



## Referential learning of French and Czech labels in African grey parrots (*Psittacus erithacus*): Different methods yield contrasting results

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### ABSTRACT

Some African grey parrots (*Psittacus erithacus*), the most famous being Pepperberg's parrot Alex, are able to imitate human speech and produce labels referentially. In this study, the aim was to teach ten African grey parrots from two laboratories to label items. Training three parrots from the first laboratory for several months with the Model/Rival method, developed by Pepperberg, in which two humans interact in front of the subject to demonstrate the use of a label, led to disappointing results. Similarly, seven parrots from the second laboratory, having been trained with several variants of Model/Rival attained little success. After the informal observation of the efficiency of other methods (i.e. learning to imitate labels either spontaneously or with specific learning methods and use of these labels referentially), four different teaching methods were tested with two birds: the Model/Rival; Repetition/Association which consisted of repeating a label and presenting the item only when the parrot produced the label; Intuitive in which the experimenter handled an item and repeated its name in front of the subject; Diffusion in which labels with either variable or flat intonation were played back daily to parrots. One bird learned three labels, one of which was used referentially, with the Repetition/Association method. He learned one label non-referentially with the Model/Rival but no labels were acquired using the other methods. The second bird did not learn any labels. This study demonstrates that different methods can be efficient to teach labels referentially and it suggests that rearing conditions and interindividual variability are important features when assessing learning ability of African grey parrots.

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### 1. Introduction

Traditionally, language has been considered to be an ability restricted to humans, but it is now accepted that as an evolutionary trait shaped by natural selection, there are likely to be some cross-species continuities (Pinker and Bloom, 1990). Although the ability to produce language that can convey diverse information including abstract thought seem to be specific to human, studying cognitive aspects of animal communication can help us to identify which characteristics are specific to language (Hayes and Nissen, 1971). Studies in this field often tackle two distinct aspects: production and comprehension of a symbolic communication system.

Numerous studies have explored the abilities of the great apes. After realizing that apes are physically unable to produce oral speech (e.g. Hayes, 1951; Fitch, 2000), scientists developed new ways to study production abilities of these primates (e.g. Gardner

and Gardner, 1969). The main feature of these projects was to establish a novel system of communication with apes, by exploiting their spontaneous abilities. For example, chimpanzees were trained and able to use the manual signs of American Sign Language (Gardner and Gardner, 1984), and lexigrams, which are pictorial symbols (Rumbaugh, 1977), or small objects to represent words (Premack, 1971; Premack and Premack, 2003). They mainly used these symbols to request things they wanted or to comply with the experimenter's requests, such as putting an item in a box and another item in another box. They were also able to use quantitative concepts such as "more" or "less" and conditional construction ("if-then") (Premack, 1971; Premack and Premack, 2003). Rumbaugh and Savage-Rumbaugh developed with the bonobo Kanzi, a method that resulted in considerable success. It consisted of informal exchanges using the lexigrams between the trainer and the trainee, each lexigram referring to particular objects, items, actions, etc. (Savage-Rumbaugh and Lewin, 1994). Kanzi and other apes were able to use these lexigrams to express requests or intentions (Savage-Rumbaugh and Lewin, 1994). This teaching method is close to the one intuitively employed with children who are learning to talk.

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Contrary to primates, several bird species are capable of vocal imitation and of vocal learning (songbirds, hummingbirds and parrots; [Kroodtsma and Miller, 1996](#)). Among parrots, African grey parrots (*Psittacus erithacus*) are well known for their vocal imitation of human speech and, since the work of Pepperberg with her most successful subject Alex, they are known for their complex cognitive skills. Pepperberg used the imitative abilities of parrots to teach Alex the referential use of vocal labels. To do so, she adapted the Model/Rival method invented by Todt (1975, cited by [Pepperberg, 1999](#)). This method involves one subject and two experimenters. The subject participates in interactions with the two experimenters. One experimenter is the “Teacher” who holds an item and then, for example, asks the other experimenter (the “Model/Rival”), what the object is. The Model/Rival has to say the correct label in order to obtain the item as a reward. The second experimenter is a “Model” because his role is to demonstrate to the parrot that he also has to say the label to obtain the item. He is also a “Rival” for the subject: if the Model/Rival labels the item before the subject, he obtains it first. The experimenters’ roles are regularly reversed: the Teacher becomes the Model/Rival and the Model/Rival the Teacher; Pepperberg added this reciprocity in order to facilitate the subject’s understanding and to allow him to learn how to communicate with multiple human trainers ([Pepperberg, 1999](#)). Whereas Todt trained his birds to answer questions in the absence of items, Pepperberg asked questions about specific objects in order to demonstrate that parrots understand the labels they were imitating ([Pepperberg, 1999](#)). Using this method, Pepperberg was able to teach Alex approximately one hundred English labels and concepts ([Pepperberg, 2006](#)).

Alex was able to referentially produce English labels, for example, to identify differences between two items (in terms of shape, matter or size), and to count up to six items ([Pepperberg, 1990, 1999](#)). Pepperberg conducted several experiments in order to demonstrate the efficacy of this method. She exposed two grey parrots, Alo and Kyaaro, to audio and video playbacks or to audio playbacks of Model/Rival sessions recorded with Alex ([Pepperberg, 1994](#)). In this situation, none of the parrots were able to learn label use referentially. In another experiment, she also demonstrated that parrots do not learn when the Model turns his back to the subject; in this case, social interactions between the subject and the Model are restricted and the subject cannot observe the functional aspects of the item ([Pepperberg and McLaughlin, 1996](#)). Pepperberg and her colleagues also demonstrated that the inability of parrots to learn from video recordings is not due to the nonpresentation of the reward during the training sessions ([Pepperberg et al., 1998](#)) and that the presence of a live Model is essential for the acquisition of referential labels ([Pepperberg, 1999](#)). These experiments reveal that the ability of parrots to learn referential labels is related to social interactions (and thus joint attention), between the individuals and the objects, allowing demonstrations of both functionality and the referential meaning of labels. Pepperberg and her colleagues also demonstrated the importance of demonstrating errors to the subject (if the Model makes a mistake, he does not receive the object), of the role inversion (between the experimenters), and that the number of experimenters (two), facilitates the referential learning ([Pepperberg et al., 2000](#)). [Pepperberg et al. \(2000\)](#) also showed that an individual learned to imitate a label, but not referentially, with a method similar to that employed by Savage-Rumbaugh.

