tion of interferon as part of the mechanism by which urethan exerts its enhancing effect on viral leukemia. It will be possible to judge the validity of this hypothesis only when sufficient information about the interaction of endogenous interferon and leukemia viruses is available.

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Training without Reward: Traditional Training of Pig-Tailed Macaques as Coconut Harvesters

Abstract. Macaca nemestrina, *the pig-tailed macaque, is the only monkey regularly and extensively used for work. For centuries it has been trained in Southeast Asia to pick coconuts and other fruits. The training is based exclusively on punishment and avoidance of punishment.*

Macaca nemestrina is found in southern Burma, Tennasserim, the Malay Peninsula, and on the islands of Banka, Sumatra, Java, and Borneo. The monkeys are used to pick coconuts wherever the height of the trees makes the work uneconomical and dangerous for men. They provide the only contemporary example of an infra-human primate being trained as an agricultural laborer. Wild macaques, preferably males 1 or 2 years of age, are trapped in the jungle and kept tied in or near the house. They are not truly domestic animals, as their breeding is not controlled. The monkeys are generally trained during their third year, when they are less emotional than infants and easier to handle than adults, yet when they are capable of almost as much concentration as adults. During their fourth year the males begin to grow canines which may become as long as 6 cm. Their strength increases and their temperament becomes somewhat unreliable. Most of the animals who are trapped as adults do not learn to work and must be released or sold.

For 10 days in February 1966 I observed the training of two pig-tailed macaques and the work of three others in four villages in southern Thailand. The training is divided into three stages in which the subject learns: (i) to spin the coconut so as to twist the rough stem, which weakens the fibers enough to enable him to bite through them, (ii) to climb up a tree, work, and climb down according to the trainer's commands, and (iii) to distinguish various stages of ripeness of the coconuts so as to detach only the required type.

The most difficult part of the training is the first stage. The main problem consists in keeping the monkey interested in the coconut, which is too hard to bite or to eat. To induce the monkey to maintain contact with the coconut, the trainer ties him to a wall with a leash so short that the monkey must remain standing. The trainer sits facing him, with his legs on either side, in a position to unbalance the monkey with his feet. He passes the leash around his neck and holds it between his toes; this enables the trainer to increase the pressure on the collar of the monkey by shortening the leash. If the monkey struggles or attempts to escape, he can punish him by unbalancing him, choking him, and sometimes also by beating him. A coconut or other hard inedible fruit is suspended between the monkey and the trainer. When unbalanced or choked, the monkey tends to grab at the fruit for support. The trainer rotates the coconut so that the monkey feels the circular movement beneath his hands; then he holds the hands of the monkey and makes him spin the coconut. This is repeated until the monkey begins to rotate the coconut by himself. As soon as he does so, the trainer gives him more leash and moves away from him. The trainer makes the monkey practice; at the same time he cuts the string occasionally, so that the monkey associates the fall of the coconut with the twisting motion. If the monkey stops spinning, the trainer points at the coconut with his whip, a threat which generally results in the resumption of training. The monkey is also taught to spin the fruit backward, and to bite the stem on command. He first bites the stem, as well as other nearby objects, spontaneously and often just after he has been punished. This may be redirected aggression. Whenever the monkey bites the stem, the trainer says "Bite," and the word becomes associated with the act so that the monkey learns to bite the stem when the trainer gives the order. A few other commands are continually repeated beginning with the first lesson.

After the monkey has learned to twist the coconut, he is taken to a long pole from which a coconut is suspended. He learns to go up and down the pole on command, and to twist off the coconut while clinging to the pole (Fig. 1). This is the easiest part of the training and is often mastered in one lesson. The monkey climbs up willingly—indeed it is quite a natural thing for a pig-tailed monkey to do. The monkey is more reluctant to come down, but he has learned that he cannot resist a strong pull on his chain, and he usually does not attempt to do so. Monkey and trainer then climb up a small tree. The monkey is usually confused because he is faced with a compact cluster of nuts instead of a single one. He also may try to escape, since he is in a tree for one of the few times since his capture. Even though he was very obedient on the ground or on the pole, he may go as far away from the trainer as the chain will permit, jump around, or cling to a palm and refuse

to move (Fig. 2). He is whipped and left dangling in midair, clinging to his chain to avoid suffocation. The trainer then pulls him under the cluster, which he now seizes.

