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Artigo Científico

Successive identity matching to sample tests without reinforcement in *Cebus apella*

Testes sucessivos de pareamento ao modelo por identidade sem reforçamento em Cebus apella

Ana Leda de Faria Brino, Olavo de Faria Galvão, Romariz da Silva Barros

Universidade Federal do Pará (UFPA), Belém, Pará, Brasil

Resumo

Na pesquisa sobre controle de estímulos emergente (e.g., identidade generalizada e formação de classes de equivalência) com o procedimento de pareamento ao modelo, é comum utilizar protocolos de testes de repertório emergente na ausência de reforçamento. O uso desse tipo de protocolo de teste, contudo, pode ser difícil com sujeitos não humanos: ele pode produzir resultados negativos em função da extinção discriminada do desempenho que está sendo testado. O objetivo deste estudo foi criar condições para testar desempenhos emergentes na ausência de reforçamento com um macaco-prego como sujeito que apresentava altos índices de desempenho em testes de pareamento ao modelo por identidade, aplicados com reforçamento. Foi usado um procedimento de pareamento ao modelo com atraso zero. Testes sucessivos de identidade foram arranjados de forma que as tentativas de teste eram inseridas entre tentativas de linha de base. Sessões de teste com reforçamento eram alternadas a sessões de teste sem reforçamento e a sessões de retomada de linha de base com reforçamento intermitente. Estas condições foram suficientes para manter o desempenho bem acima do acaso na grande maioria dos testes (20 sessões de um total de 21). O macaco-prego mostrou capacidade de desempenhar IDMTS com sucesso, inclusive com estímulos completamente novos, em sessões com ou sem reforçamento. Estudos futuros podem usar o mesmo delineamento para testar desempenho emergente em tarefas de pareamento ao modelo arbitrário com sujeitos não humanos. © Cien. Cogn. 2009; Vol. 14 (2): 002-011.

Palavras-chave: pareamento ao modelo por identidade; testes sem reforçamento; *Cebus apella*.

Abstract

In the research on emergent stimulus control (e.g., generalized identity matching and equivalence class formation) with matching to sample procedure, it is common using test protocols for emergent repertoires in the absence of reinforcement. There are, however, problems in the use of this type of test protocol with non-human subjects: negative results can be attributed to discriminated extinction of performance during tests. The objective of the present study was to create conditions to carry out tests in the absence of reinforcement with a capuchin monkey with history of highly accurate identity matching under continuous reinforcement (CRF) conditions. A 0-delay matching to sample procedure was used. Successive identity matching test sessions were arranged in a way that test trials were intermixed in baseline trials. Sessions with test trials in CRF were alternated with sessions with test trials with no reinforcement and with baseline sessions under intermittent *reinforcement. Alternating test and baseline sessions with different reinforcement probabilities was sufficient to maintain performance well above chance in almost all testing sessions (20 out of 21). The capuchin monkey successfully showed highly accurate identity matching with completely new stimuli, in sessions with or without reinforcement. Future studies can use the same design to test emergent performances in arbitrary matching-to-sample with non-humans subjects. © Cien. Cogn. 2009; Vol. 14 (2):002-011.*

Keywords*: identity matching-to-sample; tests without reinforcement; Cebus apella.*

1. Introduction

In tests of indirectly trained relations with matching to sample procedure (*e.g.*, generalized identity matching and equivalence class formation), to make sure that the performance is not learned during test trials, tests in the absence of reinforcement are usually adopted. However, the use of tests without reinforcement with non-human subjects often causes the deterioration of the performance to be tested (Galvão *et al.*, 1992; Sidman, 1994). Part of the negative results reported in the literature on emergent stimulus control with non-human subjects may be due to procedural issues related to the test protocols instead of a lack of performance (Barros *et al.*, 2003).

Trying to overcome this problem, some researchers used continuous reinforcement in all test trials arranged in a way that the results could still suggest emergence of new performance. Schusterman and Kastak (1993) and Kastak and Schusterman (1994), for example, analyzed the subjects performances on the very first presentation of each one of multiple new relations to evaluate emergent performance in arbitrary and identity matching tests, respectively. Because the first choice response to a new relation occurred before the first reinforcement, it could not be explained by direct reinforcement, that is, it could not be considered as a result of training. One consequence of this procedure is that having only the first trial of each tested relation as a reliable occasion to evaluate the emergent performance, many exemplars of the task (*e.g.*, identity matching) have to be presented to obtain a convincing number of emergent relations to report.