In this study, we used different methods to teach French and Czech labels to African grey parrots. We reproduced Pepperberg’s “Model/Rival” method in two laboratories (a French and a Czech laboratory), and in one laboratory, we subsequently tested three different methods of teaching: “Intuitive”, inspired by Savage-Rumbaugh’s approach, consisted of handling an object in front of the subject before giving it to the parrot, and of repeating the

appropriate labels or words according to specific situations. “Repetition/Association” which takes advantage of parrots’ spontaneous tendency to repeat words they often hear and which implies a repetition of a label and then the association between the label and the object; “Diffusion/Association” in which recordings of French labels with either variable or flat intonations were played back to parrots. Variation in intonation was explored because in humans, the prosody used in parent/baby interactions plays an important role during the acquisition of labels by infants ([Gratier, 2007](#)). Thus, the production of labels with various intonations could facilitate label learning in parrots.

In a pre-experiment, we performed preliminary trials to assess each teaching method with parrots of the French laboratory. The “Model/Rival” method was used to teach the labels “stylo” (meaning “pen” in French) and “cacahuète” (meaning “peanut”) to two grey parrots (Léo and Zoé) and the label “raisin” (meaning “grape”) to another subject (Shango<sup>F</sup>). Training sessions were conducted during 24 months with Léo and Zoé, with 3–5 sessions a week (ranging from 20 min to 1 h, according to birds’ motivation). With Shango<sup>F</sup>,<sup>1</sup> sessions were conducted over six months, with 1–2 sessions a week (ranging from 20 min to 1 h). Léo, Shango<sup>F</sup> and Zoé never pronounced any labels during training sessions. However, after 18 months of training, Zoé started to imitate the label “cacahuète”, but only during babbling periods, outside of the training session context. With the “Intuitive” method, Shango<sup>F</sup> and Zoé learned some labels and used them in contextually relevant situations, e.g. “bonjour” (meaning “hello”) and “ça va” (meaning “how are you”), when we entered in their aviary or “au revoir” (meaning “goodbye”), or “à demain” (meaning “see you tomorrow”), when we left the aviary. Shango also learned to produce the labels “carotte” (meaning “carrot”) and “pomme” (meaning “apple”) for fruits or vegetables, but not always appropriately (for example, he said the label “pomme” for a banana). With the Repetition/Association method, Zoé quickly learned to imitate (in four days) a label (“bouton” meaning “button”) but she did not associate this label with the corresponding item (probably because of her lack of motivation to obtain this object). Shango<sup>F</sup> also learned a label (“stylo”) after intensive repetition of this label (three weeks) and he associated this label with the corresponding item (a pen) a few days later.

Interestingly, Shango<sup>F</sup> learned to imitate the labels “cacahuète” and “bouton” by hearing them from Zoé. He was then able to associate these labels with the corresponding items (in six weeks). Zoé associated the label “cacahuète” with a peanut within one week of observing Shango receiving a peanut after having pronounced the label.

Based on the unexpected failure of the Model/Rival method, the performances of grey parrots obtained in the Czech laboratory were analyzed (experiment 1), and a full study was carried out in the French laboratory to evaluate the efficiency of the four teaching methods (experiment 2).

## 2. Methods

### 2.1. Subjects and housing conditions

#### 2.1.1. Laboratory 1 (French laboratory)

Three hand-reared African grey parrots were studied: two males, Léo, Shango<sup>F</sup> and one female, Zoé. Léo and Zoé were 4.5 years old at the beginning of experiment 1. Shango<sup>F</sup> was 2.5 years old at the beginning of experiment 1 (see below). Léo, Shango<sup>F</sup> and

<sup>1</sup> Because both laboratories named one of their parrots Shango, we distinguish between them with the index <sup>F</sup> for the French laboratory (1) and <sup>C</sup> for the Czech laboratory (2).

**Table 1**  
Czech labels taught and number of training sessions according to method used during experiment 1.

Subjects	Model/Rival I	Model/Rival II	Model/Rival III	Model/Rival IV	
Labels	“mičuda”, “kostka”, “burák”, “korek”, “víčko”, “papír”	“tužka”, “papír”, “lego”, “klíč”, “mičuda”	“tužka”, “papír”	“šipka”, “kolík”, “barák”, “bunán”	“šilík”, “kopka”, “banán”, “burák”
Subjects and number of training sessions	Markéta (317), Jarina (125), Markéta & Jarina (365)	Asabi, Shango <sup>C</sup> , Titilayo, Tokunbo, Yemaya Each bird tested alone (between 97 and 124)	Asabi, Shango <sup>C</sup> , Titilayo, Tokunbo, Yemaya Each bird tested alone (between 5 and 72)	Asabi (234), Shango <sup>C</sup> (234), Tokunbo (235), Asabi & Shango <sup>C</sup> (210)	Titilayo (235), Tokunbo (235), Titilayo & Tokunbo (206)
				Asabi, Markéta, Jarina, Shango <sup>C</sup> , Titilayo, Tokunbo, Yemaya (not defined)	

Birds were either trained alone or with a conspecific. Number in brackets corresponds to the number of training sessions received by one or two subject(s). “mičuda”: “ball”, “kostka”: “cube”, “burák”/“bunán”: “peanut”, “korek”: “cork”, “víčko”: “cup”, “papír”: “paper”, “tužka”: “pen”, “lego”: “lego”, “klíč”: “key”, “šipka”/“šilík”: “dart”, “kolík”/“kopka”: “cloth-pin”, “barák”/“banán”: “banana”, “t’uká”: “knock”, “píská”: “whistle”, “brčko”: “straw”.

Zoé imitated their first French label at 5.5 and 8 months of age, respectively.

Subjects were housed together in an aviary of 340 cm × 330 cm × 300 cm in which several perch structures and toys were provided. Water and parrot pellets were available *ad libitum*. Parrots were fed daily with fresh fruits, vegetables and parrot formula. When an experiment was conducted, non-tested parrots were brought to another room of 270 cm × 500 cm × 275 cm.

