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CAT RESTRAINT TECHNIQUES

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INTRODUCTION

In many animal research situations, restraint of the subject is a necessary part of the experimental procedure. This need is most apparent in behavioral studies, such as classical conditioning, where the accurate measurement of discrete responses (e.g., leg flexion and eyelid closure) as well as knowledge concerning the dynamics of response formation is desired. In addition, in such situations it is mandatory that the delivery of stimuli be constant, thus eliminating the possibility that response alterations are due to variations in stimulus delivery. Likewise, some form of restraint is often desired to reduce electrical artifacts caused by movement during brain recording. Where it is desirable to correlate brain activity with behavioral responses, free ranging situations can be particularly troublesome due to the difficulties of accurate response measurement as well as additional problems with obtaining artifact-free recordings. In this instance, restraint serves an important dual function in the collection of interpretable data.

An example of the usefulness of adequate restraint techniques is seen in the rabbit nictitating membrane preparation. This elegant classical conditioning paradigm developed by Gormezano and his associates (e.g., Gormezano, Schneiderman, Deaux & Fuentes, 1962) has provided an abundance of behavioral data regarding classical conditioning of the nictitating membrane response in the rabbit. In addition, this paradigm has led to a growing body of research concerned with neural correlates involved in the conditioning process (e.g., Berger, Alser & Thompson, 1976). This trend toward the increased use of the rabbit in both behavioral and certain neurobehavioral and neurophysiological studies is due in part to the relative ease with which the animal can be restrained for measurement of behavior and delivery of stimuli.

Unlike the rabbit, the cat has long been a favorite subject for neurophysiological and various sensory studies, partially due to the animal's size and availability. The cat has also been successfully used in neurobehavioral studies requiring no restraint such as the concomitant recording of instrumental responses and brain activity. However, as a behavioral or neurobehavioral subject in studies requiring restraint, the cat has proved to be somewhat less than ideal. The cat's inherent dislike of and lack of tolerance for restraint has been a major obstacle in its wide use in detailed studies of response parameters and brain-behavior correlates. This situation can be contrasted with that of the rabbit, whose brain has been much less extensively studied, but whose behavioral responses have been well documented. The development of adequate restraint techniques for the cat, that can be used in as successful manner as that developed for the rabbit by Gormezano and his associates, should result in the aquisition of valuable data concerning the behavioral responses of the cat. This data, coupled with the wealth of neurophysiological information that is available concerning the cat, would make it an ideal subject for further studies of brain-behavior relationships.

The purpose of this article is to examine the various attempts that have been made to avoid or reduce problems involved with cat restraint. These attempts include those in which the cat has been minimally restrained as well as systems involving long periods of adaptation, paralysis, or invasive measures such as skull bolts. Although these methods are briefly discussed here, the reader is encouraged to refer to these articles for more details regarding these restraint techniques. In addition, a cat restraint system recently developed in our laboratory will be described as a potential answer to many cat restraint problems encountered during behavioral and neurobehavioral research.

Restraint Circumvention

Some investigators have circumvented the restraint problem by developing techniques to collect data from animals who were minimally restrained or free-ranging. In studies

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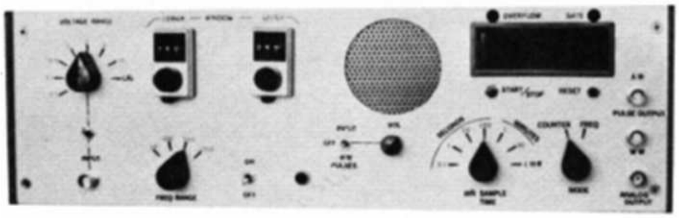

FIGURE 1: RAD II-A

requiring no restraint, the cat can be easily trained to perform various tasks such as bar pressing while brain activity is concomitantly recorded. Perhaps the most elegant example of such studies are those of John and his colleagues correlating bar press choice behavior with brain activity in a discrimination task (John, Bartlett, Shimokochi & Klein-man, 1973). In this study and many similar situations response dynamics are not correlated with brain activity but rather the response is used as an indicator of a decision or choice. Restraint is therefore not necessary.

