The Growth of Competence

For all the world's children

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Nature and Uses of Immaturity

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To understand the nature of any species fully, we need to know more than the ways of its adults. We need to know how its young are brought from initial, infantile inadequacy to mature, species-typical functioning. Variation in the uses of immaturity tells much about how adaptation to habitat is accomplished, as well as what is likely to happen given a change in habitat. The nature and uses of immaturity are themselves subject to evolution, and their variations are subject to natural selection, much as any morphological or behavioral variant would be.

One of the major speculations about primate evolution is that it is based on the progressive selection of a distinctive pattern of immaturity. It is this pattern of progressive selection that has made possible the more flexible adaptation of our species. Too often this pattern is over-explained by noting that human immaturity is less dominated by instinct and more governed by learning.

Because our ultimate concern is with the emergence of human adaptation, our first concern must be the most distinctive feature of that adaptation. This feature is man's trait, typical of his species, of "culture using", with all of the intricate set of implications that follow.

Man adapts (within limits) by changing the environment, by developing not only amplifiers and transformers for his sense organs, muscles, and reckoning powers, as well as banks for his memory, but also by changing literally the properties of his habitat. Man, so the truism goes, lives increasingly in a man-made environment. This circumstance places special burdens on human immaturity. For one thing, adaptation to such variable conditions depends heavily on opportunities for learning, in order to achieve knowledge and skills that are not stored in the gene pool. But not all that must be mastered can be learned by direct

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encounter. Much must be "read out" of the culture pool, things learned and remembered over several generations: knowledge about values and history, skills as varied as an obligatory natural language or an optional mathematical one, as mute as using levers or as articulate as myth telling. Yet, though there is the gene pool, and though there exist direct experience and the culture as means for shaping immaturity, none of these directly prepare for the novelty that results when man alters his environment. That flexibility depends on something else.

Yet, it would be a mistake to leap to the conclusion that because human immaturity makes possible high flexibility in later adjustment, anything is possible for the species. Human traits were selected for their survival value over a four-five-million-year period, with a great acceleration of the selection process during the last half of that period. There were crucial, irreversible changes during that final man-making period — recession of formidable dentition, doubling of brain volume, creation of what Washburn and Howell (1960) have called a "technical-social way of life", involving tool and symbol use. Note, however, that hominidization consisted principally of adaptations to conditions in the Pleistocene. These pre-adaptations, shaped in response to earlier demands of the habitat, are part of man's evolutionary inheritance. This is not to say that close beneath the skin of man is a naked ape, that "civilization" is only a "veneer". The technical-social way of life is a deep feature of the species adaptation.

But we would err if we assumed a priori that man's inheritance places no constraint on his power to adapt. Some of the pre-adaptations can be shown to be presently maladaptive. Man's inordinate fondness for fats and sweets no longer serves his individual survival well. And human obsession with sexuality is plainly not fitted for survival of the species now, however well it might have served to populate the upper Pliocene and the Pleistocene. But note that the species responds typically to these challenges by technical innovation rather than by morphological or behavioural change. This is not to say that man is not capable of controlling or, better, transforming behaviour. Whatever its origin, the incest taboo is a phenomenally successful technique for the control of certain aspects of sexuality—although its beginning among the great apes (Van Lawick-Goodall, 1968) suggests that it may have a base that is rooted partly in the biology of propinquity, a puzzling issue. The technical innovation is contraception, which dissociates sexuality from reproduction. What we do not know, of course, is what kinds and what range of stresses are produced by successive rounds of such technical innovation. Dissociating sexuality and reproduction, for example, may produce changes in the structure of the family by redefining the sexual role of women, which in turn may alter the authority pattern affecting the child, etc. Continuous, even accelerating, change may be inherent in such adaptation. If this is so, then there is an enormous added pressure on man's uses of immaturity for instruction. We must prepare the young for unforeseeable change—a task made the more difficult if severe constraints imposed by human pre-adaptations to earlier conditions of life have created rigidities.