Oden and collaborators (1988) presented non-differential reinforcement in test sessions with both consistent and inconsistent responses being followed by reinforcement (praise and food). In this case, a higher number of consistent trials could not be attributed to training since the same schedule of reinforcement was available for inconsistent performances.

Barros and collaborators (2002) and Galvão and collaborators (2005) carried out successive tests of generalized identity matching to sample (IDMTS) with capuchin monkeys. This procedure produced selective disruption of the performance on the test trials as the successive tests were presented (i. e., discriminated extinction of the performance on test trials presented without reinforcement intermixed in baseline [BL] trials with continuous reinforcement). Some of the initial tests were presented in sessions composed by BL trials with reinforcement probability of 1.0, and test trials with no programmed reinforcement. After some exposure to this kind of session, the animals discriminated that there was no reinforcement scheduled for trials presenting novel stimuli. The accuracy of the performance dropped to chance level selectively when new stimuli were presented (see also Rocha, 2002). As reported by Galvão and collaborators (2005), about the use of tests in extinction:

"… when we endeavored to conduct several tests for generalized IDMTS in extinction with a 0% reinforcement schedule on test trials, we noticed that test trial accuracy was selectively disrupted." (p. 225)

To solve this problem, two other procedures for test sessions were used with other subjects by Galvão and collaborators (2005). One of the procedures consisted on scheduling reinforcers for a proportion of correct choices on both BL and test trials (see also Kuno *et al.*, 1994). The other procedure consisted of scheduling reinforcers to all the correct choices on both BL and test trials. The second alternative, however, implies the same problem above described with respect to the difficulty to judge if the tested performance was, in fact, emergent (Galvão *et al.*, 2005).

Although some researchers consider the results of tests with reinforcement with non-human subjects or human participants with learning disabilities reliable (Barros *et al.*, 2002; Dugdale and Lowe, 2000; Kelly *et al.*, 1998), an efficient test protocol to preclude discriminated extinction in sessions compounded by trials without programmed reinforcement could provide more reliable results.

The objective of this experiment was to develop a test protocol to be used in studies with many successive IDMTS tests without reinforcement, with a capuchin monkey. The intended test protocol should be efficient enough to maintain high levels of accuracy on both BL and test trials.

For that end, the sequence of conditions was planned in a way to preclude discrimination between trials with and without scheduled reinforcement. Each stimulus set was presented in two different types of testing sessions: with and without scheduled reinforcement (in unpredictably alternated sessions).

2. Method

Participant

A 3-year-old male capuchin monkey (*Cebus apella*) participated. He was previously given some training on repeated shifts of simultaneous simple discrimination (RSSD) and identity conditional discrimination and showed positive results in tests for generalized IDMTS with continuous reinforcement (Galvão *et al*., 2005). In a trial of RSSD task, three stimuli were presented simultaneously in the screen of the computer and the monkey had to choose one of them. The stimulus correlated with reinforcement was changed in successive sessions. RSSD sessions are usually applied to avoid novelty effect in generalized IDMTS tests (Kastak and Schusterman, 1994) and changing continuously the function of stimuli presented to the subject, an intrinsic characteristic of matching procedure, may reduce persistence of stimulus control (Dube and McIlvane, 2001). In the general procedure there is a detailed description of an identity conditional discrimination trial.

Apparatus

An experimental chamber measuring 0.80 x 0.80 x 0.70m was used. The floor, ceiling, and left wall of the chamber were made of steel screen with circular holes. A hinged door (0.35 x 0.20m), located in the left wall, permitted the participant access to the chamber. On the front wall, there was a window (0.26 x 0.26 m) through which the subject could reach a computer video monitor equipped with a touch-sensitive screen. All the stimulus presentation and response recording was controlled by a microcomputer AMD K6 150 connected to the

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experimental chamber, using an application named TREL V. 2.1, developed by José Iran Ataíde dos Santos. An automatic pellet dispenser released a 190mg banana pellet contingent to each correct choice when reinforcement was scheduled for that trial.

