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KOEHLER AND TOOL USE IN ORANG-UTANS

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We will comment on some specific behaviors observed by Koehler, on the basis of our studies of semi-wild orang-utans conducted in 1991 and 1992 at Sepilok/Sandakan and Semengoh/Kuching Orang-utan Rehabilitation Centers in East Malaysia. Most of our comments refer to tool use, although these may be connected with other observations.

1. REGURGITATING FOOD AND TOOL USE

Koehler refers to the young captive orang-utan Catalina as not being "especially clean" because she frequently regurgitates food into her hands and then licks it up again. We have observed the same regurgitation of food. In fact, it is not certain whether the food is simply masticated and spat out, or whether it is swallowed and then regurgitated. In our observations, the regurgitation was linked to tool use. After gathering a mouthful of bananas at the feeding table, the orang-utan would climb high up into the canopy, on the way gather six to twelve largish leaves (probably mango leaves) in one hand, adopt a propped position so that both hands were free, and then proceed to fashion the leaves into a fan shape, forming a "plate" of leaves. The fan is held by the fingers with the broader span facing down the arm, on which the "plate" could rest. The chewed or swallowed banana was then spat out onto the plate to be slowly re-eaten. We observed this behavior on three occasions, each time in a different animal (all females, aged 6, 9 and 15 years). All of these observations were made at Sepilok, although a keeper at Semengoh reported that he had seen the same behavior twice in a 14 year old female, indicating that this rather remarkable example of tool use is not regionally specific.

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FIGURE 1. Use of the mouth as a vessel. The lower lip is protruded so that food can be seen as it is being eaten.

It is possible that the behavior developed as a result of food provisioning at the Rehabilitation Centers: the orang-utans may take a large mouthful of food at the feeding table and then move to a more remote locality where they can feed without interruption. In fact, orang-utans are more solitarly than other primates (MacKinnon, 1971, 1974; Mitani, Grether, Rodman, & Priatna, 1991), and group feeding may not suit them. Alternatively, the behavior may aid digestive processes by increasing the exposure of the food to enzymes in the saliva. Some additional observations support the latter possibility: on several occasions very young orang-utans in the vicinity of others spat out food onto the ground and then licked it up again.

Frequently, a small piece of food was placed from the mouth onto the back of the hand, examined, and then eaten. The latter behavior is not connected to regurgitation, but regurgitation may be a further development of visual food examination. Indeed, orang-utans also visually examine food while it is being chewed by protruding the lip with a piece of food (e.g., a berry) on it so that it can be easily seen by looking downwards (Figure 1). In this case, the mouth is being used as a vessel, and we suggest that use of leaves as a plate may be an elaboration of this behavior pattern to include tool use.

As an aside, it may also be noted that Koehler regards soil eating and the smearing of soil onto the skin as an "unclean" habit. He mentions that Catalina ate soil in large quantities in the first weeks after her arrival

in Teneriffe. Soil eating is common in orang-utans living in their natural environment, and presumably it serves dietary requirements of, for example, certain minerals. We observed soil eating on several occasions at Sepilok, and Harrisson (1963) has reported that an orang-utan released into the rainforest at Bako National Park, Sarawak, went into a cave and ate soil. Three others which Harrisson (1960) observed in semi-captivity ate soil regularly from an early age, one preferring clay and the other a variety of soils. Sometimes clay is smeared over the face and arms, as Harrisson (1960) reported and we also observed, the function of this being unclear.

2. LIMB USE AND TOOLS

The thumb of the orang-utan is smaller than that of the chimpanzee, gorilla or human and it is placed further from the four fingers. Koehler notes that the relatively lesser opposability of the orang-utans' thumb and fingers hinders their ability to perform tasks using sticks to retrieve food. We suggest that the orang-utan thumb may have a greater degree of opposability than Koehler suggested and that it can be used in precision manipulation of at least small sticks (Figure 2), if not to apply pressure for manipulation of food dishes by sticks. Nevertheless, the position and size of the thumb may influence the positioning of the leaf-plate so that it lies along the forearm, the firm hold being provided mainly by the fingers. The leaves chosen and fashioned into a plate are strong enough to hold food when projecting out from the hand, but this holding position would require strong pressure from the thumb, whereas no thumb pressure would be needed with the position of the plate as used by the orang-utans. Furthermore, it is not impossible for orang-utans to hold leaves in a fan shape projecting out from the hand, as a human holds a fan, as they often do so to fan themselves (not using the fanning motion employed by humans but rather by making larger sweeping motions). It would therefore seem to be the extra weight of the food, together with the lack of ability to apply more thumb pressure, that determines angling of the leaf-plate along the arm.

