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Perceptual Learning Ability in *Mandrillus sphinx* and *Cercopithecus nictitans* *

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Several *Mandrillus sphinx* and one *Cercopithecus nictitans* were tested in their perceptual-learning ability with the patterned-string problems test. The error percentage, the time spent in problems solving, and the hand used were considered. The correlation between errors and time was calculated. The discrimination ability related to shapes of strings is discussed. The ability in problems solving and learning capacity of *Mandrillus* and *Cercopithecus* is compared with those of *Ponginae* and monkeys studied by other authors.

The learning ability of higher primates is an interesting question for the ethologist and the experimental psychologist. Since TILNEY (8) it is known that the development of the brain is not the same among the different primates. So some correlation between the capacity of learning and the neurophysiological studies and data might be expected.

Many methods are available to provide data about relative intelligence or learning ability (5, 7). One of them, considered as a test of perceptual-learning ability is the «patterned string problems». Different authors have worked with several *Ponginae* (1, 2, 4), and with *Catarrhine* and *Platyrhine* monkeys (3).

The purpose here is to provide more data about *Mandrillus* and *Cercopithecus* ability in patterned strig problems solving. Specially *Mandrillus* is a scarcely studied primate, perhaps due to its limited disponibility in Zoos or research centers. Therefore a knowledge about its learning ability could perhaps be of interest for possible neurological and physiological studies.

Materials and Methods

The procedure and apparatus was as described by RIESEN *et al.* (4), adding consideration of the time required to solve the problems. There was a Klüver type tray to

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which strings were attached. These strings were arranged in 17 shapes of graded difficulty (fig. 1) from the extremely simple to the extremely complex, which are the same utilized by FISCHER and KITCHENER (2). The food was placed randomly to the ends of strings out of sight of the subject. Afterwards the tray was presented to the animal. Correct choice was rewarded by food, and incorrect choice punished by removal of the tray.

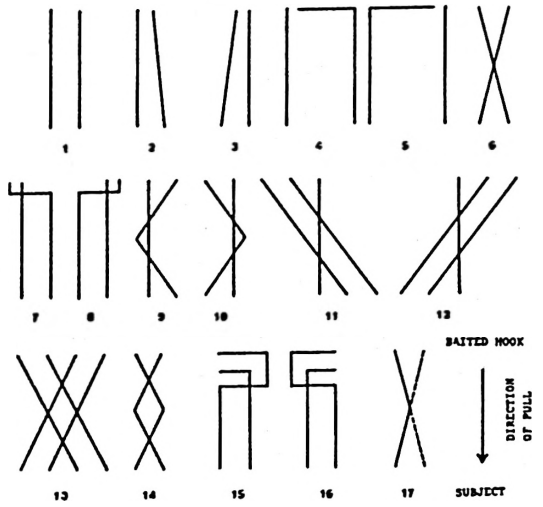

Fig. 1. *Strings with bait hooks that might be pulled by the subjects.*

100 trials were made for each problem in two succesive sets of 50 trials (1-50 and 50-100). The number of errors, the time spent in problem solving, and the hand used were recorded.

The subjects were: A male *Mandrillus sphinx* 10 years old (Pipo). A male *M. leucophaeus* more than 15 years old. A male *M. sphinx* 7-8 years old (Rufo). A female *M. sphinx* 6-7 years old (Chita). A male *Cercopthecus nictitans* 2 years old.

All were born in wild state, and after being captured, they were living some time with human families, being afterwards transferred to Zoo of Barcelona where they were tested. A previous essential adaptation of the subjects to test conditions was made in each case, according to the characteristics of each animal.

Results

The number of errors made by the three *M. sphinx* and the *C. nictitans*, both in the two blocks of 50 trials and the total ones, are shown in table I. An asterisk in the table means that the subject did not attempt to resolve the problem, but tried a more simple solution by pulling always the same string, without scarcely thinking about it. The subject was (even in its general behavioural manifestation) in its border line of its discrimination ability.