Housing conditions, manipulation, food, and medical cares, as well as experimental procedures, were in accordance to local and international rules for the treatment and manipulation of experimental animals.

Stimuli

Stimuli were black pictures on a gray square background (2.43 x 2.43cm). Figure 1 presents all stimulus sets. Set A was used as BL. The other eight stimulus sets were used in test sessions. Five of them (Sets B, C, D, E, and F) had already been used in repeated shifts of simultaneous simple discrimination procedure and tests of identity matching to sample with continuous reinforcement (Galvão *et al.*, 2005) with this participant. Three of them were novel (Sets G, H, and I).

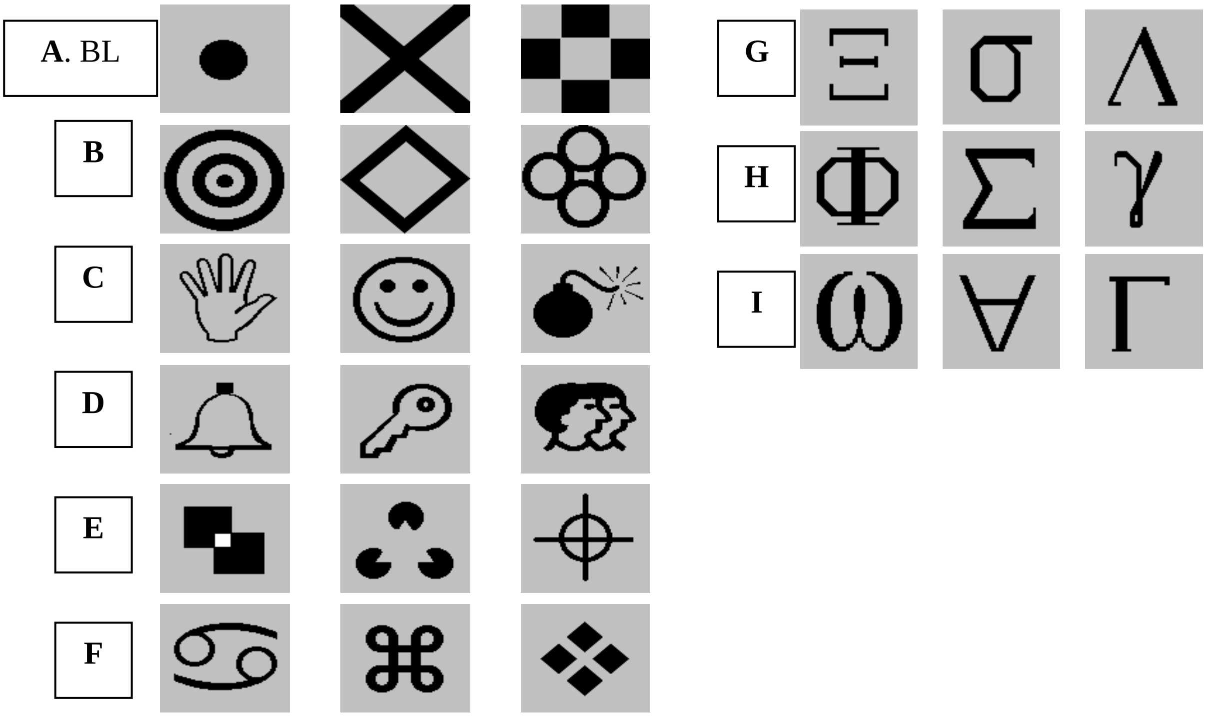

Figure 1 - Stimulus sets. Set A used for BL: A1, A2, and A3; Set B: B1, B2, and B3; Set C: C1, C2, and C3; Set D: D1, D2, and D3; Set E: E1, E2, and E3; Set F: F1, F2, and F3; Set G: G1, G2, and G3; Set H: H1, H2, and H3; Set I: I1, I2, and I3.