In the last stage of training the subject learns to recognize the young coconuts, which are small and green and have a smooth skin, and the ripe ones, which are large and yellow and have a rough shell. He often begins by twisting the first nut he comes across. If it is the right kind, the trainer does not interfere and shouts "Anee" (this one). If it is the wrong kind, a tug on the chain and the word "Bpaii" (go) indicate that another nut must be tried. As in a series of discrimination reversals, the subject learns to respond consistently after the first correct choice. Later he will be left on his own, selecting young or old coconuts according to the day's instructions.

Although words are constantly used during work, they are probably not the most important cues in directing it. Tugs on the chain, which may mean different orders according to different trainers, are also used. E. G. H. Corner, who taught previously trained coconut monkeys to collect plants in the forests of Malaya (*1*), found that his monkeys attended more to his gestures and facial expressions than to any other signal. Furthermore, the monkeys that I observed often looked at their master during work. Visual communication is more important than vocal communication in the social interaction of higher primates (*2*), and a monkey reacts to human facial expressions and gestures, even to those which are not consciously emitted as signals. Whatever cues the monkey responds to, he is able to recognize many commands, such as "go up, go higher, go to this side, pick this, not that, send more of that, set the chain free, jump across to the next tree, come down," and the like.

Once a monkey has learned to pick coconuts, he retains the skill for a long period of time, even if he does not practice it. Monkeys trained at 3 years of age might not be used until they are 4 or 5, when their daily coconut output is far greater than the output of a juvenile.

The training is based on punishment and omission of punishment. The monkey gradually learns that if he keeps working on the coconut, he will not be unbalanced, choked, or whipped. Reward was never used during a lesson, and a lesson was always terminated because the trainer was tired, not because the monkey had mastered a step. Food might be given afterwards, but generally not by the trainer, and often after considerable delay. Apparently the monkey learns to respect and obey the trainer as he would learn to respect and obey a dominant monkey in a pig-tailed group where orders of dominance are similarly established by punishment and threat of punishment. The trainer asserts his dominance immediately through punishment, and can then expect his subordinate to do what he requires, provided he finds a way to make his orders understood. The major difficulty of the training is probably the development of a system of communication between trainer and monkey, rather than the problem of obedience. Once the dominance relationship is established, it remains stable until the strength of the inferior becomes much greater than the strength of the dominant. Fully mature males, around 7 or 8 years of age, often start to rebel and cannot be made to work any more. The monkey often generalizes the fear of his trainer to other men, so that a monkey trained by one person will work for another. It often happens, however, that a man who obtains a trained monkey must first establish his dominance by beating the monkey before it will work for him (*3*). A beating may also be necessary to reestablish the order of rank when a man has not worked with his monkey for several months.

Fig. 1. Training of a young adult at the pole. The trainer induces the monkey to resume practice by pointing at the coconut with a stick.

In Southern Thailand coconuts ripen throughout the year, and pig-tailed macaques may work almost every day, from about 7:00 to 10:00 a.m. and 2:00 to 5:00 p.m. They are fed three times a day, before and after the morning work, and in the evening. What keeps them working for several consecutive hours, particularly when they are in treetops 25 meters above their master? Fear is certainly one factor, since an animal who stops working is whipped. Yet many animals

Fig. 2. The same individual is whipped for refusing to work in a coconut tree.

work without being punished at all, and some work without a chain. Apparently social reward and perhaps two types of activity rewards are involved. In many primate societies a high-ranking dominant is not only feared, he is also a focus of attraction: other members try to stay near him and to interact with him. The coconut monkey probably derives social reward from the interaction with his master, at least if the master is a "friendly" dominant. In a macaque group, there are two types of dominants: the "nonassertive" ones (*4*), who elicit more attraction than avoidance, and the "assertive" or aggressive ones, who elicit the opposite response. Monkey owners can also be divided into these two categories, and a coconut monkey will perform well with one man and poorly with another. Whether or not the master feeds the monkey seems irrelevant to their relationship. Indeed the women and children who generally feed the monkeys are often threatened and sometimes bitten by them, probably because they show fear. Corner has suggested that a monkey works partly because he is afraid of being beaten, and partly because he enjoys breaking, smashing, and knocking things down. Such activities are a basic component of the behavior of male macaques. Finally, monkeys may prefer working in trees to being tied to a pole all day. When not working, they are kept chained, and some show definitely stereotyped motions, such as clutching their head, biting their feet and hands, and rocking back and forth.