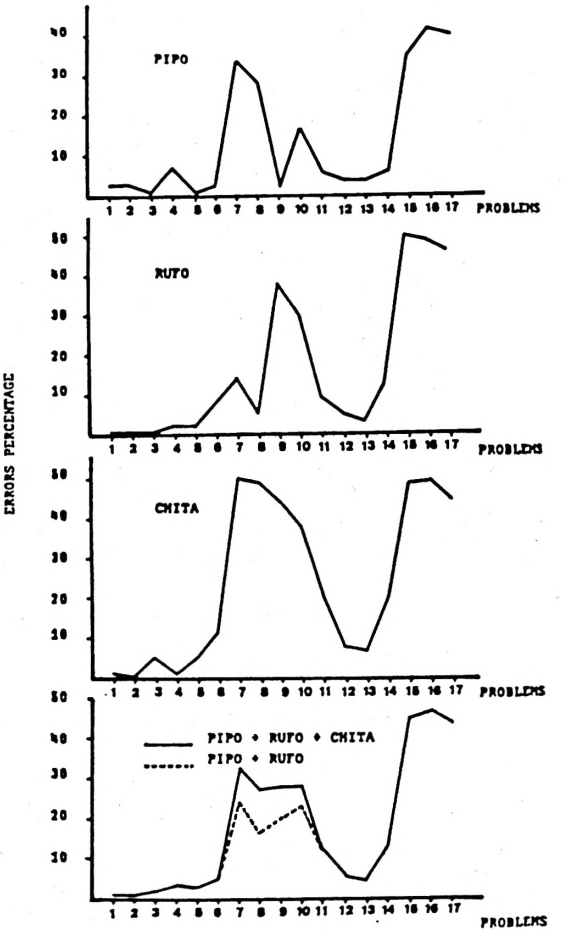

Fig. 2. *Percentage of errors in* Mandrillus sphinx.