We have observed the use of sticks to scratch the ground (Figure 2). The intense concentration of the orang-utan performing this behavior is evident from the photograph. In the context in which we observed this behavior it must only have been for self-enjoyment (play), although orang-utans also make use of twigs in a similar fashion to poke and scrape at termite and wasp nests (Harrisson, 1963). Harrisson (1963) has reported a case of an orang-utan fashioning a tool to open a wasp nest: first the orang-utan listened to the wasps inside the tree, made the hole bigger by biting, and then inserted a finger followed by a twig. The twig proved to be too large, so he bit the stick to size by taking shavings off one end, similar to Catalina's remarkable feat of fashioning a tool by

FIGURE 2. BJ using a stick to scratch the ground. Note the position of the thumb relative to the figures. Opposability is possible.

biting a piece of a beam to the length required for retrieving the food dish. He then reinserted it, holding the twig between his teeth and punching into the hole using head thrusts. Reminiscent of Koehler's suggestion, powerful use of a stick may best be achieved by use of the mouth and head, although we have observed orang-utans making powerful downward thrusts with large sticks using the grip which Koehler describes as akin to holding a dagger.

As Koehler suggests, this angle of hold might well be related to the position of the hand in gripping branches during climbing (cf. species variation amongst primates, in Bishop, 1962, 1964). The arboreal existence of orang-utans is most certainly an overall determinant of their behavioral repertoire. Catalina's exceptional accuracy in assessing the exact stick length in solving the problem which Koehler presented to her might also reflect accuracy of distance measurement and assessment necessary for survival in an arboreal environment.

Here we would like to touch on the main focus of our studies on the semi-wild orang-utans by mentioning handedness (Rogers & Kaplan, in preparation). Koehler meticulously noted that Catalina used her right hand to hold the stick which she used to pull the food dish into her cage. Interestingly, in our three observations of use of leaves as a plate the right hand was used to hold the tool (leaves). The left hand was used to arrange the leaves into the plate shape. Could this suggest a right-handed preference for holding tools? The right bias could, of course, result from chance. Many more observations are needed to determine whether there is handedness for specific functions. Chimpanzees show individual, but

not a population, bias in hand preference to hold the tool which they use for termite fishing (McCrew & Marchant, 1992).

Our large study of hand use in orang-utans, sampling more than 40 of the semi-wild individuals, has revealed a strong bias to use the left hand to touch the face (to clean the teeth or ears, for example) but no population bias for handedness in feeding. A similar left-hand preference for face touching has been reported for other primates (Dimond & Harries, 1984; Suarez & Gallup, 1986), and for a single infant orang-utan (Cunningham, Forsythe, & Ward, 1989). For feeding, some individuals show a left-hand bias and others a right-hand bias, and for yet others there is no clear bias. The handedness is much stronger when they feed in a seated or propped position compared to when they are hanging. This result is also largely supported by studies of caged orang-utans (Olson, Ellis, & Nadler, 1990), although no influence of body posture on handedness has emerged in caged orang-utans. We would stress the need to study handedness in orang-utans which have been reared in the rainforest environment with opportunity for a multitude of different hand uses in climbing, food gathering, tool use, etc. Orang-utans living thus may also show different (possibly superior) abilities in problem solving tasks, if they can be persuaded to take part in the experiments. Rarely do researchers testing problem solving abilities in primates take into account the past experience of their subjects or the contextual interactions occurring at the time of testing.

Koehler describes the lack of leaping motions in the orang-utan compared to the chimpanzee. That information is borne out by other observations of orang-utans in their natural environment. In his extensive field studies, MacKinnon saw only one example of a leaping orang-utan, and this occurred when the animal was fleeing from the researcher (MacKinnon, 1971). Unlike Koehler, instead of seeing lack of leaping as a deficiency, we interpret it as another adaptation to a highly arboreal life in a large animal. The orang-utan locomotes from tree to tree by swinging and always grasping a branch or creeper with at least one hand or foot, and usually more. Leaping is never used, although contrary to Koehler's claim, "temporary energy derived from the motion of the body-mass" is in fact used. In order to reach a distant tree, orang-utans swing back and forth on smaller saplings or branches until they gain sufficient displacement to reach their goal. In a sense, this is assisted "leaping," the only safe way for a large animal to locomote in the trees. The fact that neither the hands nor feet are designed for landing on the ground is another consequence of adaptation to arboreal life rather than being an explanation of why leaping does not occur, as Koehler claims. Thus, many of the behavior patterns of orang-utans become more explicable when they are observed in their natural environment.

