FORCED-CHOICE TRAINING ON ODDITY PROBLEMS IN MACAQUE MONKEYS

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF PSYCHOLOGY

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF ARTS

In the Graduate College

THE UNIVERSITY OF ARIZONA

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STATEMENT BY AUTHOR

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ACKNOWLEDGMENTS

The author expresses his gratitude to the thesis director, Dr. James E. King, for his assistance toward the completion of this research.

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ABSTRACT

Four experimentally naive macaque monkeys served in a two phase oddity learning experiment. In phase I, the Ss received one oddity problem per day for 40 days wherein each problem consisted of 36 forced trials and four free-choice (test) trials. During phase II, in which one oddity problem per day was presented for 20 days, all trials were free-choice. The purposes of phase I were to determine if naive macaque monkeys could derive information about oddity responding from forced-choice experience and to assess the effectiveness of a checking response on the part of the Ss. The purpose of phase II was to obtain data for an error factor analysis. It was concluded that the interproblem learning of phase I was highly significant and that there are large error factor differences between sophisticated and naive monkeys.

INTRODUCTION

The oddity problem involves two identical pairs of objects that are randomly labeled A and B. On any given trial S is simultaneously presented with three objects two of which are identical and one which is different and the odd object is rewarded. The possible combinations of the objects are AAB, ABA, ABB, BBA, BAA, and BAB. These six configurations are randomly presented an equal number of times in each problem. In order to master the problem S must learn to respond to the cue of oddness.

The oddity paradigm was introduced by Robinson in 1933 and since this time oddity learning has been extensively employed in primate research (for a review see French, G. M. in Schrier, Harlow, & Stollnitz, 1965, pp. 193-199). Since it has been found that more errors result from a placement of the odd object in the center position (Moon & Harlow, 1955; Lockhart & Harlow, 1962), a modified two position model is now used in which the odd object never appears in the center position, i.e., configurations ABA and BAB are eliminated. Two additional center-position modifications are the center-forced procedure (Levinson, 1958) and the restricted procedure (Levine & Harlow, 1959). In the center-forced modification, S is forced, on every trial, to choose the non-odd center object after which a screen is lowered so that additional center-object responding is blocked. The restricted procedure also employs screening or blocking of the center object but in this case S is never allowed to respond to the center object. In comparison to the two-position oddity procedure, the restricted method retards learning while the center-forced procedure facilitates learning.

One of the major problems in oddity learning research is that all reported experiments on oddity learning in macaque monkeys have used Ss who have had extensive prior experience with discrimination learning and reversal problems. It has been pointed out that some aspects of this previous learning will transfer positively to oddity while other aspects will transfer negatively (Moon & Harlow, 1955). The use of sophisticated Ss unfortunately renders the effects of various independent variables on oddity learning somewhat equivocal since it is not clear to what extent the variables influenced the transfer from prior learning apart from the oddity learning per se.

The purpose of the present experiment was to determine if naive macaque monkeys could derive information about oddity responding from forced-choice experience and to obtain an error factor analysis of oddity responding in naive Ss. The present experiment used the forced-choice procedure in which there were 36 blocked trials and 4 free-response trials per problem. Moreover, if S made a correct response on the free-response trials, then it was allowed to check the other objects.

METHOD

Subjects

Ss were three female rhesus monkeys (*Macaca mulatta*) and one male bonnet monkey (*Macaca radiata*). Two of the female *Ss* (HH and BYA) were adult feral animals. The other female rhesus (SP) and the bonnet (E) were laboratory raised animals whose ages were 1-1/2 and 2 yr. respectively. All *Ss* were experimentally naive.