### 2.1.2. Laboratory 2 (Czech laboratory)

We taught Czech labels to six hand-reared African grey parrots and one parrot captured as adult. Except for the trapped parrot (Jarina), birds started training at the age of approximately one year. The majority of the training has been done with five (later four), hand-reared birds hatched in spring of 2003 in our laboratory – siblings Tokunbo, Shango<sup>C</sup>, and Yemaya, and a second set of siblings, Titilayo and Asabi. The seventh parrot – Markéta – arrived at the laboratory as a subadult from a household where it was kept as a pet. All these birds had also been involved in another study using the method matching to sample.

Subjects were housed in cages with one or two animals per cage. Cages were placed together first in two (about 250 cm × 400 cm × 275 cm), and later in one room (690/550 cm × 385 cm × 275 cm). The parrots were ordinarily let out of the cage every day for at least 1 h to move freely around the room(s). Several perches and toys were available for them both inside and outside the cages. In addition to the basic feeding mixture (sunflower with corn), they were fed daily with fresh fruit and vegetables. Water was provided *ad libitum*. For training, parrot(s) were taken into an adjacent room measuring 310 cm × 400 cm × 275 cm.

### 2.2. Teaching methods: general procedure

The “Model/Rival” method involved two experimenters and one or two subject(s). As described above, one experimenter was the Teacher and the other one was the Model/Rival. The teacher showed an object to the Model/Rival and asked him/her what it was. Then, he/she held out the object to the Model/Rival and labelled it several times before asking him/her one more time what it was. The Model/Rival then had to say the label in order to obtain the object. Once the Model/Rival received the object, the roles were reversed, so the Model/Rival became the teacher and vice versa. This interaction was repeated several times (about 15 times by session), with

the same object. Overall, during a training session, the label was pronounced about 15 times per min. In order to demonstrate that it was not correct to simply emit just any sound, the Model/Rival sometimes made errors: he/she would either pronounce the label of another item, or he/she would imitate sounds emitted by the subject (in both cases, he/she did not receive the item). To maintain motivation, approximations produced by the subject were rewarded with the item.

The “Intuitive” method was inspired by Savage-Rumbaugh and consisted of handling an object in front of the subject before giving it to the parrot, while repeating the object’s label during the whole procedure.

The “Repetition/Association” method involved two phases. During the first phase, the Repetition phase, the label of an object was repeated without showing the corresponding item. Once the subject imitated a label, the corresponding item was given to it in reward each time it said the label for the next few days.

The “Diffusion/Association” method is similar to the Repetition/Association method except that, during the first phase, labels were played back in the absence of the experimenters with various intonations.

### 2.3. Experiment 1

During this experiment, we taught seven parrots to pronounce and comprehend Czech labels. The main method used was Model/Rival, which was slightly modified in individual training phases.

#### 2.3.1. Model/Rival

Four variations of the Model/Rival method were tested. The labels taught and the number of sessions per bird is presented in Table 1. During Model/Rival I (2000–2005), the procedures utilized are described above. During Model/Rival II (Fall 2005 and 2007), only two items were taught – pen and paper, and the trainer who was in the role of teacher did not pronounce the label before the Model/Rival answered correctly. During Model/Rival III (2006–2007), birds were taught to label items either alone or in pairs. During Model/Rival IV (2008–2009), training was very free, although still being based on the Model/Rival method. The birds were either in or out of the cages, trained individually, in pairs or groups. Besides objects, the birds were also encouraged to label activities of trainers and of the birds themselves. Play, music and spontaneous labelling were also used to attract the birds’ atten-

**Table 2**  
Labels taught to each parrot in each method in experiment 2.

Subject	Model/Rival	Intuitive	Repetition/Association
Shango <sup>F</sup>	"agrume"; "pignon"; "pétale"	"soldat"; "penne"; "citrouille"	"rouleau"; "semoule"; "maïs" ("yaourt"; "biscuit"; "liège")
Zoé	"fourchette"; "fève"; "œuf dur"	"brindille"; "pois chiche"; "biscotte"	"flacon"; "groseille"; "lentille"

Labels in brackets are those presented once first labels were learned. "agrume": "citrus fruit", "pignon": "cedar seed", "pétale": "cereal flakes", "fourchette": "fork", "fève": "broad bean", "œuf dur": "hard-boiled egg", "soldat": "toy soldier", "penne": "pasta", "citrouille": "pumpkin seed", "brindille": "twig", "pois chiche": "chickpea", "biscotte": "rusk", "rouleau": "cardboard roll", "semoule", "cornmeal", "maïs": "sweetcorn", "yaourt": "yoghurt", "biscuit": "cookie", "liège": "cork", "flacon": "plastic bottle", "groseille": "red currant", "lentille": "lentil".

tion. At the end of this phase, a single series of referentiality tests (as described below) was performed.

### 2.3.2. Intuitive method

From 2004 to 2005, the caretakers who came to feed the birds each day, spontaneously labelled items of bird interest and activities with which they or the birds were involved. Among the activities, the most frequently labelled one was knocking ("t'uká"). As caretakers frequently used a pen and paper, we could not avoid these two items being also taught intuitively (in addition to Model/Rival).

### 2.3.3. Statistical analyses

Referentiality of label use was measured by carrying out two-tailed binomial tests with a chance level of 0.05: (a) on the proportion of cases of correct label use out of all label use cases (Model/Rival I and II), or (b) on the proportion of trials where a label was produced correctly out of the sum of all trials where the label was produced (Model/Rival IV), compared to the proportion expected by chance; i.e. the proportion of cases of teaching such label to all teaching cases. Additionally, a series of referentiality tests were performed at the end of Model/Rival IV.

## 2.4. Experiment 2: controlled evaluation of teaching methods of French labels

Considering the results obtained during the preliminary experiment, we decided one year later to test the efficiency of the different teaching methods in a more controlled manner. The teaching methods were conducted as described above.

