INSTRUMENTATION & TECHNIQUES

Apparatus conceptualization for psychopathological research in monkeys¹

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Investigation of psychopathology in monkeys requires analysis of multiple variables mediating specific behaviors. Assessment of both the relative contribution of each variable and the interactions among them is facilitated by the use of apparatuses whose designs permit separate or simultaneous manipulation of several variables. Three such devices, the pit, the tunnel of terror, and the standard living-experimental cage, each specifically constructed for the production of depression or despair in monkeys, are described.

The function of psychological apparatuses is to aid and abet the analysis of psychological problems and their underlying variables. If one attacks a new or relatively new task, essential apparatus will not commonly be predesigned, and the creation of appropriate instrumentation will be dependent upon limited leads and intuition. Fortunately, intuition is a valuable psychological tool, even though it is not the ultimate validating criterion of either problem contribution or problem solution.

All important behaviors or behavior syndromes operate through the mediation of multiple variables. It is therefore desirable, when this can be accomplished, to create apparatuses that, with minimal modification or combination, will permit the measurement of the role, or relative role, of each and all of the multiple variables mediating the behaviors to be measured.

An excellent example of such an apparatus, exquisite in part because of its extreme simplicity, is that of the dummy or surrogate mother, first analyzed by Harlow (1958) and Harlow and Zimmermann (1959), and subsequently reanalyzed in greater detail by Harlow and Suomi.² By minor variations, superficial in more ways than one, it was possible to assess the contributions of variables of nursing (hunger), contact comfort, contact surface, rocking motion (proprioceptive), warmth, and cold on the infant monkey's attachment to the mother and the basic social implications of this attachment.

The apparatuses described in this paper were designed to produce depression or despair in monkeys, i.e., the devices were created to induce measurable, quantitative psychopathological traits in subhuman primates. We do not mean to imply that depression in monkeys is analogous to depression in human beings, even though we believe it is. This problem transcends the scope of an apparatus paper.

THE PIT

As can be seen in Fig. 1, we know how monkeys behave when they appear depressed, but we do not know how they feel. Depressed human beings report that they are in the depths of despair or sunk in a well of loneliness and hopelessness. Therefore we built an instrument that would meet these criteria and euphemistically called it the pit, or the vertical chamber for those who find the term "pit" psychologically unacceptable. For neonatal monkeys we built a baby pit and for more mature monkeys an adult pit.

Fig. 1. Typical posture of depressed monkey.

The basic pits are illustrated in Fig. 2. Essentially, they are troughs constructed of stainless steel, open at the top, with sides that slope inward to a rounded bottom that forms one-half of a cylinder. The baby pits are 18 x 16½ in. at the top, 28½ in. deep, and the bottom half-cylinder is 18 in. long with a 1½-in. radius. Equivalent dimensions for the adult chambers are 18 x 12 in. at the top, 36 in. deep, with bottom half-cylinder of length 18 in. and radius 1½ in. One inch above the bottom of both pit types is a 3/8-in. wire mesh floor that allows waste material to drop through to the pit bottom. Holes drilled in the bottom permit

Fig. 2. Baby and adult pits.

Fig. 3. Effect of pit experience on selected behaviors of four rhesus monkeys.

Fig. 4. Typical posture of animal during pit incarceration.

drainage of liquid waste material. Food boxes and water-bottle holders are attached to one end of each chamber. A variety of special tops have been designed to cover the openings, ranging from wire mesh or Plexiglas panels, used primarily for photographic purposes, to a pyramid-shaped top, used to discourage incarcerated monkeys from climbing up the pit sides and hanging from the mesh ceiling.

Prior, intuitive rationale has been given for construction of the pits. In earlier studies, we had observed psychopathology in monkeys subjected to relatively prolonged partial (Harlow & Harlow, 1962) and total social isolation (Rowland, 1964). These isolation techniques were relatively slow in pathology production and created a greater variance in behavior syndromes than was desired. With neonatal and infantile monkeys long delay in syndrome production confounds the role of exteroceptive variables with basic normal maturational processes, both those which are positive, such as maternal and peer love, and those which are negative, including physical and social fears and aggression. Exploratory studies indicate that pit incarceration greatly accelerates the production of such behavior syndromes. In one study, four wire-cage-reared rhesus monkeys, with an age range of 6-13 months, were each incarcerated for 30 days. Figure 3 illustrates the pre- and postincarceration levels of four behaviors of the Ss, while Fig. 4 shows one of the Ss in a pit.