Apparatus

The apparatus employed in this experiment was a variation of the Wisconsin General Test Apparatus (see Harlow, 1949; Meyer & Harlow, 1949). The overall dimensions of the testing apparatus were 48 in. long by 27 in. wide, by 32 in. high. The apparatus was built on a table of the same dimensions. The table and testing apparatus were built of wood and painted a uniform grey. A transport cage (24 in. square) was mounted on a small rolling table and it clamped to the back end of the test apparatus. The transport cage was separated from the testing compartment by a 1/4 in. masonite screen (23 in. by 19 in.) and by three plexi-glass screens (3/16 in. by 7-1/2 in. by 12 in.) which were positioned side by side. The end of the transport cage facing the test area was made of 1 in. wire mesh which had three 4 in. by 3 in. openings cut from it. The masonite and plexi-glass screens were attached to pully-cord arrangements which were manually controlled from the front part of the apparatus. The Ss were observed through a one-way vision mirror (9 in. by 5 in.) which was mounted on plywood (1/2 in. by 24 in. by 27 in.) and was attached to the front of the test compartment. Within the test compartment there was a light for illumination of the test tray and a white, movable form-board tray (base, 22 in. by 12 in. by 1-1/2 in.; handle, 3/4 in. diameter by 14 in. long). The tray contained three 2 in. diameter foodwells (1/4 in. deep and 7-1/2 in. apart from center to center).

The stimulus objects were constructed from paired junk items (e.g., toys, bottle caps, paper cups, etc.) and were mounted on 4 in. squares of 1/8 in. masonite which were painted silver-grey. The objects defining each problem varied in color, size (small or large), shape, and depth (mounted on front of base or back of the base).

Procedure

During the initial adaptation, the Ss were placed in the WGTA for 30 minutes per day over a 2 week period and were fed during this time. The Ss then received 40 trials per day for 5 days during which time they displaced a single object from one of the two end foodwells to procure a raisin.

During phase I which lasted 40 days, the Ss received 40 trials per day of which 36 were forced-choice and 4 were free-choice. The forced-choice procedure involved baiting either the extreme right or the extreme left foodwell according to a Gellermann (1933) sequence and covering the appropriate foodwells with the stimulus objects the odd object of which was determined by a second Gellermann sequence. The masonite screen was raised and the form-tray was pushed about half way between S and E for 3 seconds. The tray was then pushed up to the plexi-glass screens, and only the screen in front of the odd object was raised thus forcing S to displace the odd object. On free-choice trials, all 3 plexi-glass screens were raised simultaneously.

In phase II which lasted 20 days, the Ss received 40 free-choice trials per day. Again, only one problem per day was presented. In all other respects, the procedure in phase II was identical to that of phase I. In both phases a new set of objects was used for each day and problem.

Following a correct free-choice trial, Ss were allowed a 5 sec. period during which they could displace one of the incorrect non-odd objects. Such responses will be referred to as checking responses.

RESULTS

The percentage of correct responses on free-choice trials over blocks of 10 problems each are portrayed in Figure 1. A summary of an analysis of variance for the free-choice trials in phase I is presented in Table 1. This table indicated that the increase in percentage of correct responses over problems 1 through 40 was highly significant ($F = 6.817$; $df = 3/12$; $P < .01$). Performance during the last blocks of 10 problems was significantly higher than a chance 50% correct ($P < .01$ for all four Ss as determined by the binomial test).

Two Ss (BYA and E) checked the incorrect objects after making a correct response about 80% of the time while the other two Ss (HH and SP) only checked approximately 10% of the time. Curves for checking and non-checking Ss are presented in Figure 2. With the exception of block 1, the checking Ss made more correct responses than the non-checkers. Because of the limited number of Ss, these results were not statistically tested.

The original analysis of the errors in oddity learning was reported by Moon and Harlow (1955). In their study eight error factors were isolated and defined. Three of these error factors are trial-one errors, where S makes an error on trial 1, object-preference errors, defined as