While investigating heart rate conditioning in the cat, Hein (1969) developed a training procedure whereby cats were not physically restrained but rather were trained to sit on a 2 ft x 1 ft stand for the duration of the conditioning sessions. Hein developed this method after encountering problems with other types of restraint systems. Even though this method greatly reduces movement during recording, the training procedure requires additional time and effort.

Suzuki and Takahashi (1974) have noted the difficulties that cats encounter when responding under a head-restrained condition and thus developed a method for single unit recording from a free-ranging cat. Their system involves soldering lead wires from implanted electrodes onto a modified 9-pin miniature socket which is then cemented to the cat's skull with acrylic resin. During subsequent recording sessions, a 9-pin miniature plug with an input FET stage is inserted into the socket. The animal is allowed to move freely about by connecting a length of flexible lead wires between the animal's head unit and the recording equipment. This offers the advantage of reducing artifacts caused by movement while recording single unit activity from animals in situations where free-ranging responses are desired. However, this single unit recording method does not allow for situations where physical restraint is necessary, such as the concomitant recording of brain activity and discrete behavioral responses.

Chemical Restraint

A number of investigators have employed paralysis of the animal to measure autonomic responses (e.g., Wein-berger, Oleson & Haste, 1973) or neural response parameters {e.g., Woody and Brozek, 1969). Gallamine tri-ethiodide (Flaxedil) has been frequently used for this purpose. This approach, while simplifying restraint problems, negates correlation of overt skeletal behaviors with brain activity and does not allow determination of the conversion of neural to peripheral skeletal behaviors. In addition, the

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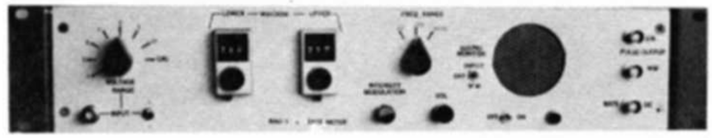

FIGURE 2: RAD I-A

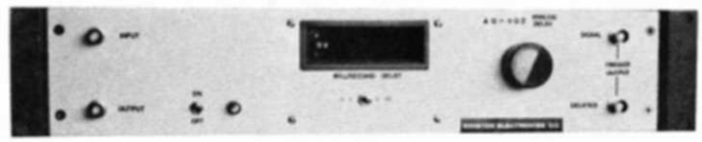

FIGURE 3: AD-502

NEW PRODUCTS

SCOUTEN EXTENDED WIRE KNIFE

The Scouten extended wire knife and holder is a new versatile efficient and easy to use wire knife with the following advantages:

1. Guide cannula can be reinforced and shortened for tough cutting (i.e. optic tract).
2. Holder will revolve about the long axis of the knife for rotational cuts and is adjustable for asymmetrical cuts.
3. The drive mechanism allows precise extention and r etraction of the blade by discrete increments.
4. Wire knife is enclosed in telescoping tubings its entire length and fixed at the top. It will not buckle or slip. The wire is easily replaceable.
5. Extended wire knife blades do break after a number o f extensions. The holder may be adjusted to use the wire above the break. The number of adjustments is about 10 and then the wire blade may be replaced without replacing the knife cannula.
6. The versatile holder will accept different types of knife cannula as well as a type of microsyringe.

You may see the Scouten extended wire knife and holder at Neuroscience in Cincinnati.

WINSTON ELECTRONICS

For the first time, all Sutler and Winston Products will be on display at Neuroscience in Cincinnati, November 10-13, Booth D9A.

Winston Electronics is now offering two new Window Discriminator/Rate Meters, unit activity counters. The RAD IA and RAD IIA.

RAD I-A

The RAD I-A window discriminator/rate meter is an improved version of the RAD-I used in electrophysiology for counting unit activity. New features include: Input voltage range steps, built in calibrator, extended frequency range and audio monitor.

