Learning and Motivation 47 (2014) 12–17

Contents lists available at ScienceDirect

Learning and Motivation

journal homepage: www.elsevier.com/locate/l&m

The easy-to-hard effect in a voluntary exposure to toxin paradigm with rats☆

Naiara Arriola*, Gumersinda Alonso, Gabriel Rodríguez

Universidad del País Vasco (UPV/EHU), Spain

ARTICLE INFO

Article history:
Received 26 December 2013
Received in revised form 13 February 2014
Available online 11 March 2014

Keywords:
Easy-hard effect
Discrimination
Aversion
Ingested lithium
Rats

ABSTRACT

In Experiment 1, one group of rats (Group Easy) received initial discrimination training consisting of alternate presentations of two flavor stimuli easily discriminable (presentations of a compound consisting of 0.15% saccharin and 0.15 M lithium chloride, LiCl, and presentations of the saccharin alone). In a subsequent phase, these rats learned a hard version of the discrimination (in which the concentration of the saccharin solution was increased to 1.2%) faster than another group of rats (Group Hard) that received continuous training with the hard discrimination throughout all of the experiment. Experiment 2 led us to discard a possible interpretation of these results in terms of differences in the rates with which the neophobic reaction to the saccharin was habituated in the two groups. This study constitutes the first demonstration of an easy-hard effect in a free-intake toxin paradigm.

Initial training with an easy version of a discrimination facilitates subsequent learning of a harder task involving stimuli that vary along the same dimension. This *easy-to-hard* effect has been demonstrated in a wide variety of species and procedures (e.g., Lawrence, 1952; Liu, Mercado, Church, & Orduña, 2008; Scahill & Mackintosh, 2004; Suret & McLaren, 2003; Walker, Lee, & Bitterman, 1990). For example, Scahill and Mackintosh (2004; Experiment 1) trained rats to learn a discrimination between two flavor compounds: saline + lemon and saccharin + lemon. Consuming from one of these compounds was safe, but consumption of the other was followed by an injection of Lithium Chloride (LiCl) that caused gastrointestinal malaise. In the *easy-trained* condition, the discrimination was easy, since the concentration of the distinctive features of the two compounds was relatively high (0.9% saline and 0.05% saccharin). In the *hard-trained condition*, however, the discrimination was more difficult, since the concentration of the distinctive features was lower (0.05% saline, 0.01% saccharin). Following this pre-training phase, the rats from the two conditions were required to learn the hard discrimination. In this second phase, the discriminative performance (i.e., avoiding the compound followed by the LiCl injection, and maintaining consumption of the safe compound) was found to be better in the *easy* than in the *hard-trained* condition, although the animals in this latter condition were trained on the hard discrimination from the outset. In this demonstration of the easy-to-hard effect, Scahill and Mackintosh used a "forced exposure" to toxin paradigm (cf., Good, Kavaliers, & Ossenkopp, 2013). In this type of paradigm the animal receives a fixed amount of toxin (depending on its body weight) regardless of the amount of flavor consumed previously. This feature of the procedure does not match the natural conditions usually encountered by the organism in which the amount of toxin (and the magnitude of the induced illness) directly depends

☆ This research was supported by grants from the Spanish Ministerio de Economía y Competitividad (PSI2011-2431), Spanish Ministerio de Ciencia e Innovación (PSI2008-00412-PSIC), Gobierno Vasco (IT-694-13), and Vicerrectorado de Euskera de la UPV/EHU. The experimental procedures were approved by the Animal Welfare Ethics Committee of The University of the Basque Country (UPV/EHU). The authors would like to thank to SGIker for personal and technical support.
* Corresponding author at: Facultad de Psicología, Universidad del País Vasco (UPV/EHU), San Sebastián 20018, Guipuzkoa, Spain.
E-mail address: naiara.arriola@ehu.es (N. Arriola).

http://dx.doi.org/10.1016/j.lmot.2014.02.001
0023-9690/

Table 1
Experimental designs.

