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Increases in Skin Resistance of White Rats Following Scopolamine Injection

ROSS J. HORSBURGH[1]

Psychology Department, University of Canterbury, Christchurch, New Zealand

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HORSBURGH, R. J. *Increases in skin resistance of white rats following scopolamine injection.* PHARMAC. BIOCHEM. BEHAV. **14**(1) 1–3, 1981.—Thirty-six male albino rats were injected with either saline or 0.6 mg/kg scopolamine and placed on a metal grid. The grid was wired to a transistor-biased detector which determined, every second, whether the subject's resistance was above or below a preset threshold value. Over test sessions of five minutes, drug subject's resistances were above each of the three threshold values used (5, 10, 15 megohms) for significantly longer than those of control subjects. Scopolamine treated rats would therefore receive lower shock levels than control subjects in a shock experiment.

Scopolamine Anticholinergic Skin resistance

MUENZINGER and Mize [11] report that the resistance of an albino rat standing across the bars of a metal grid is typically about 300,000 ohms. The highest figure obtained with the 77 rats they tested was 1,100,000 ohms. These values may, however, drop to almost zero if the paws become soaked in urine [3]. In shock experiments the effect these resistance variations have in determining current flow through a rat may be reduced by adding high value resistors in series with the shock grid. Changes in subject resistances are then relatively small compared to total circuit resistance. Such an arrangement is popular in animal experimentation for regulating shock levels and is known as a constant current circuit, because current fluctuations occurring with changes in subject resistance are small. However, constant current systems do not regulate shock levels satisfactorily if subject resistance levels are markedly increased, because the subject's resistance then becomes too large a proportion of the total circuit resistance.

Drugs such as the anticholinergics inhibit sweat gland activity [7]. This may increase subject resistance by decreasing the moisture content, and therefore conductivity across the cornified layer of skin on the paws. The present study examined resistance values of scopolamine treated rats placed on a metal grid. As movement across a grid may result in a variation of subject resistance over at least a 1,000 percent range [3], a time sampling procedure was used to determine the percentage of five minute test sessions that resistance was above a predetermined level.

METHOD

Animals

Subjects were 36 male Sprague-Dawley albino rats (110 days old) from the University of Canterbury colony. They were housed four to a cage, and had been handled regularly from birth. Ad lib food and water was available up until testing.

Apparatus

The test chamber consisted of a Lafayette 85000 modular testing unit fitted with blank stainless end plates. Light was provided by a 15 watt circular fluorescent tube mounted directly above the Perspex ceiling of the chamber. The metal grid floor of the 20 cm W × 30 cm L × 20 cm H unit was phased alternately and connected to a detector based on a transistor-biased relay circuit [12]. The resistance of the rat across the grid bars completed the base-bias circuit of the detector, allowing collector current to flow and activate the relay. Also wired on to the control board was a recycling timer which produced a 200 msec pulse every second. Using a 2-way AND gate, a counter registered one count each time the closure of the detector relay coincided with a pulse from the timer. A switch which turned the timer off and on enabled control of the test session duration.

Included in the base circuit of the detector was a potentiometer which enabled the threshold resistance of the detector to be adjusted. Any resistance across the grid less than or equal to that threshold value would operate the detector.

Procedure

Immediately before testing each animal the threshold resistance level was established by setting the sensitivity adjustment so that the detector relay just operated when two bars of the grid were bridged by a resistor of the threshold value. The grid bars were thoroughly cleaned and dried before testing each subject.

Subjects were randomly assigned to one of six groups of

[1]Now at Department of Psychiatry, School of Medicine, University of Auckland, Private Bag, Auckland, New Zealand.