EVOLUTION OF EDUCABILITY

LeGros Clark's (1963) echelle des etres of the primates runs from tree shrews through the prosimian lorisiformes, lemuriformes, and related forms, through the New World and Old World monkeys, through the hylobates such as the gibbon, through the great apes, through the early hominids like Australopithecus and Homo habilis and other small-brained predecessors, terminating in the modern form of Homo sapiens with his 1 300 cm$^3$ brain. Closing the gap between great apes and modern man is, of course, a complex and uncertain undertaking, particularly where behaviour is concerned, for all that remains are paleontological and archaeological fragments, and little by way of a behaviour record. But there are inferences that can be made from these fragments, as well as from the evolution of primate behaviour up to the great apes. Enough is known to suggest hypotheses, though no conclusions. Such an echelle des etres is bound to be only a metaphor since contemporary species are only approximations to those that existed in the evolutionary tree. But it can tell us something about change in the primate order. We propose to use it where we can to make inferences, not so much about pre-adaptations to earlier conditions that characterize our species, but rather more to assess crucial changes that have been recurring in immaturity. My interest is in the evolution of educability.

But you will know by my credentials that I am not primarily a student of prehuman primates. I have brought the materials of primate evolution together to understand better the course of human infancy and childhood, its distinctiveness or species typicality. I propose to go back and forth, so to speak, between primate phylogeny and human ontogeny, to establish any shallow parallel between the two, but in the hope that certain contrasts will help us see more clearly. If indeed the fish will be the last to discover water, perhaps we can help ourselves by looking at some other species.

Specifically, I should like to look at several issues whose resolution might be of particular help. The first of these has to do with the nature and evolution of social organization within a species and how this may
affect the behaviour of the immature. The second has to do with the structure of skill and how the evolution of primate skill almost inevitably leads to tool using. We must then pause to consider the nature of tool using and its consequences. That matter in turn leads us directly to the roles of both play and imitation in the evolution of educability. Inevitably, we shall deal with that distinctly human trait, language: what it is and how its emergence drastically alters the manner in which we induct young into the species.

My emphasis throughout is principally on the evolution of intellect—problem solving, adaptation to habitat, and the like. But it will soon be apparent that, to use the jargon (Bloom, 1956), one cannot easily separate the cognitive from the conative and the affective. I have been told that the Chinese character for thinking combines the character for head and the character for heart. It is a pity it does not also include the character for others as well, for then it would be appropriate to what will concern us. At the end of this paper, I try to deal with the question of what can be done to better equip the young for coping.

Any species depends, as we know from the work of the last half century (e.g. Mayr, 1963), on the development of a system of mutuality—a set of mechanisms for sharing a habitat or territory, a system of signalling that is effective against predators, dominance relations that are effective without being pre-empting (Chance, 1967), a system of courtship with matching mating releasers (Tinbergen, 1953), etc. There is, at the lower end of the primate line, a considerable amount of rather fixed or linear structure about such mutuality. Behaviour repertoires are limited in prosimians and in monkeys, and the combinatorial richness in their behaviour is not great (see Jolly, 1966), though one can make a case for their goodness of fit to habitat conditions (as Hinde, 1971, recently has). Even where there is, within a given species, an increased variety in behaviour produced by enriched or more challenging environments—as in the contrast between urban and forest-dwelling rhesus monkeys (Singh, 1969) or among Japanese macaques tempted by new foods introduced in their terrain (Itani, 1958)—the difference is not toward variability or loosening of social structure, but toward the incorporation of new patterns into the species-typical social pattern. Action patterns that are altogether fixed prevail; and play, that special form of violating fixity, is limited in variety, early and short lived, and irreversibly gone by adulthood—a matter to which I shall return.