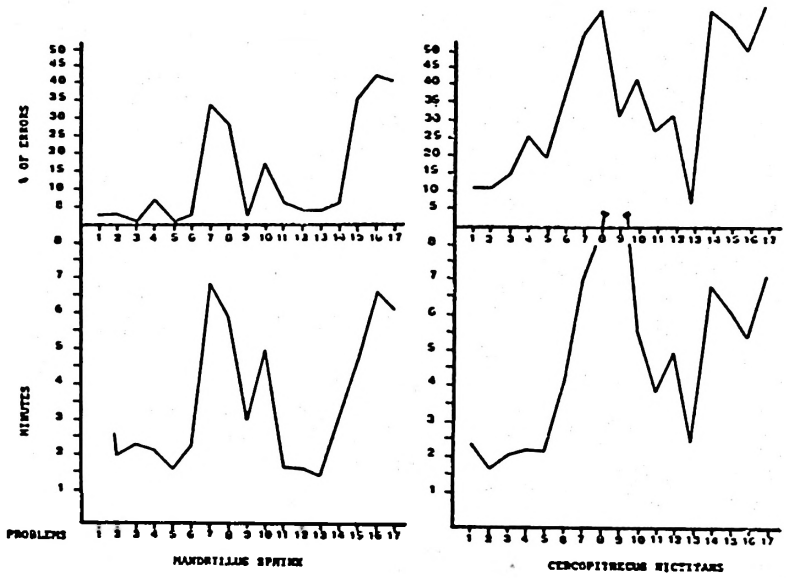

Fig. 3. *Percentage of error and time required to resolve the problems.*

Table I. *Number of errors in two succesive sets of 50 trials.*

Problem	Mandrillus sphinx									Cercopithecus nictitans		
	Pipo			Rufo			Chita					
	1-50	50-100	Total	1-50	50-100	Total	1-50	50-100	Total	1-50	50-100	Total
1	2	2	4	0	0	0	1	0	1	8	4	12
2	0	3	3	0	0	0	0	0	0	8	4	12
3	1	0	1	0	0	0	4	1	5	7	8	15
4	6	1	7	1	1	2	1	0	1	16	10	26
5	1	0	1	2	0	2	2	3	5	15	5	20
6	2	1	3	0	0	0	8	3	11	20	17	37
7	24 *	10	34	12	2	14	25 *	25 *	50	32	23 *	55
8	11	17	28	4	1	5	24 *	25 *	49	30	32	62
9	1	1	2	23	15	38	26	18	44	26	16	32
10	8	9	17	22	8	30	23	15	38	23	20	43
11	4	2	6	8	1	9	15	6	21	16	12	28
12	2	2	4	4	1	5	4	4	8	20	12	32
13	4	0	4	2	1	3	5	2	7	3	4	7
14	3	3	6	9	4	13	14	6	20	34	28 *	62
15	22	13	35	22	28	50	25 *	24 *	49	31	27 *	58
16	21	21	42	27	22	49	25 *	25 *	50	25 *	26 *	51
17	22	18	40	24	22	46	23	22	45	28	35	63
	134	103		158	113		225	179		342	283	

* Discrimination border line.

In figure 2 the percentages of *M. sphinx* errors are graphically shown.

In figure 3 (top) the percentages of one *M. sphinx* (Pipo) and *C. nictitans* errors are graphically shown. Figure 3 (bottom) shows the time required in solving the problems.

It is possible to see in figure 4 the patterns of errors commited when the problems are presented in an increasing order of error percentages. The three *M. sphinx* and the *C. nictitans* are represented in this figure 4.

Respect to *Mandrillus leucophaeus* the adaptation time to test was hard and long. Its character was always rough and aggresive. After the beginning of the test, when 9 problems were already made (always with difficulties), it was necessary to forsake. In view of an increase of roughness and the lack of interest or cooperation to test, this animal was rejected.

Referring to the hand used to pull strings, the *M. sphinx* Pipo employed its right hand in 87 %, the left hand in 11 %, and both hands in 3 % of times. The *M. sphinx* Rufo and Chita employed the left hand in 100 % of times. *C. nictitans* used the right hand in 17 %, the left hand in 35 %, and both hands in 48 % of times.

Discussion

Respect to the difficulties found by each subject in solving each problem, the three exemplars of *M. sphinx* (table I and figure 2) show a rather resembling pattern, but with some differences: the two males (Pipo and Rufo) show a similar capacity level — Pipo somewhat superior —, with the difference that problems 7 and 8 appear of hard difficulty to Pipo and are comparatively well solved by Rufo, while the reverse is seen for the problems 9 and 10. Perhaps this difference may be due to the fact that Pipo was right-handed, while Rufo was left-handed. Chita shows a general ability level lower than the two males. Nevertheless, during the test she

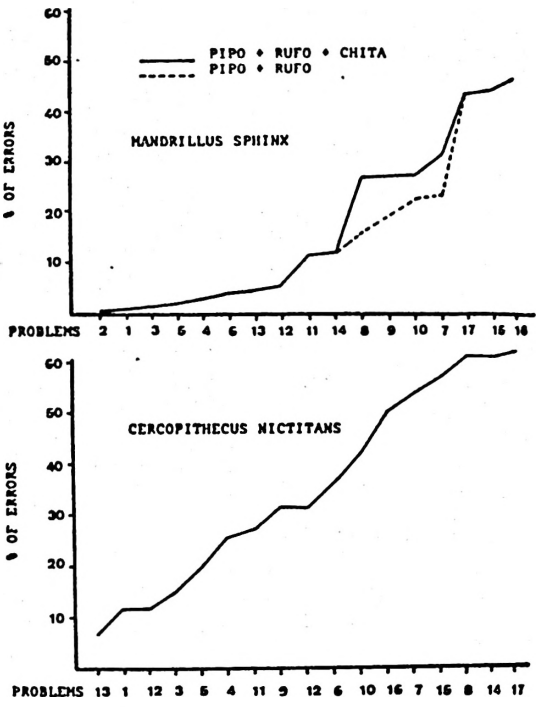

Fig. 4. *The problems are presented in an increasing order or error percentage.*

came into estrus, and this disturbed her general behaviour and the attention degree to test. Especially the sounds of males of *M. sphinx* in neighbouring cages, which she could hear, were an interference. It is probable that estrus influenced negatively the ability to solve the problems 7, 8, 9 and 10. Figure 2 shows a double profile in problems 7, 8, 9 and 10, taking in one of them only the two male performances, what we think is nearest to the real capacities of this species of primates.

