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TECHNICAL NOTE

PRESSURIZED AIR AS A PUNISHER[1]

The stimulus most frequently employed in studies of punishment is electric shock (*cf.* Azrin and Holz, 1966). Electric shock is widely used as a punisher chiefly because its parameters can be (1) accurately specified and (2) varied over a wide range of values, producing graded degrees of response suppression. Although other stimulus events (*e.g.*, paw slaps, loud noises, bright lights, the sight of natural predators or enemies, stimuli associated with electric shock or with extinction) can serve as punishers under suitable conditions, these events often are not amenable to accurate specification, or are not effective over a wide range of values, or both. The present report describes a technique, similar in concept to that of Masserman (1946), in which pressurized air can serve conveniently as a quantifiable and effective punishing stimulus with restrained primates.

A primate restraining chair similar to that described by Hake and Azrin (1963) was modified as follows. A response lever (BRS/LVE rat lever, model 121-05) was mounted on a clear Plexiglas wall in front of the monkey and could be operated by a minimum downward force of 0.20 N. Pairs of red, green, and amber bulbs (6 W, 115 V ac) were mounted at eye level behind the front wall and could be used as stimulus lights. A food-pellet dispenser (Gerbrands, model D-1), mounted below the bulbs, could deliver 250-mg SKF food pellets (Riddle, Rednick, Catania, and Tucker, 1966) to a tray accessible to the monkey through an aperture in the front wall. The neck yoke shown in Figure 1 restricted movement of the monkey's head. A stainless-steel tube through which a stream of pressurized air could be delivered was attached to the neck yoke. The opening of the tube (inside diameter, 0.32 cm) was positioned approximately 1 cm in front of the monkey's face. A filtered air compressor (Ingersoll-Rand, model A) located outside the laboratory supplied the pressurized air. Within the laboratory, an air-pressure regulator (Air Reduction Products, model 354) determined the pressure of the air stream and a solenoid-operated valve (Skinner Electric Valve, model V5-2) determined its duration (40 msec in the present study). The restraining chair was housed inside a sound-attenuating enclosure (Industrial Acoustics, model AC-5) provided with white masking noise.

The feasibility of using pressurized air as a punishing stimulus was demonstrated as follows. Six food-deprived squirrel monkeys were exposed to a multiple fixed-ratio fixed-ratio schedule in which every thirtieth lever-pressing response produced food (*mult* FR 30 FR 30). Alternating components of the multiple schedule were correlated with the red or green stimulus lights and were 180 sec in duration. A 60-sec timeout, during which the chamber was dark and responses had no scheduled consequences, separated components. The fixed-ratio requirement reset at the beginning of each new component. Sessions terminated after five presentations of each component and were conducted five days per week. When responding stabilized under the *mult* FR 30 FR 30 schedule, an FR 1 schedule of pressurized air delivery was superimposed in the presence of the green stimulus light (punishment component). The effects of air-stream intensity were studied in three monkeys. Monkeys S-10, S-11, and S-13 were exposed to air pressures of 10.0, 30.0, and 50.0 (S-13 only) pounds per square inch (6.9, 20.7, and 34.5 N/cm^2, respectively). Each air-pressure condition remained in effect for eight to 14 sessions and until no systematic trend in responding was observed for at least three consecutive sessions. Monkeys were exposed to these conditions in ascending (S-11) or descending order of air pressure (S-10 and S-13). The relative permanence of response suppression by pressurized-air delivery was studied in three additional monkeys. Monkeys S-22, S-23, and S-331 were exposed to the highest air-pressure condition (34.5 N/cm^2) for 27 (S-23) or 30 sessions (S-22 and S-331).