We trained two parrots (Shango<sup>F</sup> and Zoé), with each method four days a week. We trained each parrot with three different labels of two different classes of items (food or non-food items), using each method (Table 2). We are aware that some labels can be difficult for grey parrots to produce, especially those with the phonemes /b/, /f/, /p/, and /s/. However, as at the time of the experiment the subjects already imitated labels with the phonemes of the labels used in this study (i.e. Shango<sup>F</sup> imitated the labels "bonjour", "bureau", "boire", "bon", "fini", "pomme", "prêt", "scotch", "stylo" and Zoé imitated the labels "bonjour", "bouton", "pomme", "Shango"), we concluded that all the labels presented comparable pronunciation difficulties.

We also tried to evaluate whether parrots would be able to learn French labels without human interaction. To do so, we used audio repetition of labels with variable or flat intonations over a period of 8 months (Diffusion method). Thus, each evening, after leaving the parrots, we played back (with an mp3 player Archos XS10D and Sony SRS-A202 loudspeakers), recordings (\*.wav file type) of six labels: three with flat intonations ("bout de bois": "branch"; "noisette": "nut"; "vitamine": "vitamin"), and three with various intonations ("ananas": "pineapple"; "cornichon": "pickle-puller"; "tournesol": "sunflower"), pronounced by their main caretaker. Each label was repeated five times (with 10 s between each repetition), the whole set of labels was repeated six times (with 5 min between each set), during a diffusion session of 1 h total. Thus,

during a diffusion session, parrots heard 30 repetitions of each label.

### 2.4.1. Teaching phase

Four experimenters, familiar to the parrots, conducted the experiments.

A teaching phase occurred in the morning during which the three methods were used. During this phase, present in the aviary would be: one bird and one experimenter (for Intuitive and Repetition/Association), or two experimenters (for Model/Rival). Each morning at the same hour (9:30 am), one bird (Shango<sup>F</sup> or Zoé) was brought to the aviary. The other parrots were kept in another room. The order in which the parrots were tested was changed each day. Each parrot was trained with a single teaching method within each session, with three sessions for each subject separated by a 45 min gap. Between each session, parrots were housed in a familiar room. The training for each label lasted 5 min during which the label was repeated 80 times. As there were three different labels, the training for each method lasted 15 min. The order of the teaching method and the label presentations were counterbalanced each day.

### 2.4.2. Recordings

Two hours and fifteen minutes after the end of the teaching sessions, the subject was brought back to the aviary to be recorded (recording A), for 30 min in order to check whether they used any labels. Ten minutes after this recording ended, the second parrot was recorded.

Recording conditions were adapted according to the subject: Shango<sup>F</sup> was recorded alone in the aviary (with the experimenter listening on headphones just outside), but Zoé was in the presence of an experimenter with his back turned and not paying visual attention to her. This was required because Shango<sup>F</sup> tended to keep quiet when an experimenter was present, whereas Zoé was quieter when she was alone. The first recording session (A) allowed us to know which labels were learned by the parrots. When a label was validated, it was removed from the teaching phase (teaching method), and inserted in the acquisition phase. It was also replaced with a new label and a new object of the same class, i.e. a food item or a non-food item. For the subsequent 5 sessions following the validation of a label, the experimenter always gave the parrot the corresponding object when he pronounced the label. After these 5 sessions, the experimenter did not intervene in the aviary during the recording session. In this way, the subject was allowed to practice the pronunciation of learned labels.

If a subject learned a label, 1 h after recording session A, a second recording period (B) of 15 min was conducted. The procedure was identical to session A except that if the bird pronounced one of the known labels, the experimenter gave him the corresponding item for all the sessions. This second recording phase allowed us to reinforce any learned labels with the further presentation of the corresponding item and thus to show the functional use of these labels.

Although the training phases were conducted during 75 sessions, we recorded the parrots for 25 more sessions after the end of the training, in order to check whether they pronounced the



taught labels. Therefore, a total of 100 recording sessions were realized.

#### 2.4.3. Acquisition phase

After the recording phases A and B, training was conducted using these validated labels. During this training, we also used other labels that the parrots emitted and probably knew referentially. Indeed, at that time, Shango<sup>F</sup> used the labels “stylo” and “cacahuète” and Zoé used the label “cacahuète” for the corresponding items, labels that they learned during the pre-experiment. Thanks to the tests described below, we ensured that these labels were eventually known referentially (i.e. they emitted these labels for the corresponding items). Before the training session, the experimenter established the pseudo-randomized presentation order of the items (no more than two consecutive occurrences of the same item), with five trials for each item. During a session, the subject is trained to label different items: the experimenter showed either a corresponding item of a label learned during the experiment 2 or, a pen or a peanut that the subject learned during the pre-experiment. The items presented were not identical to the ones used during the teaching sessions. Then, the experimenter asked to the subject “Qu'est-ce que c'est?” (“What is it?”). The subject had 20 s to reply. If the parrot pronounced the corresponding label, he received the item and verbal praise from the trainer as a reward. The following trial started immediately with the following label on the list. If the parrot made a mistake, the experimenter concealed the item and said “ce n'est pas ça” (“that is not it”) and left the aviary for 20 s. For the next one or two presentations, the experimenter presented the same item to the parrot; if the subject failed, the experimenter responded as before (verbal response and short time out). If the subject failed to label the object within these three presentations, the experimenter then returned to the aviary and repeated the label of the item until the subject pronounced this label (and then he obtained the item). Thus, the same item could be presented up to four times (if the parrot failed at each presentation). On the next trial, the experimenter showed the following item on the list to the parrot.

The acquisition and recording sessions were conducted four days a week (Monday to Thursday), with a total of 75 sessions for each parrot.

#### 2.4.4. Tests

Tests were conducted every Friday. A test was similar to the training sessions except that the parrot did not have more than a single trial to pronounce the correct label (the items presented were also different from the ones used during the teaching and the training sessions). Thus, when the subject made a mistake, the experimenter immediately presented the following item. The order of presentation of the items was pseudo-randomized as before. We considered that a subject passed the test when he produced at least four correct responses out of five presentations of each item and that he knew the corresponding label referentially after three consecutive passed tests. Preliminary trials with the labels tested were conducted to verify the identification of the labels produced; 100% inter-observer reliability was obtained. In this way, we insured that the pronunciation of the labels was clearly identifiable by the experimenter carrying out the test sessions. During the first three weeks, we conducted these tests three times each Friday but when we realized that the subjects showed good performances only during the first test session we reduced testing to a single session. The same experimenter carried out the test sessions. He was also involved during the teaching sessions. However, we excluded the possibility of inadvertent cueing, as the subjects were able to produce correct responses (i.e. labelling correctly a shown item) when another member of the laboratory (not involved during any phase of the

experiment) asked him the label of a given item (personal observations).

