Behavioural Processes 82 (2009) 244–248

Contents lists available at ScienceDirect

Behavioural Processes

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

Spontaneous categorization of vocal imitations in African grey parrots (*Psittacus erithacus*)

Nicolas Giret*, Franck Péron, Laurent Nagle, Michel Kreutzer, Dalila Bovet

Laboratoire d'Ethologie et Cognition Comparées, Université Paris Ouest Nanterre - La Défense, BSL, 1er étage, 200, avenue de la République 92000 Nanterre, France

ARTICLE INFO

Article history:
Received 3 February 2009
Received in revised form 24 June 2009
Accepted 1 July 2009

Keywords:
Categorization
African grey parrots (*Psittacus erithacus*)
Vocal imitation
Concept learning

ABSTRACT

The ability to categorize elements of the environment is a fundamental aspect of information processing. Many experiments demonstrate the ability of birds and non-human primates to classify items according to their perceptual similarities. Few data are available regarding spontaneous classification of items according to a non-perceptual account in non-human animals. Here, we report unexpected results obtained with African grey parrots learning the referential use of French labels. Parrots did not learn the correct labels but they spontaneously produced more labels corresponding to food when a food item was presented to them and more labels corresponding to an object when shown an object item, although they were never rewarded for doing so. These results demonstrate a form of spontaneous categorization by using vocal imitation of the human language.

1. Introduction

The ability to categorize elements of the environment, *i.e.* to classify objects according to proprieties they share, is a fundamental aspect of information processing. Herrnstein (1990) reported that categorization depends on interaction between physical variation in stimuli, sensorimotor abilities and functional consequences of a behavior for the individual. Zayan and Vauclair (1998) adapted the classification of Herrnstein (1990) and described four levels of categorization (with increasing level of abstractness): categorization by rote, open-ended categories, conceptual categorization and abstract relations. Categorization by rote concerns the ability to discriminate and memorize any arbitrary list of stimuli according to contingency rules. Open-ended categories are mainly based on perceptual similarity between items belonging to a given category. Conceptual categorization implies two criteria: a rapid generalization over class members of items and a classification of items not necessarily similar perceptually [e.g. 'food' vs 'tool' items (Savage-Rumbaugh et al., 1980; Gardner and Gardner, 1984)]. Abstract relations are defined as a categorization established upon the similarity between and among concepts (Herrnstein, 1990; Zayan and Vauclair, 1998). Both human and non-human animals are able to learn a wide variety of concepts (see Zentall et al., 2008; Penn et al., 2008 for a review).

Among birds, African grey parrots (*Psittacus erithacus*) are well known for their complex cognitive skills. Some individuals are able to learn and to pronounce referential labels, *i.e.* to say the correct label for a specific item (e.g. Pepperberg, 1999). An African grey parrot, Alex, was able to categorize items according to their color, shape or matter. He was capable of giving the similar and/or different characteristics of the items presented (Pepperberg, 1990, 1991). He was also able to identify the number of items according to two modalities (Pepperberg, 1994; Pepperberg and Gordon, 2005). Alex's categorization was noteworthy because he expressed this classification by verbalizing labels. However, Alex received a long training (months to years for various items and/or concepts) before being able to label and categorize correctly the items presented.

Without such training, human children of less than one-year-old are able to classify items according to their functional similarity (Mareschal and Quinn, 2001; Mandler, 2004).

In this study, while we were testing different methods to teach our birds to use labels referentially, we observed that two African grey parrots learning French labels spontaneously categorized items with vocal imitations.

2. Methods

2.1. Subjects and housing conditions

Two hand-reared African grey parrots were involved in this experiment: one male, Shango (2 years old) and one female, Zoé (4 years old).

Subjects were housed together (with a third conspecific) in an aviary of 340 cm × 330 cm × 300 cm. Water and parrot pellets were available *ad libitum*. They were fed daily with fresh fruits, vegetables and parrot formula. When an experiment was

* Corresponding author.
E-mail address: ngiret@u-paris10.fr (N. Giret).

0376-6357/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.beproc.2009.07.001

conducted, non-tested parrots were brought to another room of 270 cm × 500 cm × 275 cm. When they vocalized, both subjects either produce various calls or practice all their imitations (the 3rd conspecific never produced imitations of human labels). At the time of the experiment, Shango knew 8 referential labels belonging to two different classes (food and objects; 4 labels known in each class) and he imitated several labels that did not refer to particular items (22 labels). At the same time, Zoé also imitated labels that did not refer to particular items (11 labels) and some labels belonging to the food class (3 labels) or to the object class (2 labels) but she was not formally tested to verify whether she used these vocalizations referentially.

2.2. Teaching methods

In a larger study, we evaluated referential learning abilities in parrots by testing different teaching methods (Giret et al., submitted for publication): the Model/Rival method (developed by Todt and adapted for parrots by Pepperberg) that implied an interaction between two experimenters and one subject relating to a particular item for which the subject had to learn the label (see Pepperberg, 1999); the Repetition/Association method in which an experimenter first labels an item several times without showing the corresponding item and then, give corresponding item in reward once the subject produces the label; the Intuitive method, inspired by the method of Savage-Rumbaugh to teach the use of lexigrams to apes (Savage-Rumbaugh et al., 1986; Brakke and Savage-Rumbaugh, 1996), that consisted of handling an item in front of the subject, giving it to the subject and repeating its label when it was handled either by the experimenter or by the subject.