General procedure

BL and testing sessions both consisted of 54 conditional discrimination trials presented in a 3-choice 0-delay identity matching to sample procedure (IDMTS). A session of BL was always followed by a test session and vice-versa. An IDMTS trial was initiated with the presentation of a sample stimulus in the screen of the computer. A touch in the stimulus produced its disappearance and immediate presentation of three comparison stimuli. Both sample and comparisons were presented in anyone of nine locations in a 3X3 matrix on the computer screen. Choosing the comparison stimulus identical to the sample in a trial with

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programmed reinforcement was followed by the characteristic noise of the pellet dispenser, a banana pellet, and a 6-second inter-trial interval (ITI). Choosing a comparison stimulus different from the sample did not produce either sound or food pellet, but only initiated the ITI. Two sessions a day, four to five days a week, were carried out.

Baseline

Sessions were composed only by trials with stimuli from Set A (see Figure 1), under intermittent reinforcement schedule (Reinforcement probability = 0.75). Before successive tests were initiated, BL sessions were carried out until participant's performance reached 90% of correct responses in three consecutive sessions. A BL session was also always applied after each testing session.

Test

Testing sessions were comprised of 54 trials, 75% from BL (Set A) and 25% from the scheduled testing set (one of the eight test sets – B to I – presented in Figure 1).

Two types of testing sessions, "True" and "False", were applied with each testing set. The order of presentation of the two types varied to each set in a way that, during the successive sessions with all sets, the sequence of "True" and "False" tests was unpredictable to the subject.

In "True" test sessions, reinforcement was programmed for all BL trials (75% from the total of trials) and there was no programmed reinforcement for test trials (25% from the total of trials). In "False" test sessions, all correct choices in test trials were followed by reinforcement and, in order to maintain total session reinforcement probability at 0.75, there was reinforcement programmed for only 66% of BL trials.

After the application of the first group of tests with 8 stimulus sets, the new stimulus sets (G, H, I) were again used on "False" and/or "True" tests after repeated shifts of simultaneous simple discrimination training (see participant to a description of this procedure) with each set.

3. Results

Performances in successive tests were analyzed in terms of percentage of correct responses in each one of the 21 test sessions applied with Sets B to I (see Figure 2). A paired t-test compared the subject's performances in the first test session with each one of the stimulus sets in both "True" and "False" conditions (16 total); performances in the 8 "True" sessions and in the 8 "False" sessions (first application) were submitted to an analysis of variance (standard deviation). Additionally, Tables 1 and 2 show the sequence of correct/incorrect test trials in each type of session with each stimulus set. Tables 1 and 2 show the real sequence of testing sessions applied.

In general, percentage of correct responses in test trials in both types of test, "False" and "True", was always above chance (33.3%) in 21 sessions. The participant showed better performances in "False" tests with Sets E, F, and I and better performance in "True" tests with Sets B, C, G, and H. For Set D, percentage of correct responses was the same in both types of test.

The participant was exposed to two sessions of "False" tests with Set H (a completely new set). It occurred because he showed 100% of correct responses in the first test session ("True" type) with this set, followed by a drop in performance accuracy (78%) in the second test session ("False" type) (see Figure 2). The repetition of the "False" test had the purpose of evaluating the effect the type of the antecedent test session had over the performance that is: if the application of a "True" test with a set produced discriminated extinction of trials from the same set in a subsequent test session. Discriminated extinction means that the subject chooses in an aleatory way in trials with new stimuli, because of his history of lower probability of reinforcement. Results in the second "False" test carried out with Set H show that this assumption was not confirmed.

The lower performance accuracy was found with Set G – the first completely new stimulus set tested. The participant made correct choices in only 53.8% of test trials followed by reinforcement ("False"). Performance was better (76.9%) in the next test session carried out with no reinforcement.

A t-test demonstrated that there was no expressive difference in average performance between eight test sessions, applied in both conditions, "False" and "True" [t (7) = 0.8632, p = 0,4, not significantly different]. According to variability analysis related to media in each type of test, the standard deviation pointed that 75% of the values were inside 1 deviation to "True" tests, and 62.5% to "False" tests.

Performance in BL trials that compounded testing sessions was almost always above 96% correct. Performance in BL sessions that were alternated with testing sessions was always above 95% of correct responses.