#### 2.4.5. Maintenance phase

For labels used referentially, two weekly sessions were used to maintain the association between item and label using the same procedures as in the training phase.

#### 2.4.6. Data analysis and label validation

During experiment 2, we considered the number of labels learned in each method, the number of sessions required for production of a label, the number of sessions required to associate a label with the corresponding item and the number of test sessions required to validate the learned label. A label was considered as “heard” when less than four experimenters identified it; it was considered as “recognized” when this label was emitted at least five times and identified by the four experimenters. As said before, a label was considered as “referential” when the subject passed three consecutive tests with four correct responses out of five trials. During recordings, we also registered “false alarms” in which a label was emitted in the absence of its appropriate referent. During testing sessions, confusion errors, i.e. when a label was used inappropriately, were noted.

### 3. Results

#### 3.1. Experiment 1

##### 3.1.1. Model/Rival I

During the first 143 sessions, Markéta pronounced “mičuda” (“ball”) 80 times and “kostka” (“cube”) 23 times, and used these words to label the correct objects in 55 (referentiality of use:  $p < 0.001$ ) and 57% ( $p = 0.005$ ) of cases, respectively. During next 152 sessions, Markéta's production dropped to 15 times pronouncing “mičuda” ( $p < 0.001$ ) and less than two times other words. In the last 2 years, Markéta almost completely stopped talking; the most frequently repeated label “víčko” (“cup”) was recorded only 8 times in 156 sessions (referentiality questionable). Jarina generally pronounced any words very rarely. She most frequently repeated the label “korek” (“cork”, 17 times), and she seemed to use it correctly (66% correct,  $p < 0.001$ ).

Shango<sup>C</sup> first repeated “tužka” (“pen”) after 27 trainings with this object, but he produced this word only 3 times (2 times correctly) during the whole phase. None of the other parrots pronounced any labels.

##### 3.1.2. Model/Rival II

In the fall of 2005, Shango<sup>C</sup> started to pronounce “tužka” frequently, with 77% of cases when the word was used to label the correct object ( $p < 0.001$ ). However, in 2007 he did not use the word referentially any more (he used “tužka” correctly in 15 out of 25 sessions where this object was trained, however incorrectly in 13 such sessions, and he also used it in 16 sessions where the object was not taught at all). In the fall of 2007, he also started to say “pap”. He already knew this syllable from the word “papoušku” (“parrot”) and never pronounced the remaining “-ír” to emit the complete label “papír” (“paper”). Referentiality of use was non-significant. Since 2005, Tokunbo also repeated “tužka”, with only 50% of cases when it was used to label the correct object (here, 50% corresponds to the chance level). In 2007, Tokunbo's use of “tužka” was very similar to that of Shango<sup>C</sup>.

##### 3.1.3. Model/Rival III

During the 3rd session, Shango<sup>C</sup> pronounced “ko” for “kolík” (“banana”). He occasionally repeated “ko”, but never said the whole

**Table 3**  
Synthesis of the results for each teaching method in experiment 2.

Subjects	Label	M/R	In	R/A	Di
Shango <sup>F</sup>	Heard	“agrum” (31)“pignon” (50)	“soldat” (36)	“rouleau” (7) “semoule” (9) “aourt” (20) “maïs” (36) “biscuit” (40)	–
	Validated	“agrum” (75)	–	“rouleau” (12) “semoule” (22) “yaourt” (24)	–
	Referential	–	–	“rouleau” (32/12)	–
Zoé	Heard	–	–	–	–
	Recognized	–	–	–	–
	Referential	–	–	–	–

M/R: Model/Rival; In: Intuitive; R/A: Repetition/Association; Di: Diffusion.

Heard label: labels heard the first time during a recording session, after the learning session no. (number in brackets).

Validated label: label recognized and validated by the four experimenters and pronounced at least five times, after the learning session no. (number in brackets).

Referential label: label validated during a testing session, after the training session no. (first number in brackets) and the testing session no. (second number in brackets).

–, no label emitted.

Note that Shango<sup>F</sup> also learned to use referentially the labels “stylo” and “cacahuète” and that Zoé learned to use referentially the label “cacahuète” during the pre-experiment.

“kolík”. None of the other birds pronounced any of the labels taught.

### 3.1.4. Model/Rival IV

Although he occasionally pronounced “papír”, Shango<sup>C</sup> mostly used “pap” for paper. Referentiality of use was evident (40 trainings with correct use, 14 with incorrect use,  $p < 0.001$ ). Also, his use of “tužka” was referential (40 and 22 trainings with correct and incorrect use, respectively,  $p < 0.001$ ). After 28 training sessions, he started to pronounce “brčko” (“straw”) and seemed to use it referentially very quickly (9 and 4 trainings with correct and incorrect use, respectively,  $p = 0.046$ ). He also frequently labelled the activity “t’uká” (“knock”), but seemingly incorrectly more often than correctly (21 and 23 trainings with correct and incorrect use, respectively, ns). However, out of 23 training sessions with incorrect use, 16 were cases when “t’uká” was not trained. Thus, out of 27 training sessions with “t’uká”, in 21 the label was correctly used and only in 7, it was used incorrectly ( $p < 0.001$ ). Tokunbo pronounced “tužka” and “t’uká”, both referentially (22/24 and 13/14 trainings with correct and incorrect use, respectively,  $p < 0.001$ ). Asabi and Titilayo never learned any labels.

Referentiality tests confirmed referential use of “tužka”, “t’uká”, “pap” and “brčko” for Shango<sup>C</sup>. Since Tokunbo only pronounced two labels, the referentiality test was difficult to perform. But out of a total of 25 questions for both pen and knock, he correctly answered “tužka” and “t’uká” in the majority of cases (14 and 21, respectively). He never used an incorrect label in the series of referentiality tests.

