REACTION TO NOVEL OBJECTS IN A TROOP OF GUINEA BABOONS: APPROACH AND MANIPULATION

by

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(With 5 Figures)

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Introduction

The question of the capacities of an animal, and in particular a primate, to react to changes in its physical environment and to orient itself in space has recently been studied within the concept of "cognitive mapping" (MENZEL, 1973, 1978; MENZEL & MENZEL, 1979; SIGG & STOLBA, 1981; BOESCH & BOESCH, 1984).

The reaction to novelty constitutes a particularly suitable approach to understanding the abilities of an animal to respond to changes in, or in other words, to "map out" its environment (MENZEL, 1971; MENZEL & MENZEL, 1979).

This paper reports a study employing this mode of investigation, which was carried out on a group of Guinea baboons (*Papio papio*).

Although the type of social organisation of *Papio papio* is not well known, three studies which bear upon this issue ought to be mentioned. According to SHARMAN (1981) who carried out extensive observations of *Papio papio* at Niokolo Koba (Senegal), the social organisation of the species is apparently similar to that seen in the savanna baboons, *i.e.* large, socially complex troops in which the adults compete for mates. DUNBAR & NATHAN (1972) and BOESE (1975) saw some degree of substructuring within the troops which took the form of a single adult male and one or more adult females with associated young. These reproductive units were embedded in multimale troops.

The only study of the feeding ecology of the species (SHARMAN, 1981) shows that *Papio papio* are truly omnivorous since they were observed feeding on more than 50 different plant items and 6 species of animals.

[1]) We would like to thank Sophie WEST for her help with the English.

From a comparative study of object manipulation in different captive species, GLICKMAN & SROGES (1966) concluded that curiosity towards the physical environment is dependent on daily activities, feeding habits and the degree of freedom from predator pressure. Thus, it would seem that *Papio papio*, because of its omnivorous regime and its well structured multi-male organisation, is apt for a study of object manipulation and, in particular, the reaction to new objects.

The present paper investigates three aspects of the reactions of the baboons: (a) the capacity of the group as a whole to react to new objects in its familiar environment; (b) the differential reactions of adults and juveniles, in terms of overall exploratory and manipulatory behaviour; (c) the type of manipulations shown by subgroups, classified according to age and sex, towards new objects.

Method

Subjects.

14 Guinea baboons (*Papio papio*) living as a social group in a compound were observed. The group comprised ten adults (each about 6 years of age), of which 5 were male (MAC, BIA, YEL, POM, GRE) and 5 female (RAM, NAT, VIV, DIA, SER), and four juveniles (ranging from 12 to 17 months of age) of which 3 were male (RAT, NUA, VUL) and one female (SUS). All adults were born in the wild, and were brought to their present enclosure in 1980. It is presumed that at this stage, the animals were unknown to each other. All the young animals were born in captivity. The present experiment was conducted in March 1984.

As far as this troop is concerned, we haven't yet seen any sort of partitioning within the group which could resemble a one-male unit organisation. Our monkeys are observed twice a year (for ten day periods) in order to establish a "social photography" of the troop (affiliative relationships, dominance, *etc.*: for details of the method, see LEPOIVRE & PALLAUD, 1983). If we consider exclusively the dominance hierarchy, the latest sociogram made 6 months before the present study gave the following order for the males: the dominant male was MAC; he was followed by BIA and YEL; the lowest ranking males were POM and GRE (who were of equal status). Females came after the males in the hierarchy but their respective ranks cannot be clearly determined because the dominant female had to be removed from the troop 2 months before the beginning of the study.

The enclosure (*i.e.* the test environment) was of a total area of 640 m^2. It contained a dead tree, rocks of various sizes and a wooden construction (4.5 m high) on which the baboons could climb. At regular intervals different kinds of branches were brought into the enclosure. A tunnel connected the compound to the animal house, (a concrete building of 4×3 m) and animals were able to move freely from one to the other. Behaviours were recorded from two observation towers located in nearby trees.

Material.

Twelve objects falling into two categories, "natural" and "artificial", were selected. The 6 "natural" objects consisted of: half a coconut shell, a bone, a stone, a ball of clay, an empty seashell and a pine-cone. The 6 "artificial" objects were: a square of metal painted red, a blue aluminium mug, an iron chain, a beige PVC rectangle, a white tennis ball and a blue rubber bone. All objects had a maximum length of 15 cm and a maximum diameter of 10 cm.