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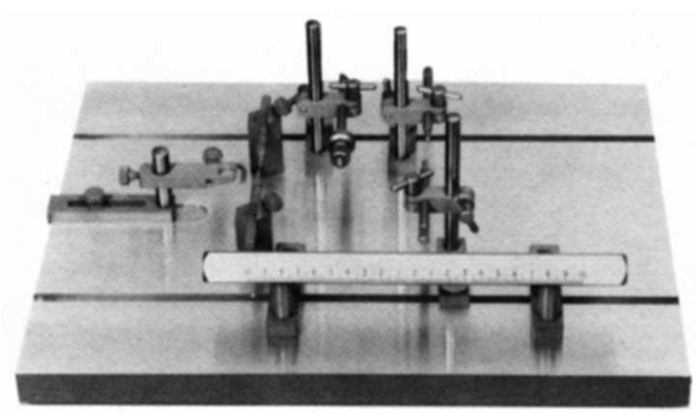

FIGURE 4: Rat Spinal with Accessories

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RAD 11-A

The RAD IIA has, in addition to the RAD IA features, a digital display, multiple output, computer/printer output, frequency counter with BIN sample time, manual and external triggered counter control. A six-column printer is available for the RAD IIA. An analog delay unit, the AD502 with 0.5 to 50 millisecond continously variable delay range is now being offered. Specification sheets are available on these products.

AD-502

The AD-502 analog delay unit will take any analog signal, such as a sine wave, triangle, or nerve impulse and continuously delay the signal by 0.5 to 50 milliseconds. If a nerve action potential responds immediately after stimulus (no time delay), the oscilloscope sweep does not start fast enough to display the first part of the nerve impulse wave form. The analog display circuit allows the wave form to be delayed and moved to any spot on the CRT. Delay accuracy is plus or minus 1%. The delay time is shown on a three-digit LED display. Specification sheets are available on these products.

RAT SPINAL UNIT

The rat spinal plate #980B is precision machined with two tee slots for the mounting of accessories. The top is left natural to assure precise location of components. Attached to the base plate via the tee slots are three #982A Adjustable Base Mounts with post and clamp. These base mounts are held with thumb screws and tee nuts, no wrenches are necessary. The #986A Vertebrae Clamp and #985A Hip Spikes are attached to the base mount clamps.
Additional accessories are the #987 V Notch Clamp and #988 Retractors. They may be attached to the spinal unit with the #982A Base Mounts and Clamps. #992 Calibrated

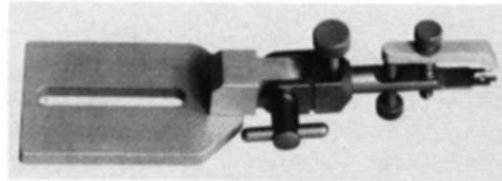

FIGURE 5: Mouse Adaptor

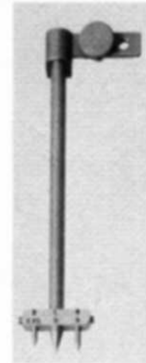

FIG. 7

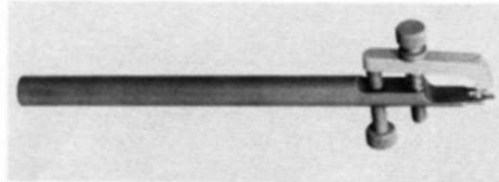

FIGURE 6: Mouse Surgical Head Holder

A-P Bar and Brackets (A-P bars are available in sizes to fit all of our carriers). Two head holders, the #931 Rat Surgical Head Holder with a vertical post and clamp, and the #921 Head Holder which consists of a tooth bar with adjustable vertical post and a set of calibrated rat ear bars.

The design of the Rat Spinal Unit assures ample lateral and vertical travel of all components. The tee slots allow rapid attachment and removal of various accessories.
Also available are special nuts to attach the rat spinal accessories to the 1780 spinal base plate.

MOUSE ADAPTOR

Now available is the #922 Mouse Adaptor. This adaptor does not require ear bars and may be attached to any David Kopf stereotaxic frame. This adaptor will minimize breathing problems associated with ear bar insertion.

MOUSE SURGICAL HEAD HOLDER

The #321 Mouse Surgical Head Holder is like the #320 Rat Surgical Head Holder and may be used with the #310 Universal Stand.

RAT ALIGNMENT TOOL

The #944 Rat Alignment Tool attaches to a David Kopf electrode carrier in the same manner as any electrode holder. (Shown in Figure 7.)

There are two Bregma points with a Lambda point between. By rotating the tool 180 degrees one can establish an equal Lambda-bregma alignment or one with a 2.25mm vertical difference.

The accuracy of this method over normal tooth bar adjustment is preferred by some investigators.