Thus fear, the motive on which training is established, may cease to be the primary determinant of performance. It is questionable if reward training would give as good or even better results than punishment training. Methods using the presentation and omission of negative reinforcers have two obvious weaknesses: they indicate to the monkey what must not be done, rather than what should be done, and they arouse escape and "freezing" reactions which interfere with learning. Perhaps the monkey would learn to make the appropriate movement sooner if he were rewarded as soon as he approximated it, rather than if he were punished for not making it. An animal that cannot be trained with the punitive method could prove amenable to reward.

There are two possible explanations for the absence of reward training in Malaya and Thailand. First, the idea of rewarding the monkeys during training and work had not occurred to the Thai villagers I interviewed. They said that a monkey should work because he is told to do so, and should be punished if he rebels, as were children in the traditional Thai schools. Furthermore, generations of trainers found that punishment is necessary to establish a dominance relationship without which the monkey will not obey. It is not surprising that the use of punishment was then extended to other aspects of training. The best training method might be to use punishment at the beginning of training, to establish a dominance relationship, and then switch to reward, to establish a system of communication.

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State as a Determinant of Infants' Heart Rate Response to Stimulation

Abstract. *With each infant serving as his own control, the data indicate that waking or sleeping states, independent of the prestimulation heart rate, can significantly affect the heart rate response to tactile stimulation.*

The role of state in determining a psychological or physiological response is not disputed. However, few studies of neonates and young infants have paid much attention to this variable. This is surprising in view of the fact that infants are more likely to show dramatic changes in state over a relatively short testing period than are adults, who maintain relatively consistent states and long periods of alertness. Recent studies have attempted to relate behavioral and autonomic indices of state (*1*), as well as to determine the effect of prestimulation level of behavioral and physiological variables on subsequent performance (*2*). These studies, as well as others using adults (*3*), have all shown the effect of prestimulation level and the necessity of controlling for this effect.

However, no studies of young infants have tested the same subject under different states or observed whether there were any differences in response to stimulation as a function of state independent of the initial level. The present study is a first attempt to investigate these problems.

Eleven subjects between 2 and 8 weeks of age were tested individually under two state conditions, asleep and awake. These states were defined by two observers who rated an infant asleep if (i) the infant's eyes were closed, (ii) he exhibited no vocalization, (iii) no gross activity or sucking, and (iv) an even respiration record (Fels Respirometer) (*4*). The infant was judged awake only if all four of the following conditions were met: (i) his eyes were open, (ii) he exhibited uneven respiration record, (iii) he showed slight body activity or sucking behavior, or both, and (iv) he was relatively alert (rated subjectively according to the amount and nature of the eye movement and scanning). Infants judged to be awake but irritable were not tested until they were quieted. High inter-observer reliability has been reported when similar measures were used (*2*). Interobserver reliability was recorded: eyes open, .94; vocalization, .84; activity and sucking, .73; respiration, .79; alertness, .71.

The tactile stimulation consisted of a calibrated series of 20 nylon filaments (*4*) which were presented to the corner of the infant's mouth and run back toward the upper angle of the ear. The stimuli were presented in a monotonically increasing order which was constant for each infant and for each state. The duration of the tactile stimulation was approximately 1 second with a variable intertrial interval of 15 to 25 seconds. The subject was placed either in a supine or prone position, depending upon his comfort, and the experimenter always approached the subject so that the infant was unable to see the experimenter. At the same time that the subject was stimulated, the experimenter depressed a key to record the stimulus duration on a