Behavioural Brain Research 341 (2018) 71–78

Contents lists available at ScienceDirect

Behavioural Brain Research

journal homepage: www.elsevier.com/locate/bbr

Research report

Individual differences in incentive salience attribution are not related to suboptimal choice in rats

Paulina López, Rodrigo Alba, Vladimir Orduña*

Facultad de Psicología, Universidad Nacional Autónoma de México, México D.F. 04510, México

ARTICLE INFO

Keywords:
Suboptimal choice
Incentive salience
Individual differences
Rats

ABSTRACT

Previous research has shown great variation in the extent to which individual rats attribute incentive salience to stimuli that are predictors of reinforcement. When using the Pavlovian Conditioned Approach procedure, in which a discrete stimulus is presented contingently before the delivery of reinforcement, the attribution of incentive salience is demonstrated by sign-tracking behavior (responses directed toward the stimulus predictor of reinforcement), while an absence of this attribution is reflected by goal-tracking behavior (responses directed toward the source of reinforcement). It has been reported that sign-tracking subjects have a higher tendency to perform some maladaptive behaviors than goal-tracking subjects, and that in non-classified rats, increasing the incentive salience of the stimuli promotes suboptimal choice in the "suboptimal choice procedure". In this task, subjects are presented with two alternatives, one of them better in terms of the information provided by the discriminative stimuli, but worse in terms of probability of reinforcement (suboptimal alternative). Integrating these ideas, we hypothesized that sign-trackers would behave suboptimally, in contrast to goal-trackers. In the present study, 45 rats were classified according to their performance in the Pavlovian Conditioned Approach procedure and subjects with extreme values (sign-trackers, and goal-trackers) were evaluated in the suboptimal choice procedure. Both groups were found to behave optimally, with no differences between them. The difference between groups in capacity of attribution of incentive salience was preserved during the entire experiment, suggesting that this variable is not related to choice performance in the suboptimal choice procedure.

1. Introduction

In natural contexts, primary reinforcers such as food and water are highly valued by organisms, and the stimuli -e.g. lights and sounds- that predict their location or availability become conditioned stimuli that control and evoke conditioned responses. Besides this predictive function, some of these stimuli acquire attractiveness and the ability to arouse emotional and motivational states, i.e., they acquire incentive salience [1,2]. Among others, two topics are relevant when analyzing the degree to which a stimulus is attributed with incentive salience: a) the form of the stimulus, or more precisely, the relationship between the form of the stimulus and the species being evaluated, e.g. pigeons attribute high incentive salience to lights [3,4], but rats attribute higher incentive salience to levers than to lights or sounds [5,6] and b) individual differences in the capacity to attribute incentive salience [7].

One of the most employed procedures to investigate these topics is the Pavlovian Conditioned Approach (PCA). In this procedure, an illuminated lever is presented contingently before a reinforcer is delivered, and as a result, the lever becomes capable of evoking conditioned responses [8]. For some organisms, the conditioned response consists in approximation to the lever, while for others it consists in approximation to the site of reinforcer delivery. The former behavior –known as sign-tracking– has been taken as evidence of attribution of incentive salience to the lever, in contrast to the latter behavior –known as goal-tracking– which is assumed to reflect exclusively the predictive function of the lever [2]. It has been found that in large samples of rats, 35% of the subjects are sign-trackers, 30% are goal-trackers, and the remaining 35% are intermediates [7,9].

These individual differences have stimulated much research because the sign-tracker phenotype has been demonstrated to be more prone to develop maladaptive decision making, for example, are more prone to develop addictive behavior [10,11] and have higher propensity to relapses [1], show more impulsivity [12], are more resistant to pavlovian extinction [13], among other interesting behavioral characteristics [14–16].

The purported relationship between incentive salience attribution and maladaptive decision-making is of paramount relevance because it seems to resolve one interesting debate that has arisen within the last

* Corresponding author.
E-mail address: vladord@unam.mx (V. Orduña).

https://doi.org/10.1016/j.bbr.2017.12.028
Received 14 October 2017; Received in revised form 15 December 2017; Accepted 22 December 2017
Available online 24 December 2017
0166-4328/

years around the "suboptimal choice procedure". In this procedure, an organism faces a choice between two alternatives: One with a lower probability of reinforcement but with discriminative stimuli that allow to anticipate whether or not a reinforcer will be delivered, and another with a higher probability of reinforcement, but without discriminative stimuli that allow such anticipation. It has been reported that pigeons consistently and strongly prefer the discriminative, suboptimal alternative [17,18], but that rats display the opposite preference, showing optimal behavior [19,20]. Recently, Chow et al. [21], proposed that an explanation for this difference is that rats do not attribute as much of incentive salience to lights (the stimuli employed with rats until this hypothesis was proposed) as pigeons do, and in order to appropriately compare these species' performance on this task it would be necessary to evaluate rats using stimuli with high incentive salience for them (e.g. levers). With this objective, they compared two groups of rats in the suboptimal choice procedure; for one of them, the stimuli associated with the alternatives were lights, while for the other one, the stimuli were levers. The results of this experiment showed that rats in the "levers" condition preferred the suboptimal alternative, while rats in the "lights" condition were optimal. Although not out of debate [22], the aforementioned result generated an interesting hypothesis that was evaluated in the present study: When the discriminative stimuli employed in the suboptimal choice procedure are susceptible to be attributed with incentive salience, sign-tracking rats would show a stronger preference for the discriminative alternative, compared to goal-tracking individuals.