The pits were designed to meet the criterion of easy adaptation to the manipulation of multiple variables. One of these that will be discussed subsequently is the variable of social separation. As shown in Fig. 5, monkeys may be individually or group housed at the bases of the chambers, and their cage or cages may be transposed to the tops. Pitting may be achieved by removal of the bottoms of the cage or cages. Incarceration may also be combined with social separation by pitting pairs of monkeys, by either neutral or traumatic methods, and then separating the pitted monkeys after predetermined times of social incarceration and housing them in individual chambers for further pit-isolation intervals.

THE TUNNEL OF TERROR

We do not believe that the mode of depression is properly achieved by the production of intense fears or by simple conflicts, such as stress induced by problem difficulty (Pavlov, 1927) or conflict between reward and punishment (Masserman,

1943; Liddell, James, & Anderson, 1934). Even so, with some misgivings we created the tunnel of terror, described by Sidowski,³ and although this is clearly a fear-producing apparatus it has other potentialities. It involves more than the simple pairing of conditioned and unconditioned stimuli and hopefully it may be manipulated to induce generalized, depression-producing anxiety. Kubie (1953), in a kindly criticism of the subhuman experimental neurosis literature produced by psychologists, intimated that human psychopathology could not be induced in subhuman animals because, while the human being is capable of two types of symbolic processes, that of self-expression and communication through language, and that of self-deception, "it is not clear whether among lower animals either symbolic process is possible to a significant degree. This is why it is doubtful if the so-called experimental neurosis in animals, which actually is an emotional disturbance that may occur in human neuroses as well, is identical with the neurotic process itself [p. 9]."

While the controversy of whether or not behavioral disturbances exhibited by subhuman primates can be considered akin to forms of human neurotic behavior is beyond the scope of this paper, the fact remains that emotionally disturbed behavior can be experimentally produced in monkeys by a number of methods. The tunnel of terror is an apparatus specifically designed to produce forms of such behaviors. As can be seen in

Fig. 5. Housing cages with pit.

Fig. 6. The tunnel of terror.

Fig. 6, it consists of a tunnel 48 in. L, 18 in. W, and 24 in. H, along which any given fear stimulus may be progressively advanced toward a S or Ss housed in any standard living unit. The top, bottom, and one wall of the tunnel are constructed of Masonite panels, while the other wall is clear Plexiglas, permitting observation and photography of action within the passageway. At either end are sliding doors. A typical fear stimulus incorporated with the tunnel is shown in Fig. 7. It is nothing more than a J. C. Penney commercial toy robot, battery powered, which when turned on moves its arms and legs and opens its chest to expose flashing lights accompanied by a machine-gun-type sound. The robot is attached to a 66-in.-long metal pole with the on-off switch at the opposite end, permitting a single E not only to control activation of the stimulus at will but also to advance or withdraw the robot throughout the length of the tunnel at any rate desired.

As an apparatus designed to produce fear or anxiety in monkeys, the tunnel of terror has considerable flexibility. Other fear stimuli can, of course, be substituted for the above-described mechanical monster. Conditioned or unconditioned stimuli, such as a light or a noxious sound, can easily be incorporated into any experimental design. Subject animals can be exposed to an advancing fear stimulus while still in the home cage, or they can be placed within the tunnel itself. The apparatus also readily lends itself to studies of the general approach-avoidance conflict paradigm as well as to studies investigating the effect of presence of a fear stimulus on restrained Ss.

We are also interested in the tunnel of terror in that it may be utilized in various ways in combination with the pits, to shorten, intensify, and possibly stereotype the depressive syndrome. For example, individual monkeys or social pairs may be driven to the pits by the gradual or rapid approach of the marching monster. Depression in individual monkeys already incarcerated may be further enhanced by the appearance or advance of the monster from the top or ends of the pit chambers. Also, pairs of monkeys may be separated after tunnel terror or monster machinations in order to assess the possible complementary contribution of social separation to psychopathological production.