Procedure.

The entire compound was marked out in 4 x 4 metre zones with plaster. An area of 240 m^2 was selected in the central portion of the compound. Each of the twelve objects was randomly allocated to one of the 4 x 4 m zones making up this central area, and placed in the middle of it. Thus at least 4 metres separated the centres of two object locations. Ten objects were placed on the ground and two above ground (*i.e.* the coconut on the dead tree and the mug on the construction).

The test started every morning, roughly one hour after the animals had been fed. Firstly, the monkeys were locked in the animal house, without a view of the enclosure, while the experimenter entered the compound to position the object(s). After the experimenter had left the compound, animals were released and given free access to the enclosure. The beginning of a trial started when all subjects had arrived in the compound (this took about 15 sec following their release). A trial lasted for 30 minutes. After the completion of each trial, all the experimental objects were removed. The experiment was conducted for 12 consecutive days.

One new object was presented each day, following a procedure similar to that used by MENZEL & MENZEL (1979) with marmosets. A novel object was presented on Day 1, in a given location. On Day 2, another new object was presented in a different location, along with the object of the previous day in its (now) old position. This procedure was repeated for the twelve days of the experiment. Old objects were always replaced in the same orientation.

The observer recorded the type of behaviour displayed by each of the animals toward the experimental objects (see below) during each 30 seconds interval. This sampling technique was similar to that described by ALTMAN (1974) as "one-zero". Following previous observation of the troop of baboons, and an investigation of data from the literature (*e.g.* in PARKER, 1974 and VAUCLAIR & BARD, 1983), five behavioural categories had been retained. These were: 1) "Looking at" (L), defined as a visual fixation within a zone and thus at a maximum of two metres from the object; 2) "Sniffing" (S), which implied only a contact with the snout; 3) "Touching with hands" (To); 4) "Grasping" (G), in which case the object was picked up; 5) "Transporting" (Tr), implying that the animal picked up the object and moved with it. The five categories were hierarchically organised according to the level of complexity involved (for details of the coding system, see VAUCLAIR & BARD, 1983). Since the system was hierarchical, only the most complex behaviour was recorded: for example, if a given animal sniffed an object and then touched it, only the "touching" was recorded for that animal within the 30 sec interval.

"Looking at" and "Sniffing" were considered to express exploratory behaviour, whereas "Touching", "Grasping" and "Transporting" described different degrees of manipulation.

Given the number of animals involved in this study, two independent experimenters shared the recording task. Thus, prior to the test phase, each had been assigned to half the objects and locations.

Results

Detection of new objects.[1])

Of all the twelve objects presented on successive days, only one (the stone) was not detected during the first session in which it appeared. Fur-

[1]) Although we are aware of the possibility that an animal can "detect" an object without displaying an overt response, for convenience, we use the term detection to describe any reaction to the experimental objects which was apparent to the observer.

thermore, the new object was always explored first, except on Day 4, when it was explored third. Four adult males (MAC, BIA, GRE, YEL) and three male juveniles were involved in the detection. The dominant male MAC discovered one object, BIA one object, GRE two objects and YEL four objects. NUA detected three objects, one of which was simultaneously detected by two other juveniles.

In general, the object most recently placed in the enclosure was detected very quickly (see Fig. 1). For the eleven objects which were discovered during the experimental session (30 min), the time taken to detect them varied between 30 sec and 3 min, as shown in Fig. 1. It can be seen that the discovery time stabilizes during the last five sessions, despite the increasing complexity of the environment.

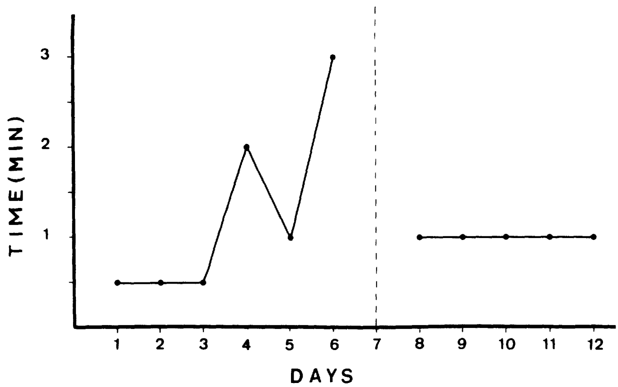

Fig. 1. Detection time for each new object over the twelve days.

