 1b). Be careful to squeeze out any bubbles that may be trapped under the fins.

(5) With a spatula or knife, slice out several wedges from the edge of the plaster when it becomes nearly solid; these wedges will later form keys for aligning the two halves of the mold (see Figure 1b).

(6) Cover the mold so that the fish does not dry out and wait for the plaster to completely solidify (usually within 1 h).

(7) Spread a thin layer of petrolatum, liquid floor wax, or oil over all exposed upper surfaces of the plaster, working this up to the edge of the plaster that outlines the fish. This serves as a parting agent to prevent newly poured material from fusing with the plaster.

(8) Following the manufacturer's instructions, mix up enough silicone and quick-cure catalyst to completely cover the fish; slowly pour it over the fish, being careful to prevent trapp-

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ing bubbles or air pockets. Occasional tapping of the box on the table will help drive bubbles to the surface.

(9) When the silicone has solidified (usually within 30 min, depending on the kind and amount of catalyst added), invert the mold, peel away the cardboard, and carefully separate and lift off the plaster top. Often, the fish will adhere to the plaster. If this happens, simply dislodge with forceps and replace it into the depression of the silicone so that it lays flush.

(10) Carefully remove bits of plaster that have stuck to the fish.

(11) With cardboard and tape, form a retaining wall around the sides of the bottom half of the mold so that more silicone can be poured to cover the half of the fish that is now exposed.

(12) Coat the entire face of the bottom half of the mold with parting agent, as done in Step IA7.

(13) Repeat Step IA8.

(14) When the upper half of the silicone mold has solidified, the halves can be separated and the fish removed. The mold can now be used, but it is advisable to let it stand overnight until polymerization is complete.

(B) Permanent silicone mold: Short method. This method results in a one-piece silicone mold with a slit along one side through which castings are poured and removed. Although the method is easy and adequate when reproducibility of fins is not crucial, it is not as adaptable as Method A, and the resulting casting is not always as good.

(1) Complete Step IA1.

(2) Complete Step IA2 but with the box open at the end rather than at the side (Figure 1c).

(3) Using insect pins, straight pins, or thin, rigid wire, suspend the fish in the middle of the box (Figure 1c). Pins can also be used to help hold the fins in extended position.

(4) Mix and slowly pour enough silicone and catalyst mixture into the box so that it is filled and the fish is completely submerged. Be careful to avoid bubbles or air pockets by pouring slowly and tilting the box whenever necessary.

(5) Let stand until the silicone has solidified, and then peel away the cardboard from around the silicone.

(6) Using one of the medially placed suspending pins as a landmark, preferably one at the ventral surface of the fish, carefully cut downward into the mold with fine scissors until the surface of the fish is reached. Carefully probing ahead with the scissors, so that the point rides just between the mold and the fish, cut the mold from the snout to the tip of the caudal fin, along the ventral midline.

(7) When the mold is slit and spread open, the fish can be lifted out and the mold will return to shape. If bits of fins or scales break off and stick into the mold, they can be picked out with forceps. The mold can now be wiped dry on the inside and then used, but it is advisable to let it stand overnight until polymerization is complete.

(C) Permanent plaster mold method. A rigid, reasonably detailed, two-piece mold can be made entirely of plaster. Plaster is inexpensive and can be carved, filed, cut, and smoothed, allowing one to alter the impression face of the mold. The disadvantage is that most plaster yields less detail than silicone, gradually loses detail with use, has a tendency to develop air bubbles, and is rigid. It is also crucial that the porous face of the mold be sealed with shellac, varnish, or something similar and well covered with parting agent to prevent it from fusing with the casting material.

(1) Follow Steps IA1-7, being careful to also coat the exposed surface of the fish with a thin, uniform coat of a parting agent.

(2) Follow Step IA8, but substitute plaster for the silicone and catalyst mixture.