### 3.1.5. Intuitive method

Both Shango<sup>C</sup> and Tokunbo repeated “t’uká” frequently. Referentiality was first tested at the end of Model/Rival IV.

**Table 4**

Labels emitted by Shango<sup>F</sup> during recording sessions (mean percentage  $\pm$  SEM).

Recording sessions	Neutral labels	Object labels	Food labels	“rouleau”	“semoule”	“maïs”	“yaourt”
1–9	61.21 $\pm$ 1.0	29.75 $\pm$ 2.1	5.51 $\pm$ 0.5	0.75 $\pm$ 0.5	2.07 $\pm$ 1.5	0.00 $\pm$ 0.0	0.00 $\pm$ 0.0
10–19	57.97 $\pm$ 0.9	13.30 $\pm$ 2.0	6.75 $\pm$ 0.8	18.78 $\pm$ 3.6	3.20 $\pm$ 1.0	0.00 $\pm$ 0.0	0.00 $\pm$ 0.0
20–29	74.83 $\pm$ 0.8	9.73 $\pm$ 1.3	7.74 $\pm$ 0.6	4.92 $\pm$ .0	2.78 $\pm$ 0.7	0.00 $\pm$ 0.0	0.01 $\pm$ 0.0
30–39	74.31 $\pm$ 1.0	8.82 $\pm$ 1.2	12.45 $\pm$ 0.8	2.64 $\pm$ 0.6	1.33 $\pm$ 0.4	0.07 $\pm$ 0.0	0.39 $\pm$ 0.2
40–49	71.75 $\pm$ 0.8	6.06 $\pm$ 0.5	18.03 $\pm$ 0.9	1.90 $\pm$ 0.6	1.56 $\pm$ 0.8	0.00 $\pm$ 0.0	0.70 $\pm$ 0.1
50–59	74.03 $\pm$ 1.0	8.74 $\pm$ 1.2	12.03 $\pm$ 0.9	4.36 $\pm$ 2.3	0.33 $\pm$ 0.2	0.00 $\pm$ 0.0	0.51 $\pm$ 0.3
60–69	80.20 $\pm$ 1.8	6.36 $\pm$ 1.5	8.54 $\pm$ 1.1	2.42 $\pm$ 1.3	2.24 $\pm$ 0.6	0.13 $\pm$ 0.1	0.11 $\pm$ 0.1
70–75	73.22 $\pm$ 1.0	17.81 $\pm$ 4.6	6.71 $\pm$ 0.6	1.34 $\pm$ 1.0	0.65 $\pm$ 0.3	0.21 $\pm$ 0.2	0.06 $\pm$ 0.1

Neutral labels were labels not known referentially; object labels were labels known referentially and referring to an object item; food labels were labels known referentially and referring to a food item. Each occurrence of labels known referentially (object labels, food labels, or “rouleau”) can be considered as false alarms.

## 3.2. Experiment 2: controlled evaluation of learning method of French labels

### 3.2.1. Model/Rival

Shango<sup>F</sup> started to try to pronounce the label “agrum” (meaning “citrus fruit”) during a recording phase after the 31st session but only with an approximate pronunciation of the correct sound. This label was only validated by the four experimenters after the 75th session. Shango<sup>F</sup> started to emit the label “pignon” (meaning “pine nut”) after the 50th session but it was not validated by the four experimenters during the 100 recording sessions. Zoé did not emit even approximations of any of the labels of the items presented (Table 3).

### 3.2.2. Intuitive

Shango<sup>F</sup> started to emit the label “soldat” (“toy soldier”) after the 36th session but it was not validated by the four experimenters. Zoé never produced vocalizations resembling the labels of any of the items presented.

### 3.2.3. Repetition/Association

Shango<sup>F</sup> started to pronounce the label “rouleau” (“cardboard roll”) during a recording following the 7th session. This label was recognized and validated by the four experimenters following the 12th session. These first pronunciations of the label “rouleau” were false alarms as they were emitted in absence of the actual corresponding item (Table 4). Thirty-two training sessions and 12 testing sessions were necessary for Shango<sup>F</sup> to associate the label “rouleau” with the corresponding object. During the first ten training sessions, Shango mainly used the label “stylo” when we showed him a roll of paper (confusion errors). When he succeed at the test,

labelling the roll of paper correctly at least four times out of five trials on three consecutive tests, he also correctly used other labels to other items: “stylo” for a pencil (he produced at least three correct responses out of five trials on three consecutive tests) and “cacahuète” for a peanut (he made at least four correct responses out of five trials on three consecutive tests). Shango<sup>F</sup> started to pronounce the label “semoule” (“cornmeal”) during a recording conducted after the 9th session (Table 4). This label was recognized and validated by the four experimenters after the 22nd session. Shango<sup>F</sup> did not associate this label with the corresponding item: he more frequently used food labels (referring to a food item, e.g. “cacahuète”) that he already knew (confusion errors). Shango<sup>F</sup> started to emit the label “yaourt” (“yogurt”) after the 20th session (Table 4). This label was recognized and validated by the four experimenters after the 24th session. He did not associate the label “yaourt” with the corresponding item: as for “rouleau” during the early association phase, he mainly used object labels (referring to an object item) that he already knew (confusion errors). Shango<sup>F</sup> started to emit the label “maïs” (“sweetcorn”) after the 36th session but it was not recognized by the four experimenters. Shango<sup>F</sup> started to emit the label “biscuit” (“cookie”) after the 40th session but it was not recognized by the four experimenters. Zoé never produced a vocalization, which approximated the sound of the correct label for the items presented.

#### 3.2.4. Diffusion

None of the parrots learned any of the labels that were played back to them daily with variable or flat intonations.

## 4. Discussion

In this study, we investigated the abilities of ten African grey parrots to learn the referential use of French and Czech labels. Overall, our parrots had difficulties with this task. Léo, Yemaya, Asabi and Titilayo never learned any labels referentially. Both the French and Czech Shangos were the best learners. Zoé learned some labels referentially prior to the more controlled experimental study. Markéta also seemed to be a relatively good learner, but stopped producing words approximately 2 years after the beginning of training. Tokunbo and perhaps Jarina also learned a couple of labels referentially during many years of training. It also seems that the Repetition/Association method was the most efficient for our birds, at least to learn to imitate French labels.