Comparison between natural and artificial objects.

No differences were found between the time taken to discover the natural objects and that for the artificial objects. The average discovery time for the five natural objects (with the exception of the stone) was 66 sec, while that for the six artificial objects was 70 sec. Furthermore, no quantitative differences were found between the frequencies of exploratory and manipulatory behaviours for each type of objects (U-test (6,5) = 13, N.S.).

Comparison between new and old objects.

The changes in the responses directed towards a particular object between Day n and Day n + 1 (where n = the first day on which the object was presented) were investigated. It is possible that any differences found between the responses during the first and second presentation, were the result of a change in the novelty status of this object. Two objects were eliminated from this analysis: the stone (object 7) because it was not detected during its first presentation, and the pine cone (object 12) because it was only presented once. The Wilcoxon T test demonstrated that objects were less explored during their second presentation than during the first ($T = 4$, $p < .01$).

Figure 2 presents the responsiveness for days 1-12 (a) to the new object, and (b) to the old objects (the total number of which increased by one daily). It can be seen that the two curves follow the same general pattern. On Day 7, when the animals failed to detect the new object, there is a clear "peak" in the "old objects" curve. From this latter curve it can be seen that there is not a cumulative effect of the progressive increase in the number of objects on the level of activity.

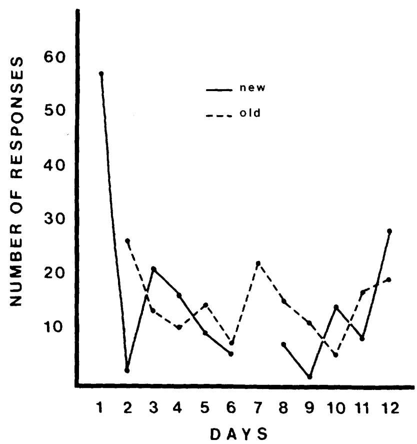

Fig. 2. Total explorations and manipulations for new and old objects over the twelve days.

The percentages of both exploratory and manipulatory behaviours for the new and old objects were compared using a binomial test. For the new objects, there was more manipulation than exploration ($z = -1.79$, $p = .036$), whereas for the old objects, animals explored more than they manipulated ($z = -2.97$, $p = .0015$).

For the twelve sessions, the mean percentage of 30 sec intervals during which the subjects were oriented to experimental objects was low (2.95%) for the group as a whole.

Group analysis.

An analysis was carried out to investigate the effects of the factors of age and sex. For this purpose, the group of animals was divided into the following three categories: adult males, adult females, and juveniles (3 males and one female).

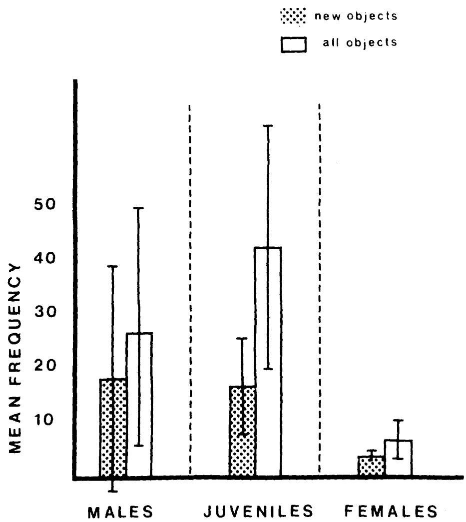

Fig. 3. Mean frequencies of contacts for new objects and all objects for each age-sex subgroup (M = males; F = females; J = juveniles). Standard errors are represented by vertical bars.

Figure 3 shows the mean frequencies of exploratory and manipulatory responses directed to, on the one hand, the new objects only, and, on the other, all the objects together (old and new). As can be seen, the males and juveniles displayed higher levels of responding in both categories than the females. However, a statistical analysis revealed only two significant differences: that between the female and juvenile levels of responding towards new objects ($t(3) = 2.99$, $p < .10$) and all the objects ($t(3) = 3.13$, $p < .10$; the value of t when $p < 0.05$ is equal to 3.15).

Figure 4 shows that the juveniles had the highest scores on 10 out of the 12 days: those for the males and females were clearly lower and virtually the same.