The so-called destructive nature of Catalina is most likely an artefact of the caged environment, although semi-wild orang-utans are also de-

structive of plants and trees, which they break either accidentally when climbing or by design when playing, threatening (Davenport, 1967), building a nest, or when eating new shoots (Harrisson, 1960). However, given the sparse distribution of wild orang-utans (Galdikas, 1985; Mitani et al., 1991), such behavior is unlikely to be noticeably destructive to the environment. It becomes a problem behavior only in captivity or in cases of local overpopulation at the Rehabilitation Centers. In the wild, it is not dysfunctional, but functional, behavior in the sense of tool use, nest building, self-defence and feeding.

3. THE COGNITIVE DEVELOPMENT OF ORANG-UTANS

Exactly how "social" orang-utans are is presently a matter of debate. Their social organisation may differ in different localities (Mitani et al., 1991). Associations outside mother offspring bonding appear to occur infrequently and to be primarily for mating or as a result of aggregation at a preferred fruiting tree (Galdikas, 1985; Mitani et al., 1991). Koehler, regretting the loss of Catalina's only companion, the young male orang-utan, emphasises that it would be desirable to observe orang-utans in group interaction. Although the importance of observing group interaction cannot be denied, no matter how infrequently it may occur, the orang-utan may be less disturbed by being solitary than other primates, such as the chimpanzee. Not knowing anything of the social organisation of orang-utans, Koehler was amazed at Catalina's enjoyment of play "even by herself." In fact, the young orang-utans at Sepilok spend at least as much time playing alone as they do with each other. That is, even when plentiful opportunity for social play is available, individuals will opt for playing alone. Of course, social organisation and bonding may determine social versus individual play, and this has not yet been studied. Certain individuals do form strong bonds and so engage in mutual play, but always interspersed with pursuing their individual interests (Harrisson, 1960). The orang-utans that have been studied by Harrisson and by us are semi-wild only and relatively used to human contact. In the Rehabilitation Centers the forest is overpopulated near the provisioning site. These circumstances may lead to enhanced social play which, in the wild, might occur with much lower frequency or more sporadically.

It is commonly assumed that higher cognitive capacity in primates is linked to greater complexity in social organisation (Cheney, Seyfarth, & Smuts, 1986), but the orang-utan's problem solving ability clearly rivals that of the more "social" chimpanzee. The relatively more "solitary" orang-utan may nevertheless have complex social communication when meetings do occur (albeit less demonstrative than that of chimpanzees), and, although the individuals are more widely dispersed, complex patterns of associations between individuals may still occur over long periods of time (Mitani et al., 1991). The vocalisations (Niemitz & Kok, 1976)

and facial expressions of orang-utans seem to be extremely complex, and they have yet to be systematically studied. Alternatively, it might be argued that orang-utans had no need to develop communication skills to the same extent as group-living species, but that they instead developed their cognitive capacities for solving problems in relatively solitary existence.

Similarly, Catalina's apparent lack of goal-directed behavior, or her easy distraction from the task set by the experimenter, may be a reflection of the relative solitariness of orang-utans compared to chimpanzees. Group-living individuals must compete by focussing on a task and completing it in minimum time, whereas a solitary individual has no such group pressure for obtaining resources. Therefore, even if Catalina's behavior is characteristic of her species, it should not be interpreted as indicating a lower degree of cognitive evolution. Present-day researchers are far less inclined to draw generalisations such as these, although elements of this approach still underlie much thinking on the evolution of behavior. Even though genetic hybridisation studies indicate that orang-utans evolved before chimpanzees, the behavior of orang-utans, whatever it might be, should not necessarily be interpreted as being more primitive.

Finally, in place of a conclusion, we would like to note the sex bias in Koehler's account. Koehler attributed possible age and state-of-health differences between his two orang-utans to sex differences in behavior. Here his interpretations of sex stereotypes were clearly a product of his time and social attitudes. To our knowledge, there has been no study of male-female differences or similarities in behavior of orang-utans. Koehler's expectations and hopes that the male might do better than the female reflect his own personal views rather than scientific evidence. The Koehler article reminds us of the need to conduct such studies from a non-culture-bound perspective, if that is possible!

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