Figure 2 shows the mean rate of responding in each component as a function of pressure of the air stream produced by responses in the punishment component for Monkeys S-10, S-11, and S-13. Under the *mult* FR 30 FR 30 schedule without punishment (O N/cm^2), the rate of responding was approximately equal in each component for individual monkeys. When the FR 1 schedule of pressurized-air delivery operated concurrently in the punishment component, responding decreased in that component. The rate of responding in the punishment component was inversely related to the air pressure. The steady-state level of unpunished responding was little affected by pressurized-air delivery. Figure 3 shows sample cumulative records of responding for Monkey S-13 under each condition. In the absence of pressurized-air delivery, responding in each component was characterized by a brief pause at

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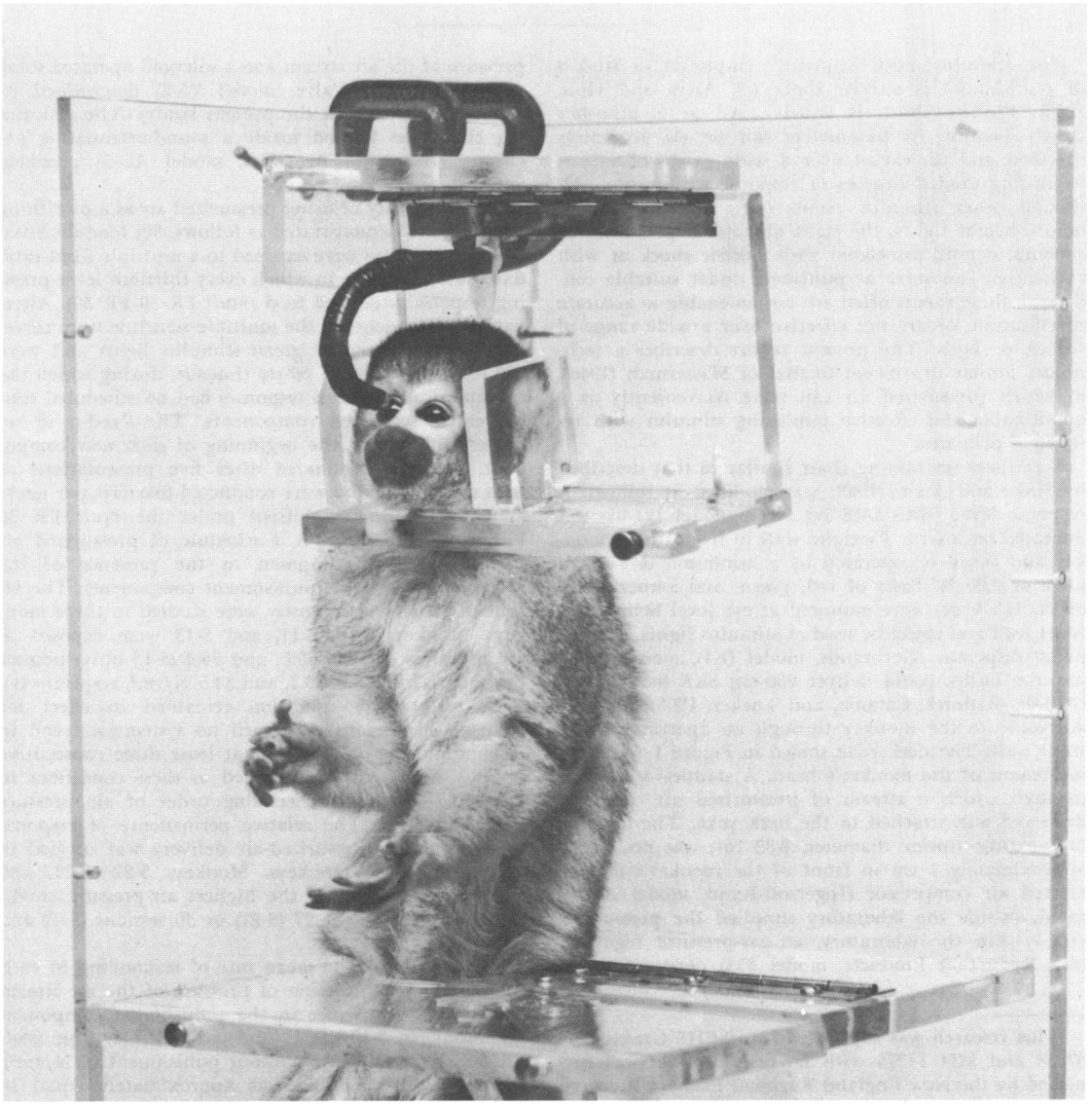