Based on the considerable success reported by Pepperberg, we expected that the Model/Rival method would be the most effective means of training. Indeed, Pepperberg conducted several studies to compare various methods and the Model/Rival method was the only one with which parrots referentially learned labels (Pepperberg, 1994; Pepperberg and McLaughlin, 1996; Pepperberg et al., 1998, 1999, 2000; Pepperberg and Wilkes, 2004). Pepperberg also reported that parrots learned some labels with other methods (such as playbacks) but not their referential use. Several hypotheses can explain this discrepancy between Pepperberg’s and our studies. In experiment 2, we trained our birds with several labels and several methods for only 5 min per label and per day. Overall, each bird heard each label a maximum of 6000 times. Pepperberg trained her birds by conducting longer sessions (30–45 min) with only one label during a period of several months (Pepperberg et al., 1998). After 26 months of training, Alex knew nine different labels that he pronounced appropriately (i.e. in front of the correct item) in 78% of cases (presented during 200 tests; Pepperberg, 1999). Two other grey parrots (Alo and Kyaaro) learned new labels after a few months of training (from one to eight months; Pepperberg and McLaughlin, 1996; Pepperberg et al., 1998). However, our pre-experiment lasted over 2 years, with sessions comparable in duration to Pepperberg’s

sessions and the birds never produced the labels taught during training sessions. In experiment 1, four hand-reared parrots with the greatest amount of training (Shango<sup>C</sup>, Tokunbo, Asabi and Titilayo) were trained for 5 years. However, because of periods without training (e.g. summer vacation), daily training totals were an average of only 25 min. Another point to consider is the age of our parrots. Five birds from Laboratory 2 started training at the age of 1 year and the other two were also subadults. Léo and Zoé from Laboratory 1 were 4.5 years and Shango<sup>F</sup> 2.5 years at the beginning of experiment 2, which is also relatively young. However, Pepperberg successfully trained younger parrots, less than one year old, to referentially use labels with the Model/Rival method (Pepperberg, 1994). An age effect could explain the fact that Zoé was able to referentially learn some labels during the first experiment, when she was less than 3 years old, and not in the third experiment, when she was about 4 years old. Actually Zoé did not imitate any new labels (even without referential use) from six months before the beginning of experiment 2 and, during the same period she started to show typical nest preparation behaviours (scratching the floor, pulling out and tiring off paper and cardboard, etc.). Zoé was reaching her sexual maturity and it may be that age and sexual maturity influenced her learning ability or motivation. Similarly, Markéta stopped producing almost any words after 2 years of training, maybe for the same reason. An alternative explanation here is that this parrot was strongly imprinted to a few caretakers and trainers and after they had left the laboratory, she was no longer motivated to imitate human speech.

Another issue to take into account to explain such divergent results with the Model/Rival methods is the housing conditions of the subjects. The birds from the French laboratory shared the same aviary whereas Pepperberg’s birds were housed alone. Parrots from the Czech laboratory who never pronounced any taught labels (Asabi and Titilayo) were housed together in a larger cage. Other birds from this laboratory were housed in separate cages, however in one room where they were frequently allowed to move around freely. These housing conditions may have various influences on parrots’ behaviour. Pepperberg’s parrots may have a much stronger bond to their main caretaker (i.e. Pepperberg, 1999) than ours do with their caretakers. This bond could mean that Pepperberg’s parrots are more attentive and motivated during training sessions. Another consequence of these housing conditions is that, in our case, group relationships could occur among our parrots (there is a clear hierarchy between them). Our birds imitate each other and produce duets. For example, Shango<sup>F</sup> learned to imitate labels produced by Zoé and she used the label “cacahuète” appropriately after observing Shango<sup>F</sup> receiving a peanut after having produced the label “cacahuète”. Moreover, the parrot from the wild (Jarina) mostly imitated words already clearly pronounced by another parrot from Laboratory 2, Markéta. The same occurred between Tokunbo and Shango<sup>C</sup>. Thus, it seems that our parrots imitated each other more frequently than they imitated humans. However, in those phases, parrots do not show a greater ability to learn labels in bird human Model/Rival sessions.

Failure to learn some Czech labels could be possibly also explained by pronunciation difficulties. Shango<sup>C</sup> never pronounced clearly the end syllables in “papír” (pronounced as “paper”) and “kolík” (“kolek”) although he was able to say the first syllables. Neither he nor Tokunbo have produced any words with “i” or “í” (as in the words “sit” or “seed”). However, Markéta often clearly pronounced the label “mičuda” (pronounced as “mitchuda”).

Clipping the wing feathers could also have an influence. Pepperberg’s birds had their feathers trimmed, preventing them from moving freely. Again this is not the case of our birds. Thus, during training sessions, when one of our subjects was not motivated enough, he could just fly away and land on any perch in the aviary/training room. Although a bird could stop working without

flying away, being dependant on humans to move may influence the parrot's behaviour during training sessions, and probably increase the attention of the subject. During the pre- and first experiments, although the approximations of the labels were rewarded by receiving the corresponding item, we were regularly confronted with motivational problems, mainly when the item did not interest the bird anymore. Thus, we adapted the duration of the training sessions in the experiment 2 in order to work in a shorter time-frame during which parrots were more attentive. However, parrots may have difficulties to concentrate on all the elements they have to take into account during sessions. Indeed, during Model/Rival sessions, the subject has to be attentive to what both the Teacher and the Model say, to the fact that it also has to say something specific to obtain the reward and of course to the item itself. During the sessions, parrots in the French laboratory mainly produced particular vocalizations, identified as "asking calls" in a previous experiment (Giret et al., submitted for publication) and which are emitted in relation to something that parrots want (either food or non-food items), and they also produced referential labels that they had already learned (but inaccurately as the labels corresponded to other objects; e.g. "cacahuète"; Giret et al., 2009). Moreover, toward the end of the experiment, Shango<sup>F</sup> emitted no vocalizations during training, neither labels he learned before nor other vocalizations. This aspect could be related to discouragement because he rarely obtained the items. Shango<sup>F</sup> also became very skilful at snatching the item the experimenters were showing to him. Thus, it seems that Shango<sup>F</sup> was not attentive to what was said by the Teacher and/or the Model because he first focused on the object and then possibly became discouraged. It is interesting to note that Shango<sup>F</sup> learned only one label with this method ("agrumes" referring to a plastic lemon). He quickly lost interest in this object: he did not take it, even if the experimenters gave it to him. Thus, the training sessions resembled the first experiment of the Repetition/Association method: his attention was not distracted by the object and was focused on what was said by the experimenters. Similarly, Titilayo and Asabi were more attentive to trained objects than Shango<sup>C</sup> and Tokunbo in the first sessions. They often tried to pick objects by themselves from the training bucket or flew away when they did not receive it.

