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A Simple Automated Test to Measure Exploratory and Motor Activity of Marmosets

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WOLTHUIS, O. L., B. GROEN AND I. H. C. H. M. PHILIPPENS. *A simple automated test to measure exploratory and motor activity of marmosets.* PHARMACOL BIOCHEM BEHAV 47(4) 879–881, 1994.—An automated device is described to test the exploratory and motor activity of common marmosets (*Callithrix jacchus*). The device consists of four boxes interconnected by PVC tubes. The presence of an animal in a box is detected by a photocell. Calibration takes place with an electric model train. Movements of the animal from one box to another are detected by disappearance from one and appearance in another box. The apparatus is linked to a PC. The effects of two doses of methamphetamine and of pentobarbital are shown.

Activity   Locomotion   Exploration   Methamphetamine   Pentobarbital

ALTHOUGH several automated devices have been developed to assess motor and exploratory activity in rodents [see, e.g. (5,6)], such devices are not available for marmosets.

Apart from observational (ethological) methods to count certain activities, to our knowledge only one type of locomotor activity monitoring has been applied to assess the activity levels of marmosets; D'Mello and Duffy (2) used a device that was mounted on the back of an animal by a simple elastic harness. Movements in the anterorostral plane operated a simple mercury tilt switch; the counts were stored and could be read out.

The level of activity, alertness, and exploratory behavior play an important role in practically all measurements of animal behavior. Hence, we decided to develop a relatively simple device by which the combined locomotor and exploratory activity can be automatically and quantitatively assessed.

METHOD

Animals

Experimentally naive marmosets (7 females and 10 males) with a body weight between 200–420 g were tested. Six animals were injected with saline, five animals with a low dose of the drugs, and six animals with a high dose of the drugs (see the Procedures section).

Apparatus

The apparatus (see Fig. 1) consists of four horizontally placed nontransparent PVC boxes (25 × 25 × 25 cm) with a meshwire top, interconnected by PVC tubes (inner diameter 9.5 cm). It resembles a four-room bungalow. Hence, the test was called the bungalow test. The tubes are wide enough to allow the animal to move directly to each of the three other boxes. The boxes are placed in a square and the distance (heart to heart) of the boxes to the adjacent ones is 43 cm. Four lights are mounted on the closed ceiling of the apparatus, each one vertically 170 cm above the center of the bottom of one of the four boxes. The floors of the boxes are made of white plastic and reflect the light. On each of the meshwire tops a photocell is mounted that is linked to an IBM-compatible PC.

A TV-camera is mounted in the center of the ceiling to allow observation of the animal. The whole apparatus is surrounded by a thick curtain to avoid distraction of the animal.

Principle

The bottom of each box reflects the light which is registered by the photocells. The presence of a marmoset in the box is detected by the decrease in reflected light.

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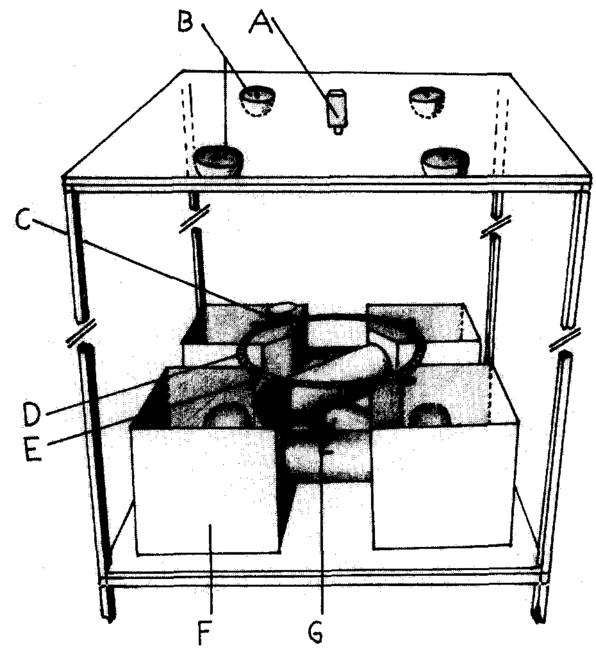

FIG. 1. A drawing of the bungalow test apparatus. (A) TV camera; (B) lights; (C) locomotive with disk; (D) railroad; (E) photocell; (F) nontransparent box; (G) interconnecting PVC tubes. The whole apparatus is surrounded by a nontransparent curtain (not drawn).

