Home cage testing of impulsivity

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Lack of self-control or impulsive decision making may be an important symptom of psychiatric disorders, such as Attention Deficit Hyperactivity Disorder [2,7]. Animal models are crucial in studying the underlying neurobiology. In the intolerance-to-delay (ID) task [3,5], subjects may choose between a late-large and a soon-small reward. Impulsive subjects are intolerant to the forced waiting for the large reward [4,5]. The rats' performance on the ID-task is investigated by placing the animals in individual operant chambers for a short period daily [4,5]. However, stress caused by handling and by novelty might influence their performance. Therefore, a new computer-controlled operant panel was developed, which can be placed inside the home cage, enabling the rat to operate it 24 hours/day. Here we report results of a pilot experiment using this panel in an ID-protocol.

Materials & methods

Subjects

Four adult male rats (Harlan, Italy; mean weight 429gr) were kept in an air-conditioned room (temperature 21 ± 1°C, relative humidity 60 ± 10%), on a 12-hr reversed light-dark cycle (lights on at 8.00 pm). Prior to the experiments animals were housed in pairs, but from the start of the protocol animals were singly housed. Water was available ad libitum, whereas food (Altromin-R, A. Rieper S.p.A., Vandoies, Italy) was available ad libitum until the start of the protocol. Rats had previous experience in impulsivity tasks in a classical skinnerbox setting, two months prior to the present pilot.

Apparatus

The testing apparatus consisted of one computer-controlled operant panel for each of the subjects, placed in a Macrolon III cage with sawdust bedding. The panel contains two nose-poking holes, hole lights, a chamber light, a feeder device, a food-magazine where pellets (#F0021-J Dustless Precision Pellet 45 mg, BioServe, Frenchtown, USA) are delivered, and a magazine light. The panel was attached through an interface to a PC, where a custom-made software controlled and recorded all events. Nose-poking in one of the two holes of the panel resulted in the delivery of five pellets (large reward), whereas nose-poking in the other hole resulted in the delivery of one pellet (small reward). After nose-poking and before food delivery, the hole light was turned on for 1s. Following food delivery the magazine light was turned on for 90s, during which nose-poking was recorded, but was without scheduled consequences (timeout). The magazine light was then turned off, the chamber light was turned on, and the system was ready for the next trial.

Protocol impulsivity test

On day 1, animals were placed in the cages containing the panel, which occupied one fourth of the total living area. The adaptation period started with 24 hours of access to ad libitum regular food pellets (Altromin-R) and BioServe pellets from the panel. On day 2, Altromin-R was removed for 24 hours, while animals still had access to BioServe pellets. Then, 12 hours of food deprivation followed in order to increase their motivation to work for food delivery.

During the subsequent training and testing phases, animals had only access to BioServe pellets during the sessions, by operating the panel, and to a limited amount of Altromin-R after each session: two 1h sessions were run daily between 9.00-10.00 and 18.00-19.00 [for arguments see ref. 6]. After each session, the total intake of BioServe pellets was calculated per individual, and additional food was given to meet their daily nutritional needs (details available on request). The end of a session was indicated by switching off all panel lights plus the delivery of the additional Altromin-R pellets. Training lasted until all subjects reached a significant preference for the large reward.

During the testing phase, a signalled delay was added to the 1s-interval, normally scheduled between nose-poking and large-reward delivery. The hole light was kept on during the entire length of this delay. The small reward delivery was unchanged. Hence, animals had a choice between a "large & late" (LL) and a "small & soon" (SS) reward. The delay length was fixed for daily sessions and was changed over days: 15s on the first day, followed by delays of 45s, 75s, 105s and 150s on subsequent days.

Results

Following four training sessions, all rats showed a significant preference for the large over the small reward (average choice of 94.4 ± 5.3% for the large reward). This finding replicated previous experiments in our lab [1] and also indicates that animals remain to probe the outcome of nose-poking at the other hole.

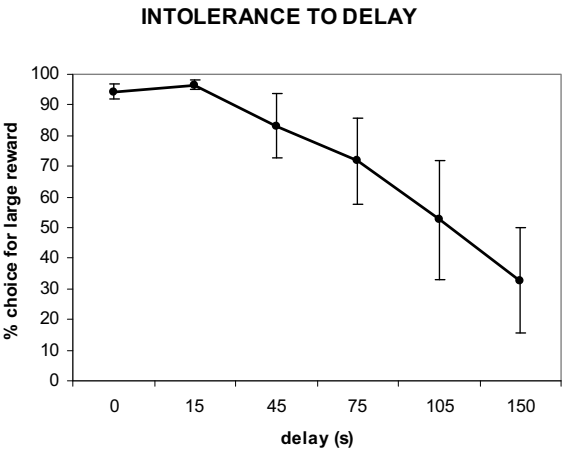

Figure 1. *Choice behaviour in rats (n = 4) tested with the intolerance-to-delay (ID) protocol, shown during daily sessions in the home cage situation. Data represent the mean (±SEM) choice (%) for the larger reward per day, delivered after a delay.*

When delays were gradually increased over days (Figure 1), rats showed a shift towards more SS choices at the longest delays [cf. 4,5]. The protocol lasted 9 days in total.

Discussion

The present pilot experiment shows that it is in principle possible to measure impulsive behaviour in a home cage setting. Future experiments are directed at validating this approach.

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