2. Method

2.1. Phase 1: PCA

2.1.1. Subjects

Subjects were forty-five male Wistar rats experimentally naïve, approximately 60 days old, obtained from the vivarium of the Institute of Cell Physiology, at the Universidad Nacional Autónoma de México. Rats were housed in groups of five in cages where food and water were available ad libitum. The experiment followed the official Mexican norm NOM-062-ZOO-1999 'Technical Specification for Production, Use and Care of Laboratory Animals'.

2.1.2. Apparatus

Testing was conducted in seven conditioning chambers (MED Associates, Inc., Model ENV 008-VP), that were enclosed in a sound attenuating cubicle (MED Associates, Inc., Model ENV-022M). The floor was a stainless-steel grid comprised of nineteen 0.48 cm diameter bars (MED Associates, Inc., Model ENV-005). The response panel had two retractable levers (MED Associates, Inc., Model ENV 112CM), which were back-illuminated with a white ultra-brilliant LED mounted inside them. Each lever was 4.8 cm wide and was located 6.5 cm above the floor. In the center of the panel a 5.2 cm × 5.2 cm food receptacle (MED Associates, Inc., Model ENV-200R2M) outfitted with a head entry detector (MED Associates, Inc., Model ENV-254-CB), was located 2.1 cm above the floor. A circular modular pellet dispenser (MED Associates, Inc., Model ENV-203M) delivered, according to the schedule, 45 mg banana-flavored food pellets (Bio-Serv, Product F0059). The presentation of the stimuli and the collection of data were controlled by personal computers using the Medstate programming language (Med-PC-IV, MED Associates, Inc.).

2.1.3. Procedure

2.1.3.1. Habituation and feeder training. Once subjects adapted to housing conditions, they were habituated to the operant chamber for 20 m sessions, during which 25 banana-flavored pellets were placed in the feeder; these sessions were conducted until subjects ate all the available pellets. In the following session, subjects were exposed to a variable time 30 s schedule, after which a pellet was delivered in the food receptacle. Sessions ended after a total of 30 food deliveries. No other stimulus was present during these sessions.

2.1.3.2. PCA training. Each Pavlovian training trial consisted of the presentation during 8 s of an illuminated lever (left or right counterbalanced across subjects) after which a single banana-flavored pellet was delivered in the feeder. Each session comprised 25 trials, separated by an intertrial interval (ITI) with mean 90 s. Subjects were exposed to this procedure for 10 sessions without food restriction. During 5 additional sessions, subjects were food deprived for 22 h, having 1 h of access to food immediately after the experimental session. These sessions had the purpose of evaluating the attribution of incentive salience under the same deprivation conditions than those prevailing during the second phase of the study, the suboptimal choice task.

2.1.3.3. Pavlovian Conditioned Approach Index. In order to quantify the performance of the subjects during Pavlovian training, we employed the PCA Index that had been extensively used to categorize subjects into sign-trackers, goal-trackers, or intermediates [7,13,23,24]. This index is obtained by calculating the average of (i) the difference between the probabilities of responding to the lever or the feeder during the presence of the lever [P(lever) − P(feeder)], (ii) the difference between the number of responses to the lever and to the feeder during the presence of the lever, divided by the total number of responses [(# lever responses − # feeder entries)/(# lever contacts + # feeder entries)], and (iii) the latency to respond to the lever or the feeder when the lever was presented [(feeder entry latency − lever response latency)/8]. PCA scores range from −1.0 to 1.0. In most studies, subjects with a score between −1.0 and −0.5 are considered goal-trackers, those with a score from −0.5 to 0.5, intermediates, and subjects with a score between 0.5 and 1, sign-trackers. In this study subjects were categorized by their PCA scores obtained in the last two sessions of training. The 8 subjects with the highest PCA scores would constitute the sign-trackers group, and the 8 subjects with the lowest PCA scores, the goal-trackers group.

2.2. Phase 2: suboptimal choice

2.2.1. Subjects

After being categorized according to their PCA index, 16 of the rats were housed in groups of four in cages where water was freely available, and placed on a food restriction schedule to maintain them at approximately 85% of their free-feeding weight.

2.2.2. Apparatus

Four modified conditioning chambers (MED Associates, Inc., Model ENV 008-VP) were used for testing. Each operant chamber measured 30.5 cm (long) × 24.1 cm (wide) × 21.0 cm (tall) and was enclosed in a sound attenuating cubicle (MED Associates, Inc., Model ENV-022M). The floor was a stainless-steel grid comprised of nineteen 0.48 cm diameter bars (MED Associates, Inc., Model ENV-005). Each chamber had two identical operative panels, one in the front side and the other in the back side. Each panel had two retractable response levers that were 4.8 cm wide (MED Associates, Inc., Model ENV-112CM). A nose-poke response device with a yellow stimulus light mounted on its back (MED Associates, Inc., Model ENV-114BM) was placed in the center, 10 cm above the floor. A 5.2 × 5.2 cm pellet receptacle (MED Associates, Inc., Model ENV-200R2M), outfitted with a head entry detector (MED Associates, Inc., Model ENV-254-CB) was located 2.1 cm above the floor, under the nose-poke device. The presentation of stimuli and the collection of data were controlled by personal computers using the Medstate programming language (Med-PC-IV, MED Associates, Inc.).

2.2.3. Procedure

2.2.3.1. Nose poke training. Each session consisted of 50 trials, in which