The results, as summarized on figures 3 and 4, indicated that males and especially juveniles played the major role in the reaction to novel objects. Such results are reinforced by the fact that juveniles' responses ac-

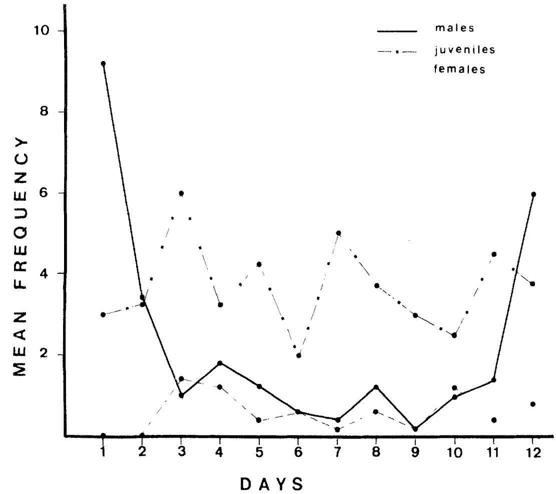

Fig. 4. Mean frequencies of all object-oriented behaviours for males, juveniles and females over the twelve days. Note: Peaks of the males' curve on Day 1 and on Day 12 are due to the fact that one single animal (YEL and BIA respectively) walked off with the new object for nearly the entire experimental session.

counted for more than 50% of the total frequencies, even though the four juveniles represented only 28% of all the subjects.

The distinction of five categories of object oriented behaviours allowed us to examine possible qualitative differences between subgroups. Fig. 5 gives the mean frequencies of all L (Look), S (Sniff) and G (Grasp) scores for the three subgroups. Categories To (Touch) and Tr (Transport) had to be discarded from the overall comparisons because of the extremely low scores of the females: one case of "Touching" and none of "Transporting". A t test performed on the raw data indicated that juveniles showed significantly more "Lookings" than the subgroups of males ($t(3) = 4.05$, $p < .025$) and females ($t(3) = 4.87$, $p < .01$).

It is also worth noting the contrast between the high "Grasping" scores of the males and juveniles and the relatively low scores of the females, even though this difference is not significant. Furthermore, a comparison of the males and juveniles scores in the "Touching" category, revealed that the latter touched the objects significantly more frequently than the former ($t(3) = 2.58$, $p < .05$). Finally, it is interesting to compare the distribution of all responses falling either in the broad category "exploration" or "manipulation" for the five most active subjects (three juveniles and two males). The analysis indicates that males

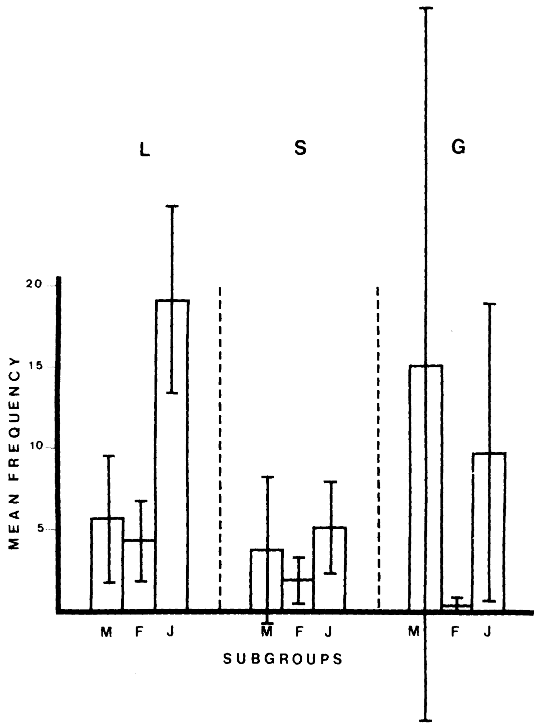

Fig. 5. Mean frequencies of Locking, Sniffing and Grasping behaviours for each subgroup. Standard erros are represented by vertical bars.

showed more manipulations (91.9% for YEL and 78.9% for BIA) than the three juveniles (53.6% for NUA, 50% for RAT and 28.2% for VUL).

Individual analysis.

Given the important variations within each subgroup, it is useful to look more closely at individual performances. Such differences already appear in the number of intervals during which subjects were oriented to experimental objects: for example, these intervals represented only 0.4% of the total for the least active animal (POM) and 9.5% for the most active subject, NUA.

