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BRIEF COMMUNICATION

Automated TV-based System for Open Field Studies: Effects of Methamphetamine

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TANGER, H. J., R. A. P. VANWERSCH AND O. L. WOLTHUIS. *Automated TV-based system for open field studies: Effects of methamphetamine.* PHARMAC. BIOCHEM. BEHAV. 9(3) 555–557, 1978.—A method is described whereby open field behaviour of rats can be automatically registered using a TV camera, a video converter, an X-Y recorder and a papertape puncher. Use is made of the scanning properties of the TV camera to obtain the X and Y coordinates of the rat's position and to print this position on an X-Y recorder to obtain the running pattern. In addition, the X and Y coordinates at 1 sec intervals are punched on papertape. With computer processing of the tape, one can obtain—for any given period—the distance run, a frequency distribution of speeds, the number of entries into an inner field, the time spent in an inner field as well as the number of changes in corner positions. As an example the effects of 1 and 2 mg/kg methamphetamine are shown. This drug enhances all parameters measured in a dose dependent fashion except the changes in corner positions which were not altered significantly.

Automated open field Spontaneous activity Methamphetamine TV-registration

THE STUDY of open field behaviour of rodents is laborious, time consuming and may be quite tedious, especially if large groups of animals are tested for prolonged periods of time [3]. For a description of the technique and interpretation of the results see Bureš *et al.* [1]; Hall [5] and Denenberg [2]. Except when video-recording techniques are used, the open field technique requires the close proximity of the investigator to enable him to count the squares crossed with 1 or both forelegs. Visual, auditory and olfactory cues, therefore, may influence the results.

The method presented here is an attempt to automate open field testing by use of a TV camera, a TV X-Y converter and a papertape puncher. A computer is required for analysis of the data.

Fleischer and Pflugradt [4] recently described a simpler version of a device using the same principle, which they employed to study moving patterns of beetles.

Provided a computer is available, the method presented here is relatively inexpensive, provides very reproducible results and lacks some of the obvious disadvantages of human recording. In addition, some parameters of activity can be derived which cannot easily be obtained by direct observation.

METHOD

The animals tested were albino male Wistar (WAG) rats of 150–170 g body weight. On the day of testing the animals were brought from the laboratory breeding centre to the experimentation room. Each animal was injected intraperitoneally with either saline or methamphetamine (1 or 2 mg/kg) and tested for 1 hr. The order of testing of individuals in the 3 groups was balanced in order to compensate for the time of day. The temperature in the experimentation room was 21–23°C, the ambient noise level 72 dB and the light level was 360 lux. Methamphetamine-HCl was obtained from OPG, Utrecht, The Netherlands.

Apparatus

Figure 1 is a schematic representation of the test apparatus. The television camera scans a field consisting of a 100×100 cm plywood floor with walls 20 cm high painted with non-reflective black paint. Any white spot or animal of sufficient size against the black background causes a change in the camera output voltage when the spot is scanned by the camera beam. The output voltages of the horizontal and vertical sawtooth generators are sampled by a sample and hold amplifier. These voltages are proportional to the TV camera's scanning time for horizontal (X) and vertical (Y) positions, respectively.

At the output of the sample and hold amplifiers a voltage U_{hor} and a voltage U_{vert} are generated, corresponding to the position of the rat with respect to the left and the upper side of the scanned area, respectively. These voltages are fed into an X-Y recorder and into an AD converter. The X-Y recorder continuously records the position of the rat and the AD converter transforms the voltages U_{hor} and U_{vert} to signals for the papertape puncher. The position-coordinates of the rat are punched every sec. Instead of a rat, any white animal could be followed. It is also possible to work with a dark animal against a light background, however, in that case

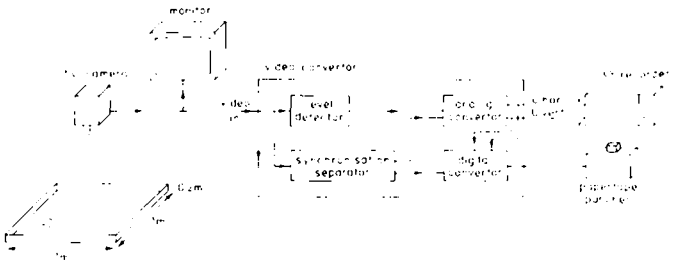

FIG. 1. Schematic diagram of the automated TV-registration of open field behaviour.

electronics will be more complicated. Analyses of the punched tape were done with a PDP-11 computer.

Computed were: (a) The distance run. (b) The distribution of speeds during a specified period. (c) The time spent in the inner field, i.e. a 60×60 cm area in the center of the field. The remaining part of the whole field is defined as outer field. (d) The number of crossings from outer to inner field and vice versa. (e) The number of times the rat changes corners. Corners are defined as squares of 20×20 cm in each corner of the field.

With the current program, all data except the speed distribution are plotted in a cumulative fashion.