Fig. 1. Photograph of Monkey S-11 seated in the restraining chair with attached neck yoke. Lateral head movement was restricted by the rectangular stops on either side of the monkey's head, and vertical head movement by the base plate of the neck yoke. Movement of the upper body was permitted through an arc determined by the hinge located above and to the rear of the monkey's head. Pressurized air was delivered to the monkey's face through the curved stainless-steel tube (covered with black tape). One end of a flexible polyvinyl chloride tube was connected to the stainless-steel tube behind the neck yoke, and the other end to the solenoid-operated valve (not shown) located below the waist plate of the chair. The front and left side walls of the chair were removed for the photograph.

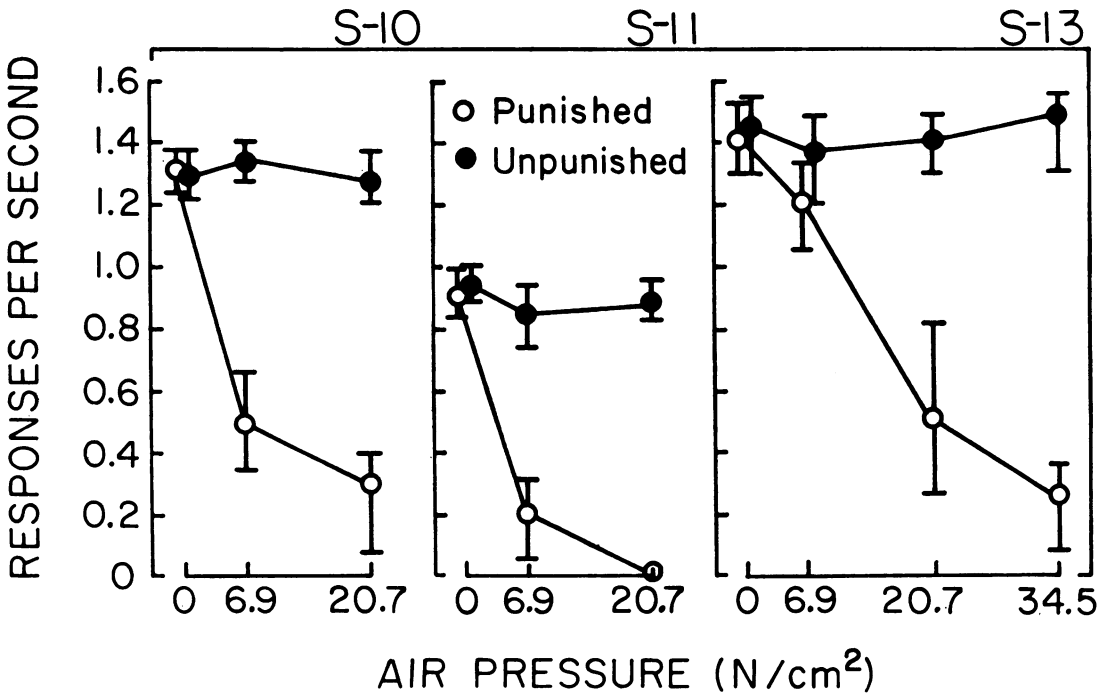

Fig. 2. Effects of air pressure on rate of punished responding (unfilled circles) and unpunished responding (filled circles) for individual monkeys. Points are means based on the last three sessions of each condition. Brackets show the ranges. O N/cm² refers to the *mult* FR 30 FR 30 schedule without punishment.

the beginning of each fixed ratio, followed by an abrupt transition to a high rate of responding that terminated in food presentation. When the air pressure was 20.7 or 34.5 N/cm², responding in the punishment component was markedly suppressed, and characteristic fixed-ratio patterning was markedly disrupted. Similar effects were observed for Monkeys S-10 and S-11 at air pressures of 6.9 and 20.7 N/cm².