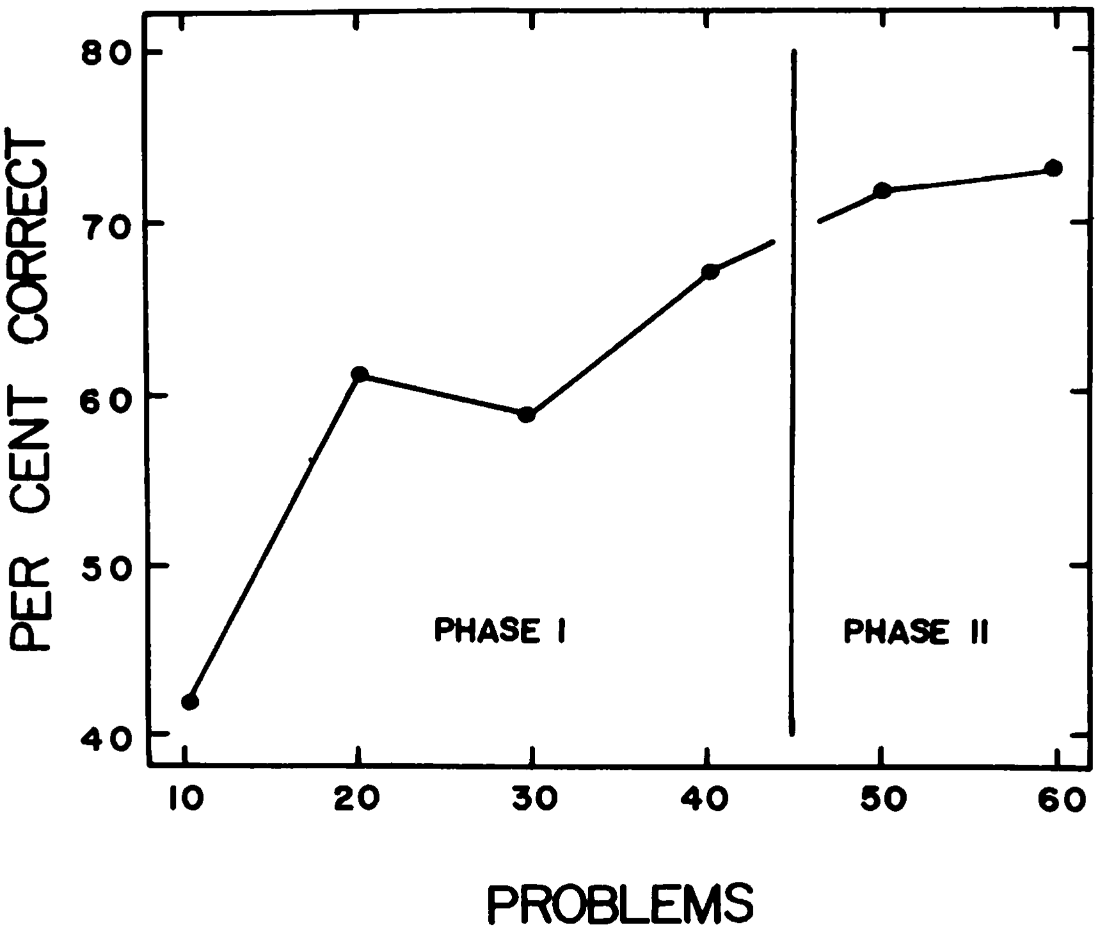

Fig. 1. The percentage of correct responses for phase I and II as a function of problem blocks.