Calibration

In order to adjust the X-Y recorder and calibrate the output of the AD converter for the papertape puncher, an animal is simulated in the extreme corners of the field. Small lightbulbs were placed at the extreme upper left and lower right corners of the field (as viewed from above). The light in the upper left corner was switched on, the output signals of the AD converter for U_{hor} and U_{vert} were trimmed to 0 and the pen of the X-Y recorder was positioned properly. Then the bulb in the lower right corner was switched on, the pen of the X-Y recorder was positioned again and both AD converter outputs were trimmed to 50. This value is punched on tape. When this tape is computerprocessed the value is multiplied by 2 and represents the coordinate distance in cm ± 1. Proper performance of the entire system was occasionally checked with the use of a device consisting of a synchronous motor with a 30 cm long rod connected radially to its rotor axis. This device was painted black except for a piece of white paper glued on the end of the rod. By placing this device at strategic locations in the field and operating the system for a few min, the value of each of the parameters mentioned above could be recorded and compared with its known true value.

The values determined for parameters d and e mentioned above are exact. Because of the summing which occurs in the derivation of parameters a and c, the relative errors are close to zero. As has been mentioned above, the coordinate values x and y represent the respective distances ± 1 cm. The speed is calculated as the distance between the coordinates at the beginning (index b) and the end (index e) of each period of 1 sec duration:

$$\text{calculated speed} = \sqrt{(x_e - x_b)^2 + (y_e - y_b)^2}, \text{ and}$$

represents all speeds between:

$$\sqrt{(x_e \pm 1 - x_b \mp 1)^2 + (y_e \pm 1 - y_b \mp 1)^2}.$$

It follows from these formulas that the accuracy of the lower speed classes is less than that of the higher ones.

Procedure

The rats were taken out of their cages, injected, and placed immediately into the field. The tape puncher was then started and each second data were fed into the puncher during the entire hour.

During the last 10 min of the hour, when the differences between animals injected with methamphetamine and those injected with saline were greatest, an XY-plot of the running pattern was made.

RESULTS

From Fig. 2 it can be seen that methamphetamine causes an increase in the values of all parameters measured, except in the "changes in corners". The XY-plotter record, obtained during the last 10 min of the 60 min exposure time (not shown), indicates that the animals injected with methamphetamine were still in motion when the saline-treated controls had settled down after the usual, initial period of exploration. Some of the rats treated with 2 mg/kg methamphetamine exhibited stereotyped running patterns.

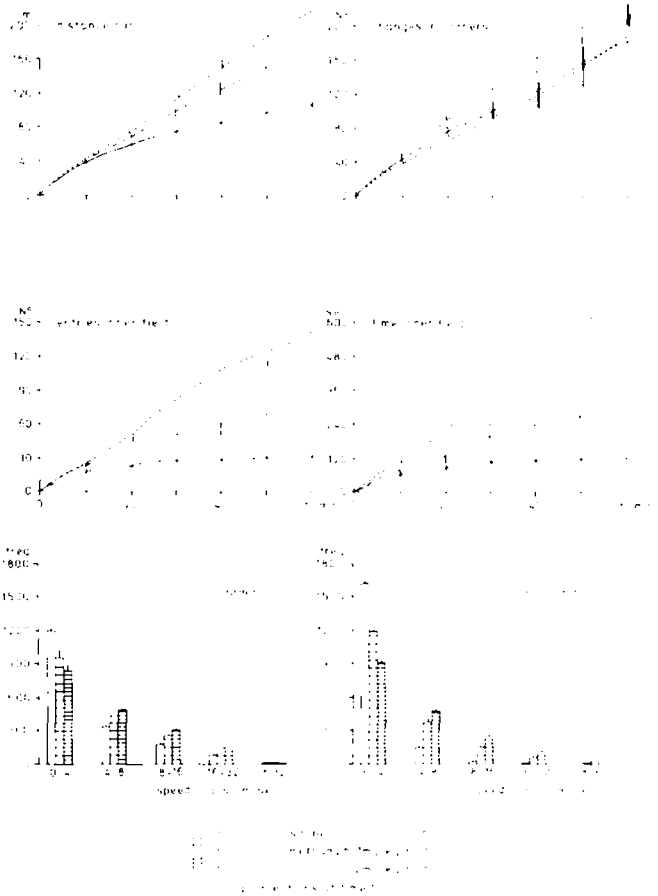

FIG. 2. The various open field parameters (means + SEM) as calculated by the computer. Methamphetamine caused a dose-dependent increase of all parameters, except for the parameter "changes in corners". For further details see text.

DISCUSSION

In this paper, the effects of methamphetamine on open field behaviour have been used as a demonstration of the usefulness of this technique. The method is especially attractive for tests extending beyond the usual 5 or 10 min observation periods.

In the present tests, the number of fecal boli produced (an index of fear [5]) were not counted, although such counts could easily be performed at the end of each test. The need still exist for a quantitative way to describe the patterns of locomotion and, especially, the duration of various stereotyped behaviours. This latter might be derived by a computer program which could recognize repetitive patterns. Present work, however, is focused on (1) the possibility of studying social interactions by using a color TV camera and color coding of the animals, and (2) the possibility of combining the device presented here with an automated apparatus to measure fine motor activity [6].

In conclusion, the technique described automatically measures a number of parameters of spontaneous behaviour. Measurement of some of these parameters was hitherto not possible with conventional apparatus, e.g. distance run and speed distribution. Provided a computer is available, the method combines low cost with an objective way to assess open field behaviour of rodents.

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