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use of paralyzing agents to achieve restraint requires the use of artificial respiration, another methodological variable that must be considered when a study is undertaken.

Head Restraint

Various methods of restraining head movements have been devised with the majority employed in neurophysio-logical recording. Siegel and Lineberry (1971) introduced a method of recording single unit activity from restrained, unanesthetized chronic cats. The surgery involved placing a cat in a stereotaxic instrument and opening a trephine hole over the general area from which later microelectrode recordings are to be made. A screwcapped teflon cylinder is then placed in the trephine hole. Microelectrode leads are next connected to an amphenol receptable which is in turn screw-fastened into a head-holding apparatus and rigidly attached to the stereotaxic instrument. The receptable is dental-cemented to the skull of the cat so that when ear, eye and mouth bars are removed, the head of the animal is still held rigidly in the stereotaxic position. During subsequent recording sessions, the cat is placed in a padded box and its head rigidly held in place by attaching the receptacle to the head-holding plate. The amphenol plug is fastened to the device and the microelectrode is stereotaxically lowered into the brain through the uncapped teflon cylinder. This device has proven to be effective in restraining cats with minimal struggling although it is recommended that the animals be run no more frequently than once per two days.

Hobson (1972) has designed a system of head restraint for cats that has been used for long-term extracellular unit recording. A 16-guage stainless-steel headplate with two projecting bolts is first cemented to the anterior portion of the cat's skull at the time of surgical implantation of recording apparatus. Restraint is achieved in subsequent recording sessions by securing the headplate to an adjustable steel arch that is anchored in a box. Adaptation sessions in which the animals are placed in the device until struggling is reduced are required before the apparatus can be used. Adaptation to the device has been found to be enhanced by the strategic use of sleep deprivation.

A head restraint apparatus for microelectrophoretic study of single neurons in the cat has also been constructed (Frederickson, Jordon, & Phyllis, 1973). The cats are anesthetized and mounted conventionally in a stereotaxic frame. A lucite block is held by four calibrated horizontal rods which are in turn secured to two vertical rods mounted on the stereotaxic frame. The block is lowered onto the skull of the animal, cemented, and the vertical and horizontal coordinates are recorded. The awake, non-paralyzed cat can later be held in this modified stereotaxic frame and subsequent electrode placement and neural recording can be undertaken by referencing the lucite block. Repetitive adaptation sessions during which the cats are placed in the apparatus until they lie still are essential for the use of this restraint method.

While studying the visual system of chronic animals, Humpherys, Menzes and Hughes (1974) observed that changes in head position during recording influenced the reliability of the visual evoked response. To circumvent this problem, they devised a procedure in which, at the time of the surgical implantation of recording electrodes, an acrylic restraining pedestal with a hole to accommodate a restraining rod is formed on the skull of the cat. Restraint is achieved by placing the cat in a box, surrounding it by foam padding and restricting its head movement by inserting the rod through the restraining pedestal. The rod is then secured to the sides of the box and neural recording is accomplished with minimal head movement.

These head restraint procedures, while holding the animals' heads firmly, are inappropriate when many subjects are to be used due to the time-consuming implantation procedures. These methods also require varying amounts of adaptation to the restraining devices.

Body Restraint

As stated previously, many behavioral and neuro-behavioral studies which employ the cat as a subject require some method of body restraint. This has been traditionally achieved through the use of casts, hammocks or slings. These restrainers usually require extensive periods of adaptation prior to experimental procedures to allow any stimuli to be presented to the subject without undue struggling.

To achieve immobilization of their subjects during a leg movement conditioning study, O'Brien and Packham (1973) utilized orthoplast plastic splints attached to an aluminum base and molded to surround the limbs, neck and trunk of the animals like a full body cast. While allowing sufficient leg movement, the device resulted in a rather low level of conditioned responses (22%), Other attempts at using cast-like devices for restraint have not proved to be successful.