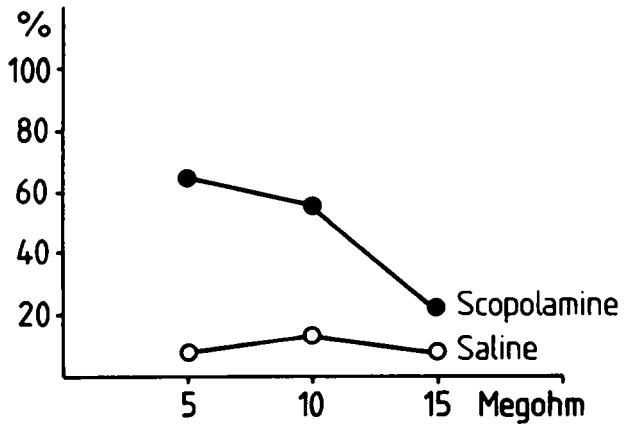

FIG. 1. Percentage of test session that subject resistance was greater than threshold value.

six subjects each. They were each injected (1 cc/kg, IP) with either isotonic saline or 0.6 mg/kg scopolamine hydrobromide, and returned to the house cage. After 30 minutes each rat was placed in the test chamber, and 10 seconds later the detector time was switched on. Three hundred seconds later the timer was switched off and the rat removed from the test chamber. The score on the counter indicated for how many of the 300 seconds the subject's resistance was lower than, or equal to, the threshold value. To establish whether any difference in the resistance score merely reflected changes in activity, every five seconds it was also noted whether the rat was moving vertically (rearing), horizontally (ambulation) or not changing location at all (motionless).

RESULTS AND DISCUSSION

Scores from the counter were subtracted from 300 and converted into percentages to give the percentage time that the threshold resistance was greater than the threshold value. Mean scores for each group are displayed in Fig. 1.

As expected from reports showing that resistance of undrugged rats is typically less than 1,000,000 ohms (e.g. [11]), resistance across the grid during test sessions for control subjects was above threshold value for only a small percentage of the 300 second sessions. This probably represents instances where the rat bridged only similarly phased bars of the grid, therefore failing to operate the detector regardless of subject resistance.

A 2×3 analysis of variance yielded a significant drug effect, $F(1,12)=184.59$, $p<0.01$. Subsequent t-test comparisons showed differences between scopolamine and saline groups at each of the three threshold values ($t=4.23$, 3.78, 2.39 respectively, $df=10$). Previous authors [11] found that the average resistance of 77 albino rats was 300,000 ohms. Between subject variation was over a range of 1,000,000 ohms, lying between 100,000 and 1,100,000 ohms. These findings, considered in relationship to the high resistance values of the drugged rats in the present study make it unlikely that the statistical differences between drug and saline animals were merely artifacts of non-random assignment. No record was made of within-session changes in resistances, but from observation of the animals during testing it appeared that the majority of detector counts for drugged subjects occurred during the latter part of the session. Had the sessions been of shorter duration, then the differences between saline and drug groups would have been even greater.

TABLE 1

PRODUCT MOMENT CORRELATION COEFFICIENTS BETWEEN ACTIVITY AND DETECTOR (RESISTANCE) SCORE FOR DRUG AND SALINE SUBJECTS (CRITICAL VALUE, $p<0.05$, 18 PAIRS=0.497)

Activity	Drug	Saline
rearing	0.007	−0.015
ambulation	0.296	−0.098
motionless	−0.239	0.059

The typical increase in ambulation with a 0.6 mg/kg scopolamine dose [8] was observed (saline mean = 15.6, scopolamine mean = 24.2; $F(1,12)=8.92$, $p<0.05$). There were no significant differences between the drug and control rats for the rearing and motionless measures. The differences in resistance levels between drug and control rats were not related to activity, as Pearson product moment coefficients showed no correlation between detector and activity scores (see Table 1).

Correlation between activity and detector scores, and probably a drug effect on the rearing and motionless measures might have been expected if differences in resistance levels were a result of differing fear levels between drug and saline groups. Therefore explanations based upon differing levels of fear, resulting from either direct drug effect or differential handling of the animals by the experimenter, would appear unsatisfactory. It would seem then that the increased skin resistance is related to the suppression of sweating by scopoalmine. Reduced moisture content of the cornified layer would further increase its resistance. An additional influence may be scopolamine's saliva suppressing effect [7] which would reduce moistening of the front paws during grooming activity.