Figure 4 shows the rate of responding in each component during the last three sessions under the *mult* FR 30 FR 30 schedule without punishment and during the next 27 or 30 sessions when each response in the punishment component produced a 34.5 N/cm² stream of pressurized air for Monkeys S-22, S-23, and S-331. When the FR 1 schedule of pressurized-air delivery was superimposed in the punishment component, responding declined rapidly to near zero for each monkey. The rate of unpunished responding first decreased, but then recovered to its previous level.

The response-produced delivery of pressurized air effectively suppressed the ongoing level of responding; the degree of response suppression was directly related to the pressure of air, with suppression being sustained and nearly complete when responses produced a 34.5 N/cm² stream of pressurized air. Since unpunished responding was only transiently affected by pressurized-air delivery, the sustained decrease in responding in the punishment component cannot be attributed to a nonspecific suppression of behavior. Since the air-delivery parameters (pressure and duration) could be accurately specified, and since increases in air pressure produced graded degrees of response suppression, pressurized air served as a quantifiable and effective punishing stimulus. Suitable modifications of this technique should be effective with other species. Since most of what is known about the process of punishment currently comes from the study of electric-shock delivery, it is desirable to compare the effects of electric shock with those of other events that can suppress responding. Pressurized-air delivery lends itself well to such study.

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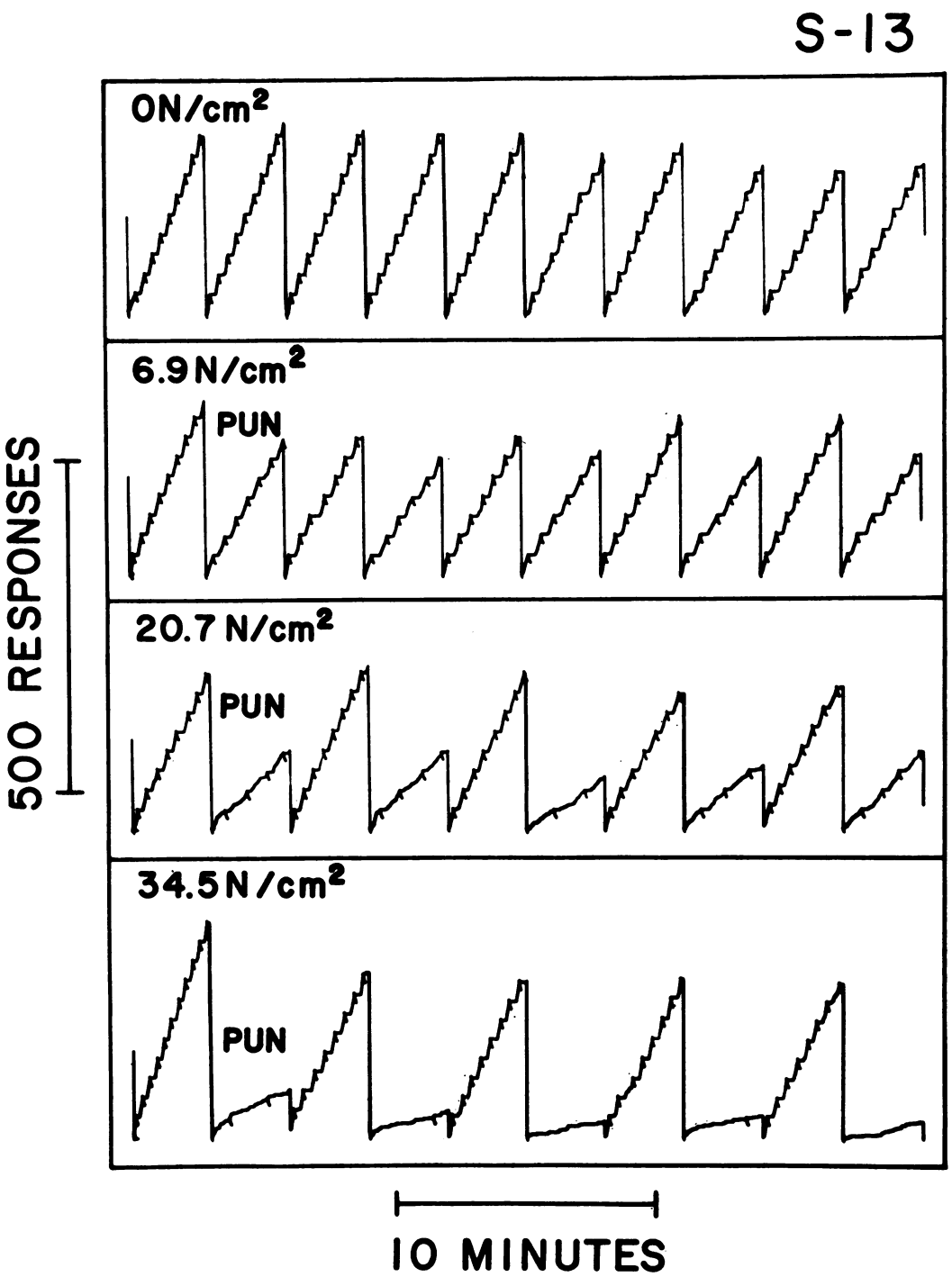