Total frequencies of responses differed greatly from one individual to another. For example, NUA made a total of 69 contacts; he was followed by YEL (62). Then came two male juveniles, RAT (50) and VUL (39). The juvenile female (SUS) had a total score of 14 contacts with the objects. Interestingly, the dominant male MAC was little active as is shown by his relatively low score of 11.

The number of different new objects contacted also varied between individuals: 8 for VUL, 7 for NUA, 7 for RAT, 3 for YEL. The two low ranking males POM and GRE contacted 0 and 7 new objects (respectively). Moreover MAC explored and manipulated three new objects altogether, compared to 4 objects for a low ranking female and an average of 6.75 objects for the subgroup of juveniles.

Discussion

The present experiment demonstrated the obvious capacity of a troop of baboons to quickly react to fine changes in their familiar environment. Such an ability is still in evidence even when the object is far from being conspicuous, as is the case for the ball of clay, which was situated on the ground among other objects (rocks) of similar shape, size and color. Baboons' performances are in this respect similar to those of a group of juvenile chimpanzees tested in a large enclosure (MENZEL, 1971) and also to the reactions of a family group of marmosets (living in a large greenhouse which were able to select a single object among up to 30 simultaneously presented test objects (MENZEL & MENZEL, 1979). We think that such a knowledge of the environment, and of changes to it, expressed by the baboons falls into the behaviours described under the terminology of "cognitive mapping" (MENZEL, 1973). Further existence of such a mapping of the environment by the troop as a whole is provided by the following facts (a) one single presentation of the object is sufficient for the animal to memorize it and categorize it as being known (cf. the significant decrease in the number of contacts for a given object between its first and second presentation); (b) new objects are mostly manipulated (*i.e.* touched, grasped and sometimes transported) whereas old objects are more explored (by simple visual fixation of sniffing) than manipulated, suggesting that a distant checking is sufficient to ascertain their identity.

Of course, given our method, it is impossible to know if the object is recognized through its physical features alone or because it occupies a specific location in the compound. In MENZEL & MENZEL's study (1979) with marmosets, both the effects of object-novelty and novelty of place were investigated. Although the discrimination based on object-novelty was a more important determinant of response than novelty of place, the authors concluded that marmosets were able to detect both types of novelty. Such a view is congruent with TOLMAN's early conception of a cognitive map which is conceived as being simultaneously built upon spatial relations and associated events, *e.g.* objects (TOLMAN, 1948).

A second aspect of the study concerns the differences between age and sex subgroups in their reactions towards the experimental objects. It can be recalled that the first contacts with new objects were achieved exclusively by four adult males and three male juveniles. Adult females were not involved at any time in this process. This characteristic is reinforced by subsequent contacts with objects: the very few reactions observed among females were for the most part of an exploratory nature. In contrast, the group of juveniles showed a constant and high interest vis-à-vis the objects throughout the twelve days of the study. The form of contacting objects also differs between juveniles and other subgroups, since juveniles looked at the objects and touched them more frequently than the adult males. This finding strengthens the general picture which emerges from the study, *i.e.* the major part played by juveniles of the troop in reaction to environmental changes. Our results are thus consistent with MENZEL's study on macaques which found that 95% of the manipulations of novel objects were displayed by one-year and two-year old juveniles. Furthermore, adult marmosets were seen to express a lower level of responsiveness than juveniles (MENZEL & MENZEL, 1979).

The relation between age and the tendency to explore and manipulate objects or space can be viewed from different perspectives. We would like to mention two of them here.

Firstly, it is possible that age alone may account for the observed differences between adult and young animals (VAUCLAIR, 1980). Young animals may simply be more curious, and therefore have a greater tendency to explore the physical environment than adults. Alternatively, the behaviour of young subjects can be interpreted in terms of both age and experience. It has been suggested that adults display faster and more integrated capacities to process information than young animals. The relatively low involvment of adults compared to that of juveniles could thus be the result of the adult's "more efficient information pickup and more immediate recognition and classification of objects" (MENZEL & MENZEL, 1979, p. 275).

Also of interest is the minor participation of the dominant male. In this respect our study confirms previous findings. For example, mid and low ranking jackdaws were seen to initiate exploration of novel space (KATZIR, 1982) as well as novel food (KATZIR, 1983) whereas top ranking birds were more conservative in approaching new objects and situations.