Stage 1	Stage 2
Experiment 1	
Group EASY	
3 × (LiCl + sac/sac)	6 × (LiCl + SAC/SAC)
Group HARD	
3 × (LiCl + SAC/SAC)	
Experiment 2	
Group LOW	
3 × (NaCl + sac/sac)	6 × (LiCl + SAC/SAC)
Group HIGH	
3 × (NaCl + SAC/SAC)	

Note: All substances were ingested. Number of trials of a given type are indicated. LiCl: 0.15 M lithium chloride solution; NaCl: 0.15 M sodium chloride solution. SAC = Saccharin solution at 1.2%; sac = Saccharin solution at 0.15%. Substances separated by a forward slash (/) were presented on alternate days.

on how much of the toxic food the animal consumes. However, a "voluntary exposure" to toxin paradigm can be readily employed under laboratory conditions by allowing the animals to orally ingest the food or solution containing the LiCl. This oral route of administration has been shown to produce a robust conditioned aversion to the salty taste of the LiCl (e.g., Ladowsky & Ossenkopp, 1986; Loy & Hall, 2002). In addition, a group of studies using oral administration of LiCl have also provided demonstrations of Pavovian discriminations (e.g., Kiefer, 1978; Nakajima & Nagaishi, 2005). For example, Arriola, Vázquez, Alonso, & Rodríguez (2014; Experiment 2) demonstrated that training consisting of alternate presentations of a LiCl + saccharin compound and the saccharin alone resulted in rats avoiding the compound containing LiCl and gradually increasing their consumption of the saccharin alone. Critically, it was found that this discriminative response depended on the concentration of the saccharin (0.15% vs. 0.3%), with the differential response being lower as the concentration increased. In other words, it was found that enhancing the concentration of the common feature of the two flavors (i.e., the saccharin) made the discrimination more difficult. This suggests that this sort of "voluntary exposure" to toxin paradigm also has the potential to provide a demonstration of the easy to hard effect. The aim of the present study, therefore, was to attempt to obtain such a demonstration.

Experiment 1

This experiment consisted of two stages (see Table 1). All rats received identical discrimination training in Stage 2, in which presentations of a LiCl + 1.2% saccharin compound were alternated with presentations of the 1.2% saccharin alone. Given that the intensity (and/or salience) of the common feature of the two stimuli to be discriminated was relatively high (i.e., the saccharin was highly concentrated at 1.2%) we anticipated that learning to discriminate between these two stimuli would be relatively difficult. The two groups of rats differed in the discrimination training that they received in Stage 1. Group EASY received an easy version of the discrimination employed in Stage 2. Specifically, animals in this group received presentations of a LiCl + 0.15% saccharin compound alternated with presentations of the 0.15% saccharin alone. Given the weaker concentration of the common feature of the two stimuli to be discriminated (i.e., the saccharin), we anticipated that learning this discrimination would be relatively easy. Group HARD received in Stage 1 the same discrimination training received in Stage 2. The relevant question was whether or not the present procedure in which animals are voluntarily exposed to the toxin (i.e., the LiCl) will provide a demonstration of the easy-to-hard effect of the sort found by Scahill & Mackintosh (2004).

Method

Subjects, stimuli and apparatus

The subjects were 16 experimentally naïve male Wistar rats with an ad lib. mean weight of 367 g (range: 324–408 g). Animals were singly housed with continuous access to food in a room with a constant temperature (23 °C), humidity (50%) and a 12:12-h light: dark cycle, with light on at 08:00. Access to water was restricted as detailed below.

The solutions used as experimental stimuli were administered in the home cages at room temperature in 50-ml plastic centrifuge tubes, fitted with a metal spout. The following flavored solutions were used: two solutions of saccharin, at 0.15% (w/v) and 1.2%, and two compounds, one consisting of .15 M LiCl and 0.15% saccharin, and the other consisting of .15 M LiCl and 1.2% saccharin. Consumption was measured by weighing the tubes before and after trials, to the nearest 0.1 g.

Procedure

The water deprivation regime was initiated by removing the standard water bottles overnight. On each of the next four days access to water was restricted to two daily sessions of 30 min, beginning at 14:00 (afternoon session) and 19:00 (evening