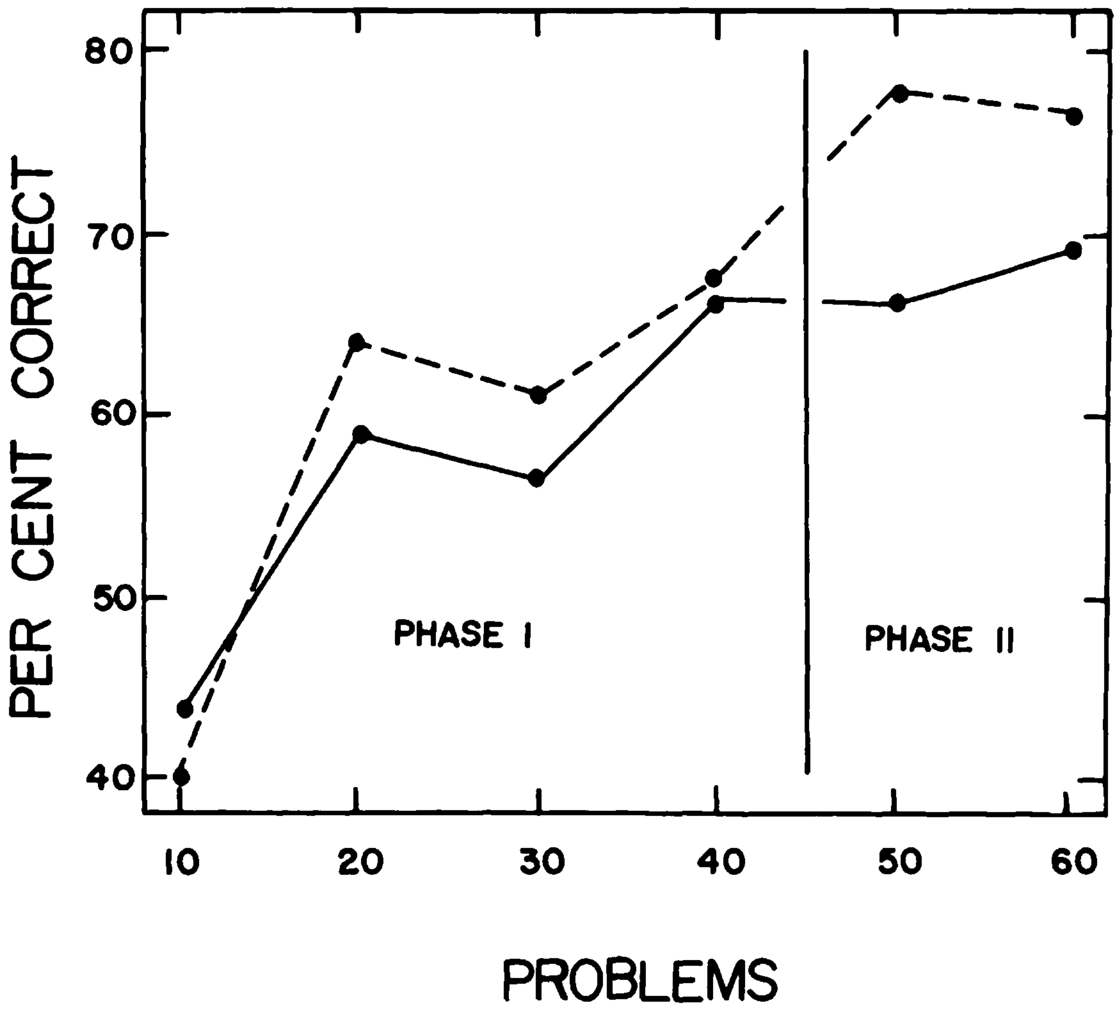

Fig. 2. Percentage of correct responses for Ss (2) who checked (dotted line) and for Ss (2) who did not check (solid line).

Table 1

Summary Table of the Analysis of Variance Computed From the Data of the Present Experiment

Source	SS	df	MS	F
Between blocks	1398.05	3	466.02	6.817
Error	820.31	12	68.36	
Total	2218.36	15		

Note.--With 3 and 12 df, the tabular F value at the .01 level of significance is 5.95.

the frequency of responding above 50 per cent to the preferred object, and position-preference errors, "measured by the number of percentage points individual animals diverged from 50 per cent right." The remaining error factors are clearly illustrated by using the A-B configurations and by underlining the responded to objects. These error factors are: Rewarded-object perseveration errors where S goes from ABB to BAA, rewarded-position perseveration errors where S goes from ABB to BBA, object-shift errors where S goes from ABB to AAB, unrewarded-object perseveration errors where S goes from ABB to BBA, and response-shift errors where S goes from ABB to ABB. The mean percentage frequencies of error factors of the present study were compared to those of the same performance level of the Moon and Harlow study. These results are presented in Figure 3. The error factors of response-shift and position-preference are about the same for both experiments. The Moon and Harlow Ss made over twice as many object-shift and unrewarded-object perseveration errors than did Ss of the present study. On the other hand, Ss of the present study made twice as many rewarded-object perseveration errors, three times as many rewarded-position perseveration errors and about five times as many object-preference errors. The only decreasing error factor in the present experiment was that of object-shift.