Results presented in Tables 1 and 2 support the conclusion that there was no difference in performance accuracy between the two types of test.

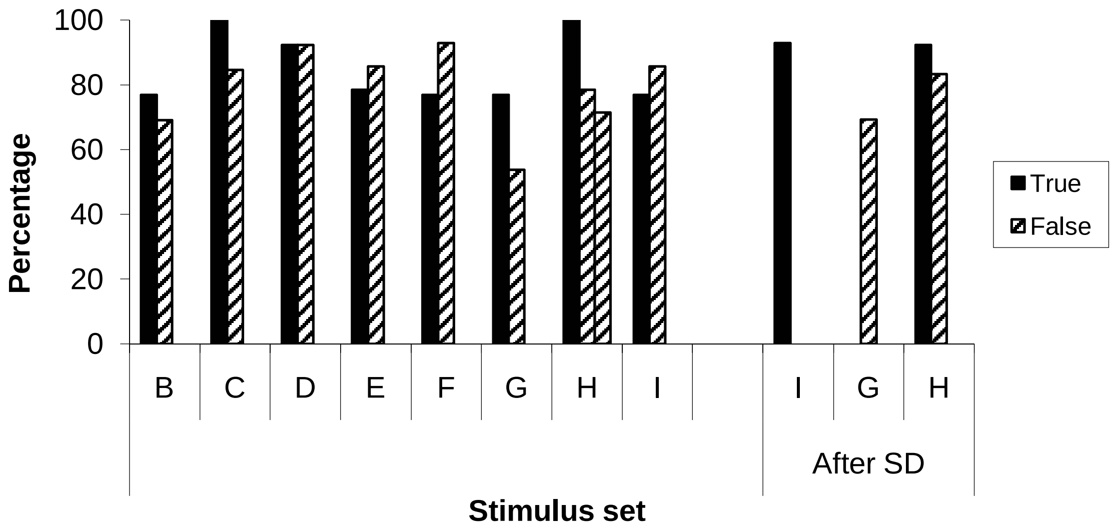

Figure 2 - Percentage of correct responses in test trials of "True" and "False" test sessions applied to each stimulus set. Tests were repeated to Sets G, H and I, after exposure to simple discrimination (SD) training with each set.

4. Discussion

Alternation of "True" tests (without reinforcement) and "False" tests (with reinforcement), interspersed with intermittent reinforcement (0.75) in BL sessions made possible to observe high levels of performance in successive tests without reinforcement, including trials with completely new stimulus sets (generalized IDMTS), such as Set H, for example.

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Type of test	Set	Stimuli	Correct (C) and Incorrect (X) choices
True	B	B1	CCCCC
		B2	XCXC
		B3	CXCC
False	B	B1	XCCCX
		B2	CXCC
		B3	XCCC
False	C	C1	CCCC
		C2	XCXCC
		C3	CCCC
True	C	C1	CCCC
		C2	CCCC
		C3	CCCCC
False	D	D1	CCCCC
		D2	CCXC
		D3	CCCC
True	D	D1	CCXC
		D2	CCCCC
		D3	CCCC
True	E	E1	XCCCC
		E2	XCCXC
		E3	CCCC
False	E	E1	CCCCC
		E2	CXC
		E3	CCCCXC
True	F	F1	CCCXX
		F2	CCXC
		F3	CCCC
False	F	F1	CCCC
		F2	CCCCC
		F3	CXCCC

Table 1 - Correct and incorrect choices to each relation in "True" and "False" tests applied with sets B to F (stimuli already used in pre-experimental history).

Three points are important to our discussion: 1) As indicated by *t* test, equal levels of performance accuracy were observed in test trials of both types, regardless of whether reinforcement was scheduled ("False" tests) or not ("True" tests); 2) Performances in testing sessions were always above chance level (33.3%) and, 3) Performance accuracy in BL trials (Set A) was almost always above 95% correct, while performance in test trials (Set B to I) varied between 54% to 100% (See Figure 2).