Fig. 3. Effects of pressurized air on performance of Monkey S-13 during one of the last three sessions under the *mult* FR 30 FR 30 schedule without punishment (O N/cm^2) and under each punishment condition. Components were separated by a 60-sec timeout, during which the cumulative recorder did not operate. The pen reset after each timeout and at the end of the session. Diagonal marks represent food delivery. PUN indicates the first of the alternating punishment components.

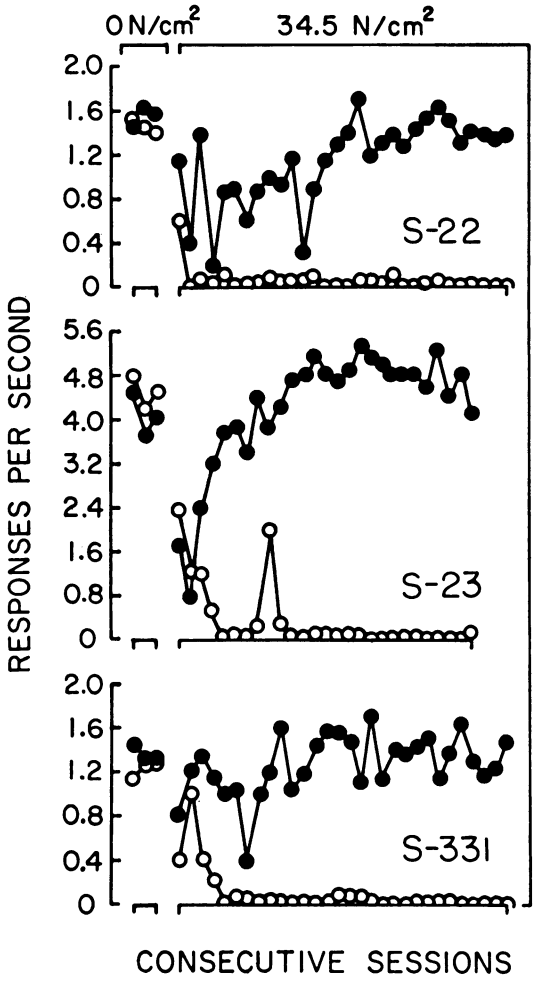

Fig. 4. Changes in rate of punished and unpunished responding during the last three sessions under the *mult* FR 30 FR 30 schedule without punishment (O N/cm²) and during the next 27 or 30 sessions when each response in the punishment component produced a 34.5 N/cm² stream of pressurized air. Symbols are the same as in Figure 2.

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