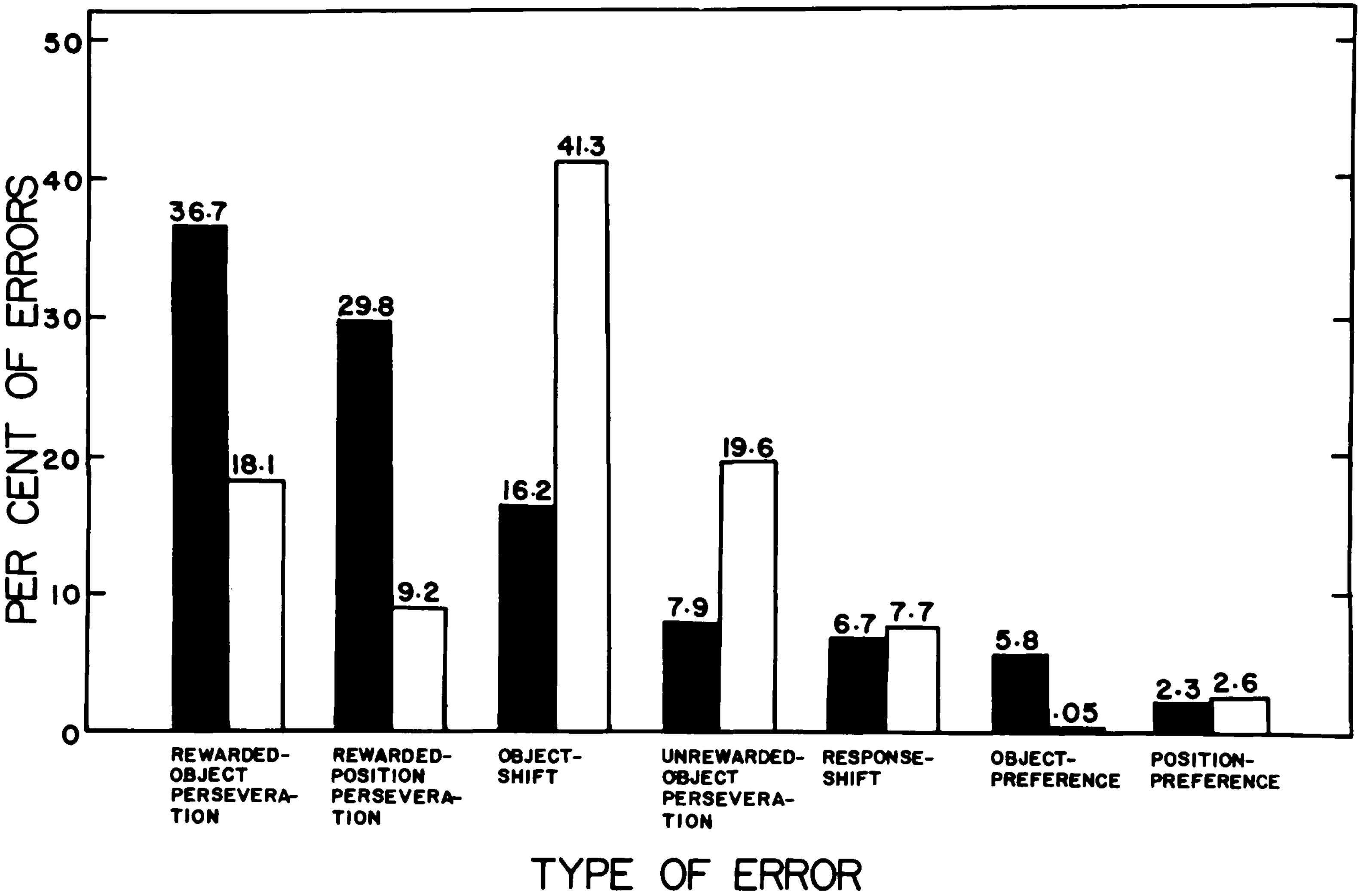

Fig. 3. The mean percentage of error factors in the present experiment (solid bars) as compared to those of Moon and Harlow (1955).