(3) When the plaster has solidified, carefully separate the halves of the mold and remove the fish. Allow the mold to dry before using.

(D) Temporary mold. Molding material consisting of alginate or hydrocolloid substances are available from dental laboratory supply houses. Both have the property that newly poured material will not fuse with that which is already hardened, thereby eliminating the need for a parting agent. Hydrocolloids are applied as a hot liquid (in sol state) and can be reused. Alginates solidify fast and are applied at room temperature, allowing construction of a mold from an anesthesized animal. By substituting either of these substances for the plaster and silicone in Steps IA3-9, one can quickly obtain a reasonable, temporary mold. Such molds are fragile, must be kept moist, and cannot be heated, features that may preclude their use with certain casting techniques.

(II) Making a Casting From a Mold

(A) Pourable substances. Castings can be made of pourable substances (e.g., silicone elastomer, polyester, polyvinyl, or polyurethane plastics) that will solidify through cooling or chemical reaction (e.g., polymerization). The casting process described here utilizes an enclosed mold; this precludes processes that depend on evaporation of water or other solvent from the casting substance.

(1) Coat entire inner surface of the mold with a parting agent.

(2) Carefully align and join mold halves and secure with rubber bands, as shown in Figure 1d. For one-piece molds, alignment occurs automatically, when the mold snaps back into shape.

(3) Spread the mold apart at the ventral edge and place the neck of a funnel in the opening between the mold halves.

(4) Prepare casting material (adding pigment if necessary) and slowly pour it into the mold, being careful to avoid the formation of bubbles or air pockets by gently squeezing the mold while pouring.

(5) When the mold is filled, slowly remove the funnel (as the mold halves close to their normal shape they will squeeze out excess casting material and air) and let set.

(6) After the casting has solidified, carefully separate the mold halves, starting at the head and working toward the tail, and lift out the casting. Any flash around the casting can now be trimmed off. It is advisable to allow the casting to cure in the air (or preferably in a drying oven) before use, so that any possible adverse effects of plasticizers, catalysts, and so on, on live fishes are minimized.

(B) Nonpourable substances. Castings can be made from substances too viscous to pour: for example, higher viscosity silicone elastomer or polyester auto body repair putty. The latter has the advantage, since it can be filed, sanded, cut, drilled, or painted and yet is strong enough for reasonably fine details, such as small fins, to be reproduced.

(1) Complete Step IIA1.

(2) Mix casting material (adding pigment if necessary) and smear into depression of both mold halves with a spatula, so that depressions are just slightly more than filled, being careful to avoid formation of air pockets.

(3) Carefully join the mold halves from the bottom upward, closing slowly to force out any air and excess casting material through the sides and top of the mold.

(4) Being sure that the mold halves are properly aligned, fasten them together with rubber bands and allow to set until the casting material solidifies.

(5) Follow Step IIA6.

COMMENTS

The polymerization of certain plastics (especially silicone elastomers) is inhibited by contact with some substances. One should always be cautious when select-

ing materials. First, request information from the manufacturer or dealer, and then test small amounts of materials if you are uncertain about them.

Certain thermal plastics (e.g., polyvinyl chloride) must be heated during casting. On cooling, such substances will contract, sometimes leaving a dent in the casting. This effect can be reduced by cutting a funnel-shaped sprue in the mold (Figure 1d) and filling this hole to the top when casting.

Castings made from flexible polymers, such as silicone, polyvinyl, or polyurethane, can be cut and purposely distorted (e.g., the mouth fixed in position, gill covers erected, fins enlarged or replaced by inserting a plastic fin into a slit along the dorsal surface, body bent by skewering on a bent wire, etc.).

Silicone elastomer castings are virtually impossible to paint, although the elastomer can be pigmented prior to casting. It is possible, however, to overlay small areas of the casting with a mixture of pigmented silicone and catalyst.

REFERENCE NOTE

1. Slovin, M. Manuscript in preparation, 1979.

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