As figure 3 shows, the performance level is clearly lower in *C nictitans* than in *M. sphinx*.

Figure 4 shows the errors commited when the problems are represented in an increasing order of error percentages. In the *M. sphinx* group, 10 problems were solved with a good effectiveness, 4 problems were poorly solved, and finally 3

problems can be considered as not solved, since the errors percentage is about 50 %.

The problems solved with less effectiveness belong to shapes were the strings follow a complex cross or pseudocross, and one of them or both follow a broken line. These shapes rarely can be found in the natural habitat of these animals, as was observed by SABATER-PI (6).

With *C. nictitans* the more difficult problems with maximum errors are the same as for *M. sphinx*, but the number of poorly solved problems is higher and a notable increase in errors percentage is observed, meaning a remarkable lower ability in problems solving.

The fact that *M. sphinx* found most difficulties when the strings complex cross or pseudocross and following a broken line is in accordance with the work of HARLOW and SETTLAGE (3). In spite of very great individual differences of the monkeys in the patterned string test found by these authors, our three *M. sphinx* appear homogeneus enough, specially the two males. The *M. sphinx* show a superior ability than adult *Macaca* (3) or *C. nictitans* and less ability than *Ponginae* (2).

Perhaps it can be said that in the «general monkey level of capacity» in solving patterned string tests hipotized by HARLOW and SETTLAGE (3), *M. sphinx* could be in a very good place in perceptual learning ability hierarchy, but separated from the *Ponginae* (2) by their incapacity of solving the complex cross or pseudocross string problems.

It appears that there is a positive correlation between the number of errors and the time spent on problems solving by one *M. sphinx* and *C. nictitans* (fig. 3). Perhaps only the problem 9 in *C. nictitans* does not show this correlation. The correlation coeficient for *M. sphinx* is $r = +0.7452$ and for *C. nictitans* $r = +0.7014$ ($0{,}01 < P < 0.001$).

Taking the factor time — having correlation — may be interesting, since is another data that brings information about the learning and discrimination ability. However, it has not been found correlation in the other two exemplars of *M. sphinx* (Rufo, Chita). These two subjects (Rufo and Chita) were tested by different researchers from the ones who tested the other animals, and also in different and more deficient instalations of the Zoo. As the researchers performing the tests in bad ambiental conditions were always experienced, with a good knowledge of the animal and the method of work, it appear possible to think that errors percentage is less influenced than time factor by the variability in ambiental conditions.

A final fact to be considered was that our subjects must be able to learn while they carry out trials per problem (early trials versus late trials). As it was expected they show learning ability in this way, but unfortunatelv it only appears when the subject is able to solve the problem. Moreover different degrees of solving ability are shown (fig. 4), prevailing upon the learning ability. When the animal is in his border discrimination line, no learning appears. As among the 17 problems there are some impossible to be solved by the subjects because of lack of ability, when a statistical test of signification is applied, the percentages of learning emerged as randomly ones.

In spite of lack of mathematical support, in a crude view of learning ability, *M. sphinx* is clearly superior to *C. nictitans* in our work. Comparing also in crude view, *M. sphinx* with *Ponginae* (2), appears inferior to them, but his performance ability is noy bad, and, as a monkey, appears to be high.

Resumen

Diversos ejemplares de *Mandrillus sphinx* y un *Cercopithecus nictitans* fueron sometidos a prueba mediante el «test de las cadenas», en relación a su capacidad de aprendizaje per-

ceptivo. El porcentaje de errores cometidos; el tiempo requerido en la solución de los problemas; y la mano utilizada, fueron considerados al aplicar el test antedicho. Se calculó la correlación entre errores y tiempo. Se discute la capacidad de discriminación a tenor de las formas geométricas formadas con las cadenas. Se compara la capacidad de discriminación, resolución de problemas y capacidad de aprendizaje de *Mandrillus* y *Cercopithecus* a la de Póngidos y monos, estudiados por otros autores.

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