Registration

Software was developed that allows automated registration of: a) time spent and time intervals of the presence of the animals in each box, b) the number of times that the animal switches from one box to another, and c) from which box these switches take place. A schematic computer printout of the results from one animal, the arrangement of the boxes and interconnections, as well as the parameters measured, are shown in Fig. 2.

Calibration

This takes place with an electric Fleishman model minitrain (type Picolo, scale N). A locomotive, carrying a horizontal cardboard disk (diameter 8 cm) rides on a circle of rails, positioned in a standardized manner on the meshwire top of the boxes. Each time the locomotive rides over a box the light thrown into the box is slightly reduced and, consequently, reflection of light via the bottom is decreased, which is detected by the photocell. When calibrated during 20 min, an equal and reproducible number of switches and periods of time spent in each box should be registered.

Experimental Procedures

Testing lasted 20 min. Recordings were taken for each animal and averaged per group. Control measurements were performed twice; the results of the second control test were taken as the starting value for each animal. The day after the second test the animals were injected intramuscularly with saline (n = 6) or methamphetamine in doses of 0.5 mg/kg (n = 5) or 1.0 mg/kg (n = 6). Testing of these animals started 30 min after the injection. Subsequently, a number of animals in the drug-treated groups were interchanged, in such a way that a number of animals that had received a low dose of drug would subsequently receive a high dose of the next drug and vice versa.

Two weeks after methamphetamine had been given, again, a control test was carried out to have a starting control value for the next drug to be tested. The day after this control test the group that had previously received saline received saline again (n = 6) and the other two groups received an IM injection of pentobarbital in doses of 4.0 mg/kg (n = 5) or 8.0 mg/kg (n = 6), respectively. Thirty minutes after injection testing started.

Statistics

For statistical comparisons, the multiple t-test of Welch (4) was applied. When the term significant is used, this indicates a $p < 0.05$, tested two-tailed.

RESULTS

The averaged time spent in each of the four boxes did not differ significantly. Before any injection was given, the largest difference in the time spent in the second control test at the beginning of the experiment was 268 ± 30.1 s in box A (see computer printout) and 349 ± 34.0 in box C (p_2 = 0.084). All 17 animals visited all four boxes. Similarly, no significant differences were found with respect to the use of the connecting tubes. Here the largest difference was found between the use of the tubes going from box B to D (mean

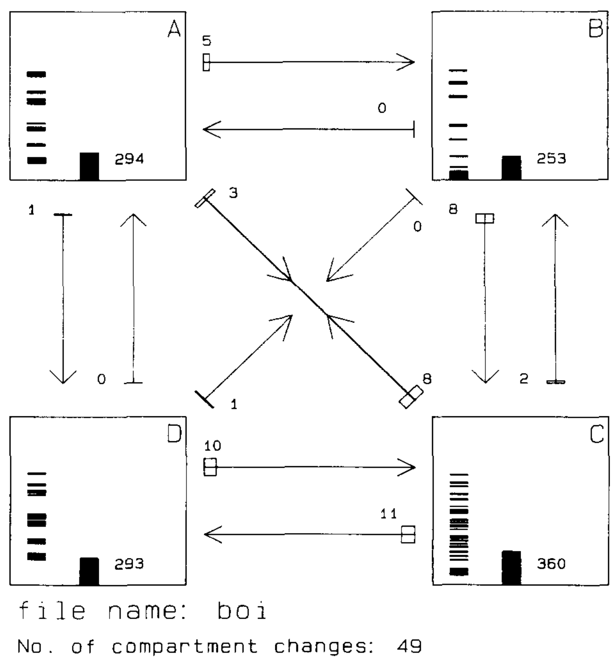

FIG. 2. An example of a computer printout of one marmoset in the bungalow test. The cumulative time in seconds that the animal spends in each box is indicated within each schematic representation of the box (see vertical bar and numbers). In addition, the various interrupted periods that the animal remains in a compartment are depicted. Moreover, the number of times that the animal leaves a compartment through one of the connecting tubes is also shown.

± SEM: 2.2 ± 0.58 times) and that of D to C 3.4 ± 0.59 times). Both tubes were not used by 3 out of the 17 animals.