Although it is debatable which parameters of shock are most important in animal experimentation, increases in subject resistance usually lowers the shock received by the subject [2]. Even the lowest threshold resistance used in the present study (5,000,000 ohms) is well above the maximum subject resistance of 100,000 ohms anticipated by designers of a popular shock control unit, the Lafayette 82400. This constant current unit delivers a shock of 1.04 milliamps to a subject of 100,000 ohms resistance, but only 0.3 milliamps if the resistance is 5,000,000 ohms. While both shock levels would be above the aversion threshold for a constant currect a.c. shock [2] there is evidence suggesting that, within commonly used ranges, performance is a direct function of shock intensity [6]. So until all subjects in both scopolamine and saline groups reduced their resistance to near zero ohms by the urination which usually accompanies shock presentation, a large difference would exist between shock levels received by drug and control subjects. This would be most pronounced in the first stage of an experiment or in studies which used short shock presentations, such as a single two second shock [1].

In some experiments this difference in shock levels between groups may be responsible for observed changes in behaviour. For example, scopolamine typically decreases passive avoidance [4,9], but as passive avoidance performance is a direct function of shock severity [6] this may be due to resistance increases decreasing shock levels, rather than disruption of inhibitory control mechanisms as is often

suggested. The same argument may apply to one-way active avoidance in which performance also depends on shock intensity [6,10]. This is not to suggest that all experiments investigating effects of shock on animals treated with anticholinergic drugs are confounded by alterations in resistance levels. However, as any system used to regulate shock will be less effective when dealing with the high resistance values that appear to be part of the scopolamine drug state, attention should be given to this factor. Moistening the feet of all subjects by placing them on blotting paper soaked in a glycerine-water mixture is one technique useful for reducing resistance differences between drug and control animals.

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REFERENCES

1. Anisman, H. Dissociation of the disinhibitory effects of scopolamine: Strain and task factors. *Pharmac. Biochem. Behav.* **3**: 613–618, 1975.
2. Campbell, B. A. and R. Teghtsoonian. Electrical and behavioural effects of different types of shock stimuli on the rat. *J. comp. physiol. Psychol.* **51**: 185–192, 1958.
3. Cornsweet, T. N. *The Design of Electrical Circuits in the Behavioural Sciences*. New York: John Wiley and Sons Inc., 1963.
4. Feigley, D. A. Effects of scopolamine on activity and passive-avoidance learning in rats of different ages. *J. comp. physiol. Psychol.* **87**: 26–36, 1974.
5. Feigley, D. A., W. Beakey and M. J. Soynisch. Effects of scopolamine on the reactivity of the albino rat to footshock. *Pharmac. Biochem. Behav.* **4**: 255–258, 1976.
6. Feigley, D. A. and N. E. Spear. Effect of age and punishment condition on long-term retention by the rat of active and passive avoidance learning. *J. comp. physiol. Psychol.* **73**: 515–526, 1970.
7. Goodman, L. S. and A. Gilman. *The Pharmacological Basis of Therapeutics*, 3rd Edition. New York: The MacMillan Co., 1965.
8. Hughes, R. N., N. M. Blampied and W. J. Stewart. Scopolamine induced changes in activity and reactions to novelty. *Pharmac. Biochem. Behav.* **3**: 731–734, 1975.
9. Meyers, B. Some effects of scopolamine on a passive avoidance response in rats. *Psychopharmacologia* **8**: 111–119, 1965.
10. Moyer, K. E. and J. H. Korn. Effect of UCS intensity on the acquisition and extinction of a one-way avoidance response. *Psychonom. Sci.* **4**: 121–122, 1966.
11. Muenzinger, K. F. and R. H. Mize. The sensitivity of the white rat to electric shock: Threshold and skin resistance. *J. comp. Psychol.* **15**: 139–148, 1933.
12. Zucker, M. H. *Electronic Circuits for the Behavioural and Biomedical Sciences*. San Francisco: W. H. Freeman and Co., 1969.