Wickens, Meyer, and Sullivan (1961) attempted to use a fiberglass cast restraint for conditioning GSR and discrimination but reported that after the first session, changes in resistance readings could be discerned. The investigators subsequently used a nylon net sling to suspend their subjects from a horizontal bar. This procedure required an approximately two week adaptation period during which the animals were restrained at first loosely and then more firmly by means of a cord attached by clamps to strips of tape

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that were wrapped around the legs. Many other studies have employed a sling or hammock system of body restraint similar in principle to that described by Wickens and his associates. These include a study by Adams (1963) recording hypothalamic temperature in cats during feeding and sleep, an investigation of tremor in cats following injections of carbachol in the caudate nucleus (Conner, Rossi & Baker, 1966), and Bruner's (1969) study of reinforcement strength in the classical conditioning of leg flexion, freezing and heart rate.

Hall and Monto (1970) have constructed a unique type of restraint system to control body movements. This device consists of a board, suspended over a wooden base, which has holes cut to accept the animal's limbs. The animal is positioned on the board with its limbs through the openings and held in place by three adjustable canvas straps that cover the dorsal surface posterior to the head and anterior to the tail. While this system offers the advantage of easy accessibility to the head, neck and hind limbs, it requires two people to place the animal in the restraint as well as a period of adaptation to the restrainer.

Simultaneous Head and Body Restraint

Systems of restraint have been designed to control head movements while restricting body movements at the same time. Wolfe (1969) has developed a restraining device for electrophysiological recording in unanesthetized cats. A plywood box with an adjustable vertical neck-slit is utilized to achieve various degrees of body restraint. Small doors at the front of the box allow for the injection of drugs while the animal is restrained. The head is immobilized by an adjustable clamp that is secured to the box and in turn fastened to a dental acrylic electrode pedestal that is mounted on the cat's skull. Some animals were found to struggle and rotate themselves in the box when first placed in it. Therefore, a gradual adaptation period of 1-2 days with reinforcement administered is recommended for this device.

Rudy (1973) has described a multipurpose restraining apparatus that is especially useful for those studies requiring chemical or electrical brain stimulation in the awake cat. The device consists of a head stockade, support frame and a thoracic harness. The upper and lower halves of the stockade are supported by two vertical aluminum rods mounted on a base. The stockade can be adjusted to accommodate animals of varying neck sizes. Body restraint is achieved by use of a leather thoracic harness which surrounds the cat. The harness is fastened to an adjustable horizontal support rod which is clamped to two vertical aluminum rods mounted on the base directly in line with the stockade assembly. Additional sets of vertical rods and support bars can be added if more restraint is desired. This restraint system secures the cat's head and shoulder area, permits free circulation of air and allows for the injection of drugs in many locations. Five to ten hours of exposure over 3-5 session are necessary for adequate adaptation.

The Present System

While providing varying degrees of immobility required for recording skeletal and/or neural activity in the cat, the restraints described above often necessitate long adaptation periods, lasting days or even weeks, prior to the onset of the experiment proper. Invasive techniques also require additional time and surgical efforts which severely restrict the number of animals which can be used in a study. In fact adaptation and invasive restraint techniques many times require more time and energy than the actual data collecting procedure itself. The restraint devices described here have also not provided sufficient restraint to allow good response resolution and invariant stimulus delivery. Furthermore, lack of adequate restraint makes it difficult to obtain stable brain records when behavioral or neuro-behavioral data is desired. In addition, the lack of universality in application of the restrainers is apparent. It is most desirable to have one restraint system that is sufficiently versatile to be applied to a variety of neurophysiological, behavioral, and neurobehavioral research situations. This type of system must be flexible to the extent that a few simple modifications to its basic structure enables one to use the device in a variety of paradigms.

We recently developed a versatile restraint system that enables us to easily and accurately measure discrete behavioral responses and brain activity from the normal, awake cat. Another major advantage of this restraint system is that it requires little or no adaptation and is tolerated well by the animal.

The restraint system consists of a thick-walled Plexiglas restraint box similar to, but more enclosed than, the rabbit box described by Gormezano (1966). The basic equipment is schematized in Figure 8. The bottom of the box measures 45.1 cm long x 15.2 cm wide. The hinged lid measures 31.4 cm long and the height of the box is 15.6 cm. Viewed from behind, the inside of the box is octagonal up to the front