An interesting feature of this technique for marmosets is, that preliminary experiments showed, when a separate group of six saline-injected animals was tested four times in 1 week during 30 min, that the averaged number of compartment changes of the group to each box remained stable and even showed a slight and insignificant increase:

	Number of compartment changes				
Date:	Sept 5	Sept 6	Sept 7	Sept 12	(n)
Mean ± SEM	108 ± 26	131 ± 23	141 ± 35	132 ± 25	(6)

The effects of the two drugs tested (see Fig. 3: compartment changes) were as expected; both doses of methamphetamine caused a significant increase in number of visits to each box, whereas this number decreased significantly following injection of 8 mg/kg, but not significantly after 4 mg/kg pentobarbital.

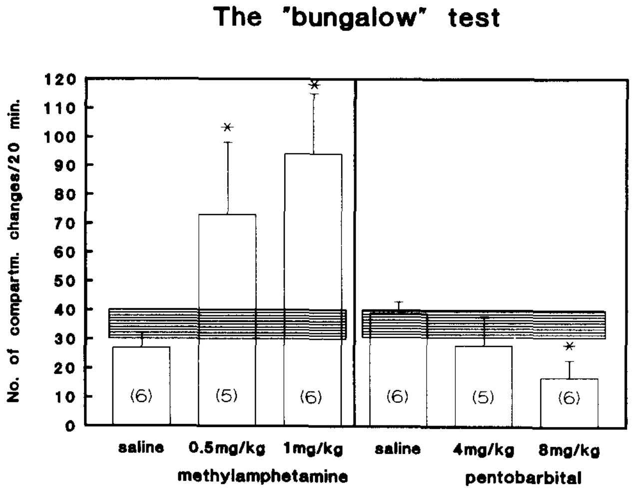

FIG. 3. The effects of intramuscular methamphetamine and pentobarbital on the number of compartment changes. The tests with pentobarbital were conducted with the same animals, after a rest period of 14 days following the injections of methamphetamine. The shaded horizontal bar represents the mean (± SEM) control number of compartment changes tested on the day before the injections with each drug took place. *Significantly different from effect of saline.

DISCUSSION

The bungalow test presented offers the possibility to quantify locomotor and exploratory behavior of marmosets in a simple and automated fashion and can—in principle—also be used for other small animal species. The tests conducted so far indicate that the method is fairly robust. A pleasant surprise was that the exploratory activity did not drastically reduce upon repeated testing, resulting in a rather stable base line, at least on four successive tests during 1 week. The number of compartment changes of these six animals is much larger than that of the animals used for testing the two drugs, even when it is taken into account that these six animals were tested during 30 min and the drug-treated animals only during 20 min. This was not due to a sudden increase in activity in the additional 10 min, but most likely due to the fact that these six animals had been in the animal room for at least a year and were used to being handled and being exposed to several test situations. The 17 animals used to test the drugs were new animals, had been in the animal room during only 2–3 weeks, and had never been injected before. Thus, it seems likely that the six animals used for repeated testing had a reduced level of fear for novel situations.

The four horizontally placed identical boxes seem equally attractive to the animals, because the time they spend in each of the four boxes is roughly the same. A restriction of the method is that vertical mobility components of these behaviors are not measured; this would require a more elaborate apparatus.

Although the tests are different, a comparison with the effects of *d*-amphetamine and pentobarbital on a visuo-motor coordination task of D'Mello et al. (2) suggests that the present test is more sensitive to the activity-enhancing effect of an amphetamine-like drug, but slightly less sensitive to an activity-reducing drug like pentobarbital. The latter authors found no changes in performance with IM doses up to 2 mg/kg *d*-amphetamine, but did find a small significant depression after an IM dose of 4 mg/kg pentobarbital. In principle, this test offers the possibility to test antianxiety drugs. This could be achieved by introducing in one of the boxes an aversive stimulus (e.g., a photograph of a male marmoset in an aggressive posture, or of an unknown human observer [see (1)]. By subsequently measuring whether a) marmosets would avoid that box, and b) whether an anxiolytic would counteract that effect, the efficacy of an anxiolytic could be assessed.

The results of preliminary tests, however, suggest that marmosets are not easily intimidated by either pictures or by video films of snakes, tigers, sounds of exploding in war movies, or movies with hard rock music and flashing lights. The animals were exposed to these pictures and movies by making a wall of a box transparent with Plexiglas and by placing a TV monitor directly in front of this transparent wall. In contrast, the animals seemed quite interested in what was shown. We will continue the search for an effective stimulus that evokes anxiety.

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