This lack of attention could also explain the difficulties with referentially learning labels with the Intuitive method from experiment 2. This method implies that the subject has to be attentive to the object and to what was said by the experimenter. It is interesting to note that Shango<sup>F</sup> was able to learn the label "scotch" and several fruit and vegetable labels ("carotte", "pomme") with this method (in the pre-experiment, without controlled evaluation). Furthermore, it appears that Shango<sup>F</sup> pronounced these labels in very specific contexts. Every other day, we changed the paper covering the aviary floor attaching it with adhesive tape. We repeated the label "scotch" when we cut adhesive tape. Shango<sup>F</sup> produced the label "scotch" for adhesive tape mainly at this time. Similarly, he produced the labels of specific fruits and vegetables when we distributed any fruits and vegetables. Thus, Shango<sup>F</sup> required the whole context to produce the different labels learned with the Intuitive method. This seems to be contextual conditioning rather than actual learning of object-labelling. Shango<sup>S</sup>' inability to learn labels in the third experiment could be due to the fact that the contexts during sessions were not salient enough or not clearly differentiated from each other. Therefore, this method could be more efficient when used during informal daily interactions with parrots, making it difficult to evaluate systematically.

On the other hand, Shango<sup>C</sup> learned one of his four referentially used words ("t'uká") only by the Intuitive method, and learning of another label "tužka", which he was trained in Model/Rival sessions, was also supported by intuitive teaching by caretakers. Additionally, he learned the label "brčko" during the last

Model/Rival training phase when training included many aspects of the intuitive approach.

The Repetition/Association method was the most efficient teaching method of referential labels. During the Repetition phase of this method, the experimenter repeated a label, with no items being shown to the subject. Thus, the bird's attention was not disrupted by external agents, as it is the case in the other methods. This method is also probably closer to the way wild parrots learn new vocalizations. In the wild, parrots imitate vocalizations of other species and surrounding sounds, probably through observing interactions among and between birds of other species (Cruickshank et al., 1993). It was also reported that parrots mainly imitate when they can interact with the emitter (Pepperberg, 1994; Pepperberg and Mclaughlin, 1996; Pepperberg et al., 1998). During the Repetition phase, the subject saw a human experimenter repeating a label several times, while looking at the subject, walking in the aviary and/or not moving in the aviary. Each time, the subject's attention was focused on the experimenter behaviour. So, even if the subject did not interact with the experimenter producing the label, the label production was a relevant and salient stimulus during this phase. Moreover, in the laboratory context, we recognized the importance of a salient context. For example, Shango<sup>F</sup> learned to imitate the "beep" of the stopwatch followed by "Shango, t'es prêt?" (meaning "Shango, are you ready?") which was said to him at the start of the sessions, after starting the stopwatch. During the Association phase, in order to associate the label with the corresponding item, we gave the item to the subject each time he pronounced this label by entering the aviary while he was vocalizing. Shango<sup>F</sup> committed a lot of false alarms in which the label was emitted in the absence of its appropriate referent. During babbling, parrots produce a lot of sounds, either imitation of human labels or of surrounding sounds. Thus, these false alarms can be related to the practice required to pronounce a label correctly. Once Shango<sup>F</sup> associated the label "rouleau" with a paper roll (session 34), this rate of false alarms dropped. This association between the label "rouleau" and a paper roll and not between the label "semoule" and cornmeal could be surprising *a priori*. However, Shango<sup>F</sup> was not motivated by the cornmeal whereas he was strongly motivated by the paper roll. Thus, the efficiency of this method is limited by the motivation to obtain each item. This remark is also pertinent to the other methods, even more so for Model/Rival and Intuitive methods which require more sessions with each item. Indeed, after several training sessions, the subject frequently lost interest in the item because of its lack of novelty.

In summary, Model/Rival and Intuitive methods should facilitate acquisition of conditional vocal/visual discriminations in parrots (which could lead to referential labelling) more than the Repetition/Association method, since the first step of this latter method involves only training the bird to repeat a label, without associating it with any object. However, vocal imitation is a prerequisite to demonstrate such conditional discrimination, as the bird needs to be able to emit the label taught in order to show an ability to associate it with an object. Therefore, as the Repetition/Association method seems more efficient to stimulate vocal imitation (because as said above, it is probably closer to the way wild parrots learn vocalizations), this latter method could finally be more efficient to show acquisition of conditional vocal/visual discriminations and referential labelling in parrots.

The fact that none of the parrots learned any labels that were played back daily to the birds for eight months is consistent with previous experiments by Pepperberg (e.g. Pepperberg and Mclaughlin, 1996). The authors demonstrated that two grey parrots learned some labels using this approach but not their referential use. The authors explained this failure by the lack of joint attention of social interactions during sessions (Pepperberg and Mclaughlin, 1996). Our results are also consistent with experiments on song



acquisition by songbirds, in which the importance of a live tutor has been demonstrated (for a review see [Beecher and Burt, 2004](#)). It could be interesting to reproduce a teaching experiment with labels pronounced either with variable or flat intonations but with an interaction between the experimenter and the subject.

This study reveals that, contrary to results obtained by Pepperberg, the Model/Rival method is not the only efficient method to teach referential labels to African grey parrots. Our experiment does not question the efficiency of the Model/Rival method, mainly considering the differences between Pepperberg's conditions and ours (i.e. free-flying birds housed together). Our study rather shows that interindividual variability and rearing conditions are predominant factors to consider when evaluating the efficiency of teaching methods.

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