DISCUSSION

Prior to phase II each S received a total of 160 free-choice trials. It is highly unlikely that this small number of trials could account for the significant increase in performance during phase I. Therefore, the results conclusively demonstrate that the forced-choice trials provided the Ss with additional information about oddity responding. This conclusion is further supported by the finding that the Ss were responding significantly above chance during phase II. However, it appears reasonable to assume that the critical factor in the forced-choice design is not just to force certain responses but to provide a design that will convey additional oddity response information. For example, the sophisticated Ss of the Levine and Harlow response-blocking study (1959) needed 3,000 trials to attain a 70 per cent level of responding while the sophisticated Ss of the Levinson center-forced-response study needed less than 300 trials to attain the same level of responding.

The phase I results also indicated that the checking procedure may facilitate oddity responding. Although the differences between the checking and non-checking Ss were not statistically tested, it does seem reasonable to assume that the checking response would provide the S with more information about oddity responding.

The comparative error factor data gave some indication that there are large differences between naive and sophisticated Ss in the percentage of the component error factor. The comparative results indicate that there are both positive and negative transfer effects from DLS experience to oddity training. The suppression of the error factors of rewarded-object perseveration, rewarded-position perseveration, and object-preference errors of the Moon and Harlow study indicate positive transfer while the high percentage of object-shift and unrewarded object perseveration errors point out the negative transfer effects. The error factor differences, between experiments, of unrewarded-object perseveration errors and rewarded-object perseveration errors are not explainable. In fact, these differences are the converse of what would be predicted.

The major limitation of the present study was the number of Ss. A sample of four does not provide for powerful inferences. A second limitation (and a suggestion for additional research) is the slight indication that the checking procedure may facilitate learning. It would be advantageous to know the similarities and differences between the checking method and the center-forced procedure. It would also be beneficial to have a trial-and-error experiment conducted on naive Ss to which the forced-choice and the sophisticated Ss experiments could be compared. Without this basic experiment an assessment of the various variables that appear to facilitate or retard oddity responding will be impossible.

REFERENCES

Gellerman, L. W. Chance orders and alternating stimuli in visual discrimination experiments. _J. genet. Psychol._, 1933, 42, 206-207.

Harlow, H. F. The formation of learning sets. _Psychol. Rev._, 1949, 56, 51-65.

Levine, M., & Harlow, H. F. Learning sets with one and twelve trial oddity problems. _Amer. J. Psychol._, 1959, 72, 253.

Levinson, B. Oddity learning set and its relation to discrimination learning set. Unpub. doc. diss., 1958. In Schrier, A. M., Harlow, H. F., & Stollnitz, F.

Lockhart, J. M., & Harlow, H. F. The influence of spatial configuration and percentage of reinforcement upon oddity learning. _J. comp. physiol. Psychol._, 1962, 55, 495.

Meyer, D. R., & Harlow, H. F. The development and transfer of responses to patterning by monkeys. _J. comp. physiol. Psychol._, 1949, 42, 454.

Moon, L. E., & Harlow, H. F. Analysis of oddity learning by rhesus monkeys. _J. comp. physiol. Psychol._, 1955, 48, 188-194.

Robinson, E. W. A preliminary experiment on abstraction in a monkey. _J. comp. physiol. Psychol._, 1933, 16, 231-236.

Schrier, A. M., Harlow, H. F., & Stollnitz, F. _Behavior of nonhuman primates: modern research trends._ Vol. I. New York: Academic Press, 1965. Pp. 193-199.