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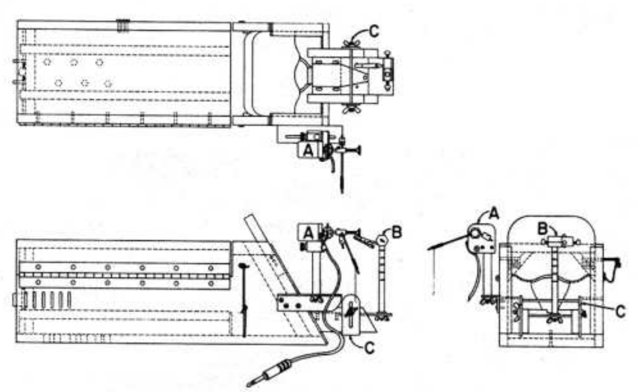

FIGURE 8

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edge of the hinged lid with each side of the octagon measuring 5.2 cm. An adjustable end-plate is used to accommodate cats of various sizes and can be locked in place in any one of six positions in the rear 9 cm of the box. The front end of the box consists of an adjustable neck yoke and a chin plate to which two nylon releasable cable ties and a bite bar (labelled C in Figure 8) are attached. The neck yoke measures 12.7 x 8.9 cm, the chin plate is 8.6 cm wide and protrudes 9.2 cm beyond the bottom of the front of the box. The animal's chin rests in a 5 mm deep trough cut into the chin plate. The trough measures 4.1 cm at its widest point and tapers to 1 cm at its front edge.

The cat is placed in the restraint box lying on its stomach with the forelegs slightly extended and the hindlegs tucked underneath the body in a manner similar to the rabbit in a Gormezano box. The lid of the box is closed and fastened and the end-plate is locked into the desired position. If further body restraint is required for smaller cats, paint rollers may be inserted between the animal's body and the lid of the box. The cat's head protrudes through the neck yoke with the chin resting in the trough. The two cable ties, which fit through slots in the chin-plate, are tightened around the head, in front of and behind the ears. The cable ties are positioned so as to allow easy access to electrode implants or cannulae over most of the surface of the skull. Finally, the bite bar is positioned through the mouth behind the lower canine teeth and is tightened sufficiently to preclude head rotation but not to produce discomfort.

As indicated earlier, the present system offers a solution to the problem of long adaptation sessions. The cat accepts this restraint for as long as two hours with little struggling after a single adaptation session of one hour. No appreciable increase in resistance to being placed in the apparatus has developed over 15 daily recording sessions. No anesthetics or special reinforcers are necessary to reduce struggling and assist adaptation of the animals to the restraint. Overall, the reduction of both time and effort spent in adapting the cats to the restraint device has proven to be very valuable.

The versatility of our restraint system is also one of its biggest advantages as can be demonstrated by the variety of situations in which we have applied the apparatus. Head restraint, body restraint, or simultaneous head and body restraint can be achieved with the device. We have primarily used the restrainer for conditioning the nictitating membrane (NM) response (Patterson, Olah & Clement, 1977). A cat can be held sufficiently secure enough to permit eyelid or nictitating membrane movements to be accurately measured. For NM conditioning, a metal plate is fastened to the underside of and protruding 4-7 cm beyond the front edge of the chin rest, and supports an upright shaft and sliding collar to which an alligator clip is attached (labelled B in Figure 8). The alligator clip holds the shock leads which deliver the UCS to the eye region. The sliding collar may be locked into place at any point along the shaft while a slot in **the metal plate allows the shaft to be moved laterally. A similar assembly is employed to position a rotary potentiometer (labelled A in Figure 8) that is used to monitor NM movements. A slotted metal bracket mounted to the front of the box along one side supports a shaft and sliding collar to which the potentiometer is attached. Thus the potentiometer may be adjusted to any position that may be necessary for optimal measurement of NM movements. For further details regarding cat NM conditioning, see Patter-son et al. (1977). The same restraint system was employed by Patterson, Berger, and Thompson (1979) in a study correlating NM conditioning with hippocampal multiple unit activity. Use of the restrainer resulted in excellent behavioral response measurements as well as an artifact-free, stable hippocampal record.**

Slight modifications of the restrainer box have permitted us to condition the cat hindleg flexion response. These modifications include making the hindlimbs accessible by opening holes in the bottom of the restrainer, raising the box on four plexiglass legs that are attached to a wooden base, and mounting a potentiometer on the base to monitor the leg movements. Figure 9 shows the two restraint boxes as well as the associated recording equipment. For more details regarding the present restraint system, including polygraph records of NM and hindleg flexion responses, see Romano, Steinmetz, and Patterson (1980).