The dependence of individual differences upon the social structure of the group (especially in relation to dominance) has been observed on several occasions in primates. For example, the propagation of new feeding habits in Japanese macaques followed a pattern within the social nexus where the dominant animals were the last to adopt the changes (KAWAMURA, 1959). Furthermore, in MENZEL's experiment with chimpanzees (MENZEL, 1971), top ranking animals just sat back and waited for someone else to do the checking. The same phenomenon is described by CHAMOVE, who observed (CHAMOVE, 1983) in a laboratory study with macaques, that responses to highly novel objects were rarely performed by the dominant animal. A lack of any direct relation between degree of novelty, dominance position and the order of contacting led CHAMOVE to discuss his results in terms of role, since "the difference in order of response is more predictably due to the role of one group member as first-contactor" (p. 226). Such a suggestion has already been made by MENZEL (1966) when he wrote that adult leader males "might actually be relying upon the juveniles to test out the situation" (p. 146).

This particular phenomenon of the relatively low investment of dominant individuals in the investigation of new objects has also been observed in situations where individuals are tested in isolation (see for example BERNSTEIN, 1966; STEVENSON-HINDE *et al.*, 1980). Moreover, in learning experiments high ranking macaques (*Macaca fascicularis*) performed less effectively than low ranking animals in reversal learning (BUNNEL *et al.*, 1980) and complex problem solving (BUNNEL & PERKINS, 1980).

For the purpose of the present discussion we would like to mention some of the hypotheses usually called upon to deal with the complex question of the relation between hierarchical position of an individual and his capacities to explore and exploit new objects. One hypothesis (KATZIR, 1982, 1983) put forward is of an adaptive nature: it states that it may be risky for a high ranking individual to be too exploratory (in terms of possible encounter with a predator in an unfamiliar environment) compared to the possible loss due to the effect of the encounter on its social position. Furthermore, low ranking animals can benefit from exploring new objects as potential food because this gives them a chance to 'exploit resources before higher individuals come to do so" (KATZIR, 1983, p. 200).

Another hypothesis is of a social nature. Given, for example, the strict hierarchy observed among males in our troop, one can easily assume that the dominant male's attention (as well, possibly, as that of the subordinate individuals) is primarily focused on the control of social regulations within the troop. This focus of the dominant male on social interactions could have the effect of permitting individuals of intermediate ranks (less busy with social negotiations than the dominant) to interact with the non-social environment.

Summary

A troop of Guinea baboons living in an enclosure was exposed every day and for twelve consecutive days to a new object. The new object and the object(s) of the previous day(s) were presented simultaneously in the compound.

The troop as a whole demonstrated excellent abilities to rapidly react to the new objects: 11 out of 12 new objects were discovered within a maximum of 3 min of their first presentation and were furthermore the first to be approached. An analysis conducted on data from age and sex subgroups showed the preponderant part played by juveniles and by some adult males in the discovery process and subsequent contacts with objects.

The results are discussed within the conceptual frame of "cognitive mapping". In addition, the extent to which social factors (*e.g.* dominance) and perceptual and cognitive factors might determine the differential role of subgroups in the exploration and manipulation of objects is examined.

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Résumé

Des babouins (*Papio papio*) vivant en groupe dans un enclos ont été soumis à une expérience consistant à introduire chaque jour un objet nouveau dans leur environnement, et cela pendant 12 jours consécutifs. L'objet nouveau et les objets des jours précédents étaient présentés simultanément dans le corral.

Si l'on considère le groupe comme un tout, on constate que les objets nouveaux ont été détectés rapidement (en effet, 11 parmi ces 12 objets ont été découverts en moins de 3 min) et qu'ils ont toujours été les premiers à être explorés.

Une analyse portant sur les sous-groupes d'âge et de sexe a montré le rôle prépondérant joué par les juvéniles et par quelques adultes mâles dans la découverte et la manipulation des objets.

Les résultats ont été discutés par rapport à la notion de "carte cognitive". De plus, on a étudié dans quelle mesure les facteurs sociaux (la dominance, par exemple) et des facteurs perceptifs et cognitifs pouvaient expliquer le rôle différentiel des sous-groupes dans l'exploration et la manipulation d'objets.