We showed in another preliminary study that Shango learned the labels "stylo", "raisin" and "rouleau" with the Repetition/Association method. He also learned the labels "bouton" and "cacahuète" by imitating Zoé and the labels "scotch", "pomme" and "carotte" by the Intuitive method. Zoé learned to imitate the label "cacahuète" by the Model/Rival method without learning to associate this label with the corresponding item during these sessions (in which the Model/Rival was a human). However, she associated this label with the corresponding item by observing Shango obtaining a peanut in reward after the production of the label "cacahuète" (so in this case, Shango was a Model/Rival for Zoé). Zoé learned the label "bouton" by the Repetition/Association method. As said above, Shango and Zoé also learned labels that are not associated to a particular item from our daily interactions.

Here, we present further data that were obtained from the larger study (Giret et al., submitted for publication) with the Model/Rival and the Intuitive methods. In this experiment, each subject was trained with three different labels for each teaching method. In Model/Rival, Shango was trained with the labels "agrume" (to a plastic lemon), "pignon" (cedar seed) and "pétale" (cereal flakes); Zoé was trained with the labels "fourchette" (fork), "fève" (broad bean), "oeuf dur" (hard egg). In Intuitive, Shango was trained with the labels "soldat" (small plastic soldier), "penne" (pasta) and "citrouille" (pumpkin seed); Zoé was trained with the labels "brindille" (twig), "pois chiche" (chickpea) and "biscotte" (rusk).

Each method was evaluated during a teaching phase during which the two methods were used. During this phase, one bird and one (for Intuitive) or two (for Model/Rival) experimenters were present in the aviary. The training for each method lasted 15 min with 5 min per label during which each label was repeated 80 times. We conducted 75 teaching sessions, four days a week.

During the teaching sessions, we noted which labels were spontaneously pronounced by the subject and we distributed them according to their class: "food labels" are imitations of food item names, "object labels" are imitations of object item names and "neutral labels" are imitations of words which are not food or object item names (e.g. imitations of words or expressions meaning "hello", "how are you").

2.3. Recording sessions

After each teaching session, a subject was placed alone in the aviary during 30 min. We recorded and analyzed the vocalizations produced by the subject with a Marantz DAT PMD 670 and a Sennheiser microphone. The labels pronounced were classified into the classes "food label", "object label" and "neutral label" as described above. This allowed us to obtain an overall frequency of production for each label.

3. Results

For each bird, two sets of comparisons were conducted. We first compared with chi-square tests the class and the overall number (*i.e.* each time a label was produced) of the labels produced when a food item or an object item was presented to the subject (during the teaching sessions) and when nothing was presented to the subject (during the recording sessions). To avoid a potential over-inflation effect by counting all words produced, we conducted a second analysis in which we compared with chi-square tests the first occurrence of each label produced in front of a given item according to their class. In each case, subsequent chi-square tests were carried out in case of significant effect.

The parrots never said any of the labels that we were trying to teach them during the teaching sessions. However, they used labels that they learned in previous training in a non-random fashion (Figs. 1 and 2 and Tables 1 and 2).

For Zoé, a chi-square test realized on the class and overall number of labels produced (for the three classes) revealed a significant

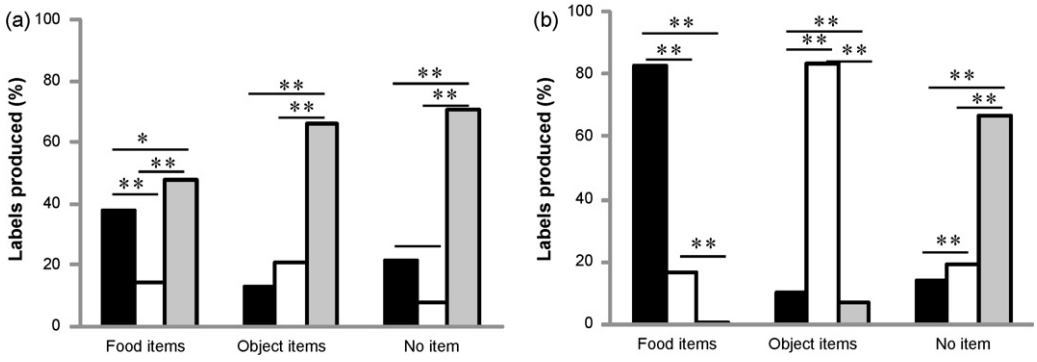

Fig. 1. Proportion of overall labels produced by Zoé (a) and Shango (b) according to the presence/absence of items and the class of the item. In black: "food labels"; in white: "object labels"; in grey: "neutral labels". (*), (**): chi-square tests, $p < 0.05$ and $p < 0.001$, respectively.