We have found our restraint system to be an extremely valuable tool that allows the cat to be used in a variety of behavioral and neurobehavioral studies that require a restrained subject. Use of the restraint techniques has resulted in excellent response definitions in both neural and behavioral records as well as a lack of spontaneous movements during recording sessions. In summary the restraint system (1) comfortably and adequately restrains virtually any cat, (2) requires little or no adaptation, (3) is extremely versatile, (4) is relatively inexpensive to construct, (5) is fight-weight and portable, (6) can easily be used by one person, and (7) requires minimal on-going maintenance.

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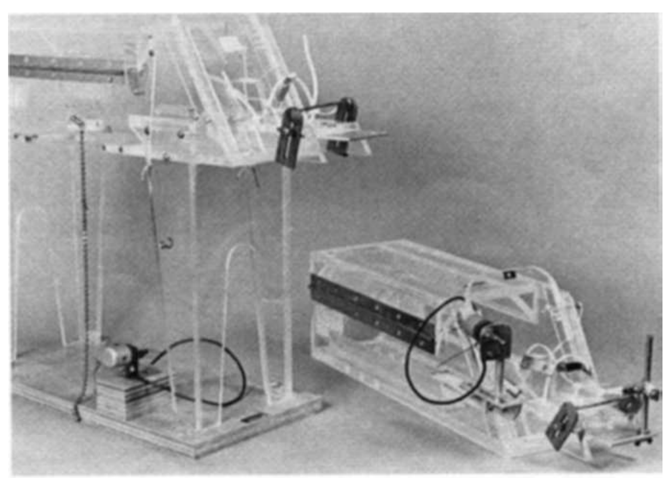

FIGURE 9

ACKNOWLEDGEMENTS

The development of the apparatus and technique presented in this report was supported in part by NINCDS grants NS14545 and NS10647.

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FIGURES

FIGURE 8. Schematic of the cat restraint box with rotary potentiometer (A), shock lead holder (B), and bite bar (C) labelled. (Reprinted from Romano, Steinmetz & Patterson, 1980. Copyright 1980 by the Psychonomic Society Reprinted by permission.)

FIGURE 9. The restraint boxes used for nictitating membrane and hindleg flexion conditioning with associated recording equipment.

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Interested persons should try and obtain the detailed booklets which are available from most of the bigger averager manufacturers which often have lots of very useful information on particular products (as opposed to the glossy brochures).

OTHER USEFUL REFERENCES

Bendat, J. S. and Piersol, A. G. Random Data: Analysis and Measurement Procedures. Wiley Inter-science 1971

deBoer, E. and Kuyper, P., Triggered Correlation. IEEE Transactions on Biomedical Engineering. BME 15 3 1968

Sokol, S., Visually Evoked Potentials: Theory, Techniques and Clinical Applications. Survey of Ophthalmology, 21 1 1976

LETTERS

Recently it was brought to my attention that M. M. Patterson ("Rabbit Stereotaxic Techniques") had referred to my book Small Animal Anesthesia in your house organ. This book has been out of print for several years, having been superceded by Veterinary Anesthesia by Lumb and Jones (Lea and Febiger, 1973).

I do appreciate his reference greatly and wanted to point out to him that a more recent reference was available.

William V. Lumb, D.V.M., Ph.D.
Professor and Director
Surgical Laboratory
Colorado State University
Fort Collins, Colorado

My very extensive experience with urethane I.V. in rabbits has convinced me that it is as close as one can hope to get to an ideal anaesthetic agent for acute procedures. It can even be used for recovery experiments if used properly and the animals are given adequate post-op care but I do not recommend it for such use. Urethane leaves the rabbit with excellent control of his regulatory mechanisms, e.g., panting and ear vasodila-tation in response to even slightly increased body temperature, inhibition of panting, ear vasoconsfriction and shivering in response to cooling (shivering is a bit blunted). The animal responds to pyrogens normally (but the rise in core temperature is less because of general muscle relaxation). One might even go so far as to say that the animal is more normal than normal because it does not show the troublesome "emotional" responses to restraint, such as emotional hypothermia. I have not studied cardiovascular and respiratory responses in detail but know that these are very satisfactory in urethanized animals used for teaching purposes.