Performance accuracy in "False" and "True" tests was the same, showing that the arrangement of procedure was efficient to refrain the extinction effect on performance deterioration (Galvão *et al.*, 1992), even when completely new stimuli were presented. Although test performances were above chance in all sessions, we also saw that performances in BL trials (set A) were higher (above 95%) than performances in test trials (sets B, E and G), even when test sets were already known by the participant (set B and E). The difference in the performance accuracy between BL and test trials may be attributed to prolonged experience with BL trials.

	Type of test	Sets	Stimuli	Correct (C) and Incorrect (X) choices
Before SD	False	G	G1 G2 G3	XXCC CCXC CXCXX
	True	G	G1 G2 G3	XCCCC XCXC CCCC
	True	H	H1 H2 H3	CCCCC CCCC CCCC
	False	H	H1 H2 H3	CCCCC CCCCC XXXC
	False	H	H1 H2 H3	CCCXC CCCCC XXCX
	False	I	I1 I2 I3	CCCCC CCCCC XCCX
	True	I	I1 I2 I3	CCXX XCCC CCCCC
After SD	True	I	I1 I2 I3	CCCCC CCCCC CCXC
	False	G	G1 G2 G3	CCXC CXCXC CCXC
	True	H	H1 H2 H3	CCCC CCCCC CCCX
	False	H	H1 H2 H3	CCCX XCCC CCCC

Table 2 - Correct and incorrect choices to each relation in "True" and "False" tests applied with sets G to I (new stimuli), before and after simple discrimination (SD) training.

Five of the test sets (sets B, C, D, E, and F) had already been used in generalized IDMTS tests with reinforcement (Galvão *et al*., 2005) with the participant, but the history of training exposition with each of them was very short when compared with exposition to Set A, designated here as BL set. Data from studies with non-humans has indicated that stimulus novelty (Kastak and Schusterman, 1994) and stimulus generalization (Barros, 1998) can produce low levels of performance in IDMTS tests. Therefore, tests with the three new stimulus sets – G, H, and I – strongly indicated generalized IDMTS.

Related to stimulus novelty hypothesis, high accuracy of performance with sets H (100% of correct responses in the first test session, carried without reinforcement) and I indicated that novelty alone cannot explain the differences between test and BL performance in the other test sets. This idea is further supported by the fact that the participant had already been exposed to sets B and E before this experiment, and performances with these two sets were not as high as with sets H and I.

Stimulus generalization has to be taken in consideration: because it can explain lower levels of performance observed in some of the test sets, this hypothesis deserves further experimental investigation. In this study, we withdraw the stimuli with which the participant maintained low performances after a relatively long time of training exposure. For example, low levels of performance with Set G in two initial tests did not improve in the final test session after exposure to simultaneous simple discrimination training with this set, indicating that novelty was not a problem and that probably generalization between them could be an explanation.

Blank comparison procedure (McIlvane *et al.*, 1987) used in a later research developed with the same participant showed generalization between two stimuli of a set. In that study, with IDMTS (3-choice, 0-delay) training with the same sets used here, substitution of S+ or S- by a blank comparison in successive trials indicated generalization between two stimuli from one set, as detected by systematic incorrect choices of the same negative comparison when the S+ was substituted for the blank comparison. That is, when S+ was absent, the incorrect choice was the same S- in all trials (Brino, 2007).

When failure of performance improvement with a given stimulus set was verified, the substitution for a new set was made to avoid exposing the participant to low reinforcement density in teaching contexts, even without knowing exactly if the similarity among stimuli was the relevant variable. Unfortunately, present behavioral knowledge doesn't allow the experimenter to predict, for the kind of stimulus features used, why a given stimulus set may generate discrimination problems for a given participant. Inter-individual variability indicates that the variables related to discrimination problems have yet to be studied. Solving the discrimination problems –through the elimination of the difficulty of the stimulus sets – and reaching a strong baseline, the conditions here applied seem to be sufficient to produce high levels of identity matching in tests with new stimulus sets without reinforcement.

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🖉 – **A.L. de F. Brino** é Bacharel em Psicologia (Universidade Federal de São Carlos), Mestre em Teoria e Pesquisa do Comportamento (UFPA) e Doutor em Teoria e Pesquisa do Comportamento (UFPA). Atualmente é Professor Adjunto I (UFPA). *E-mail* para correspondência: abrino@gmail.com.