THE STANDARD LIVING-EXPERIMENTAL CAGE

It is not conventional to think of living cages as experimental

devices, but we learned many years ago from accidental experiments on partial social isolation that living cages are always apparatuses. Therefore, we designed a combined living-experimental cage (Fig. 8). It consists of a basic frame, 48 x 36 x 24 in., with the top and bottom covered by 3/8-in. woven steel wire mesh. The unit is enclosed by sliding in two 24 x 24 in. panels for each end. Each of the end panels can serve as a cage door. The panels may be constructed of wire mesh of varying thickness, clear Plexiglas, or solid Masonite, depending on the E's need. With only the side and end panels in place, the unit forms a 4 x 3 x 2 ft cage, suitable for housing small social groups of monkeys. In addition, a metal post may be inserted in the middle of the unit allowing additional panels to be slid through the channels in the cage ceiling in order to subdivide the cage area in various ways. By appropriate placement of these interior panels, the cage may be divided into four 24 x 18 x 24 in. individual cages, two 48 x 18 x 24 in. or 36 x 24 x 24 in. cages, or other combinations. As with the sides and ends, the interior panels can be constructed from a variety of materials, according to the needs of the investigator. The entire unit can be placed on a stand, or it can be stacked on top of another basic unit. Two removable drop pans catch waste materials, and food boxes and water bottles may be attached to any side, end, or interior panel.

As a living unit, the cage is flexible in that it can house up to four monkeys 2 years of age or less, either individually or in all possible permutations of four. Enlarged versions of the cage can be used similarly to house older animals. As an experimental unit, it has even greater flexibility. Interactions between animals housed in the cage can be controlled by appropriate selection of interior panels. For example, Ss may be physically and visually isolated by the use of Masonite panels, physically but not visually isolated by the use of Plexiglas panels, semiphysically isolated by use of wide-mesh panels that allow the Ss to reach through the mesh, or permitted unrestricted interaction by removal of all interior panels. Thus, virtually all studies involving social interactions among small groups of monkeys can be carried out completely within this one unit.

Fig. 7. Typical fear stimulus incorporated with tunnel of terror.

Fig. 8. The living-experimental cage.

In addition, the cage can easily be used in conjunction with other devices, opening up almost unlimited experimental possibilities. When paired with a WGTA, for example, studies ranging from straight learning to social facilitation can be carried out. An important characteristic of the living-experimental cage is that its use, either by itself or in combination with other apparatus, eliminates the home cage vs experimental situation dichotomy, for it provides both. A second desirable characteristic is that any ongoing behavior within the unit can easily and clearly be photographed by proper placement of clear Plexiglas panels.

Virtually all previously reported instances of depression-like behavior in monkeys have been attributed to either of two general procedures, social isolation (e.g., Griffin, 1965) or separation from an attachment object (e.g., Seay, Hansen, & Harlow, 1962; Kaufman & Rosenblum, 1967). The described living-experimental cage lends itself well to studies of either type. As suggested above, the unit may also be incorporated with additional apparatus in studies designed specifically to produce psychopathological behaviors in monkeys. The chief advantage in its employment in these situations is that the act of group social living may produce normal or near-normal socialization and this is, in the very real sense, the perfect baseline for psychopathological production. The living-experimental cage not only has the capacity to produce adequate or socially normal monkeys but also, through such appropriate ancillary apparatus as the tunnel of terror, to subsequently damage or destroy them psychiatrically.

CONCLUSION

The three pieces of apparatus described above were designed to facilitate production of depression or other emotionally abnormal behaviors in monkeys. Because we believe that depression or

other psychopathological conditions are not mediated by a single variable but rather by a combination of several variables, each device was designed to permit measurement and assessment of the relative contribution of a number of variables. In making our apparatuses sufficiently flexible to the extent that they can function to achieve these goals, both individually and in combination with each other or with other devices, we have resolved or at least approached the resolution of the greatest of all instrumentation problems, that of specific utility and obsolescence. Apparatuses designed by intuition rely on the foresight and luck of such intuition for their success. The intuition that there exists no one simple solution to a complex problem is, and will not be, found in error.

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NOTES

1. This research was supported by USPHS Grants MH-11894 and FR-0167 from the National Institutes of Health to the University of Wisconsin Primate Laboratory.
2. Harlow, H. F., & Suomi, S. J. The nature of love: simplified (in preparation).
3. Personal communication. The tunnel is now being used at the Wisconsin Regional Primate Research Center in a joint research effort involving J. B. Sidowski, H. F. Harlow, and S. J. Suomi.