There are a few "tricks" to successful use of urethane: (1) it should be high quality stuff if artifacts caused by pyrogen contamination are to be avoided. (2) it should be made up in normal saline not water. In water it can cause haemolysis. My way is to use 20% urethane in isotonic pyrogen-free saline, injected via the marginal ear vein through a #22 or smaller needle (to guard against too-rapid induction and possible respiratory failure tho this is a very slight danger when compared to pentobarfa. The "basic" dose is 1 gm/kg i.e. 5ccs. Supplementation may be necessary after about 10-15 min. as distribution of the drug causes lightening of the anaesthetic level but repeated supplementation is seldom needed because the drug is very long lasting. Used in this way (and taking several minutes to deliver the basic dose) the casualty rate is zero in my experience.

One additional comment: with all things given by the marginal ear vein I find it very desirable to use a "transilluminator", i.e. a flashlight bulb soldered to a couple of leads and held in the fingers that are not holding the ear. This is especially useful with the urethane injections since the stuff causes a lot of damage if injected extravascularly.

Ronald Grant, Ph.D.
Stanford University
Stanford, California 94305

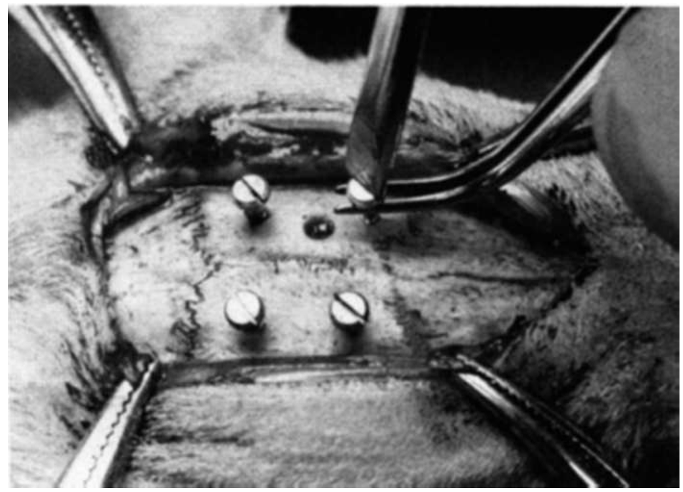
The comments by Dr. Grant on the use of urethane anesthesia in rabbits are very good. I certainly have no argument with them as they come from extended use of the drug. As he points out, urethane is a damaging drug and a lot of post-op care is necessary for recovery. As with many techniques, it is the "tricks" which make the use successful. Such was the case with sodium pen-tobarbital. Dr. Grant's though tfu In ess in sharing his tricks is appreciated and I'm sure will be helpful.

Michael M. Patterson, Ph.D.
Associate Professor
Department of Psychology
Director of Research
Ohio University
Athens, Ohio

Richard K. Cooley and C. H. Vanderwolf

32. JEWELER'S SCREWS:

Clean the skull of any bleeding from the skull holes and then turn in the jeweler's screws. Care should be taken to turn them in only about 1mm in depth. This is far enough for them to be firmly anchored but not so deep that they will depress the dura and the surface of the brain.



Over the past few decades the use of stereotaxic procedures in animal laboratories has become commonplace throughout the world. But despite the widespread and increasing use of the stereotaxic instrument in research, very few adequate books of instruction have been published for the novice and student. There has been a need for a manual which provides a clear, step-by-step outline of the procedures involved in stereotaxic surgery with the most common laboratory animal, the rat. Richard K. Cooley and C. H. Vanderwolf have written such a book. Their Stereotaxic Surgery in the Rat: A Photographic Series combines excellent illustration with a clear and well-organized text. This 8/2" x 11" paperback contains over 40 full-page photographs illustrating each of the steps involved in the routine implantation of a chronic intracranial electrode. The photographs themselves are beautifully conceived and reproduced. Each photograph is accompanied by a facing page giving a clear outline of the procedure illustrated (see above example). The book developed in its present form as a result of the authors' experience in undergraduate laboratory teaching. Therefore, it is uniquely suitable for use by individuals who have had little or no previous surgical experience.

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