There are notably fixed limits for the young of these species; and as the animal grows from infant to juvenile to adult—transitions usually marked by conspicuous changes in appearance and coat colour—social induction into the group is effected rapidly, usually by the quick response of a young animal to the threat of attack by an older animal in the troop. The sharply defined oestrous receptivity of the adult female almost assures that the young animal will be rejected and made virtually self-sufficient within a year. It is this sharply defined receptivity that also creates a scarcity economy in sexual access and leads to such a close link between male dominance and sexual access—perhaps the most notable source of linear, tight social structure virtually throughout the monkeys and prosimians. The comfort-contact system of mother and infant, involving not only initial nursing but also hair holding and grasping by the young for protection in flight and for sheer comfort, is obviously of great importance in prosimians, New World, and Old World monkeys. But as Dolhinow and Bishop (1970) have remarked, we must be careful about exaggerating it. Harlow's (e.g. 1959) pioneering studies do show that a macaque made solely dependent on a terry-cloth and wire-mesh mother surrogate is more backward than one dependent on a real mother. Yet, for all that, twenty minutes of play daily with peers in a play cage obliterates the difference between the three groups—another of Harlow's (Harlow and Harlow, 1962) findings. Note by way of contrast that a three-year-old chimpanzee deprived of a mother modelling the skilled act of fishing for termites seems not to be able to master the act later, even if among peers who are succeeding.

**LOOSENING THE PRIMATE BOND**

Probably the first step toward loosening the initially tight primate bond is the development of what Chance (1967) has referred to as an "attentional structure" within the group. Rather than behaviour patterns leading to constant interaction and mutual release of agonistic patterns, there is instead a deployment of attention in which the dominant animal is watched, his behaviour is anticipated, and confrontation is avoided. One of the major things that induction into a tightly organized Old World monkey group means, then, is an enormous investment in attention to the requirements of the troop—mating, dominance, food foraging, etc. There is, so to speak, little attentional capacity left for anything else.

The great apes represent a crucial break away from this pattern toward a far more relaxed one, and as we shall see in a moment, the effect on the young is striking. All three of the great ape species are virtually free of predators. None of them defends a territory. None of them has a troop structure nearly as well defined and rigidly maintained as, say, the least rigid Old World species, if such as phrase makes sense. In the gorilla, the orang-utan, and the chimpanzee, male dominance
does not preclude copulation between a subdominant male and a female in the presence of the dominant male. It is even difficult, in fact, in the case of chimpanzee and orang-utan to define a dominant male in the monkey sense (cf. e.g. Goodall, 1965; Reynolds, 1965; Schaller, 1964). Indeed the route to dominance may even involve a superior technological skill. Note the increased deference paid to a male in the Gombe Stream Reserve who had learned to produce an intimidating din by banging two discarded tin cans together (Van Lawick-Goodall, 1968). Thus, too, while oestrus marks the period of maximum receptivity in which the female initiates sexual activity, her availability to a male may in fact continue even into the first two months of pregnancy (Reynolds, 1965). Doubtless the achievements of a 600–700 cm³ brain in great apes also contributes to the further evolution of cerebral control of sexual behaviour of which Beach (1965) has written. The spacing of infants is over three years apart, on the average, and the bond between mother and infant, particularly in the chimpanzee, remains active for as long as five years (Van Lawick-Goodall, 1968).

One concomitant of the change is the decline in fixed patterns of induction into the group. There is much less of what might be called training by threat from adults or actual punishment by adults of a juvenile who has violated a species-typical pattern. The prolonged infant–mother interaction includes now a much larger element of play between them often initiated by the mother and often used to divert an infant from a frustrating situation.

What appears to be happening is that, with the loosening of fixed bonds, a system of reciprocal exchange emerges, the structure of which is at first difficult to describe. In any case, the system makes it possible for chimpanzee and gorilla groups to encounter groups of conspecifics in their range without fighting; indeed in the case of the more flexibly organized chimpanzees, such encounters may even include sexual relations between groups and an exchange of members (Reynolds, 1965; Van Lawick-Goodall, 1968). There can be little doubt that primate evolution is strongly and increasingly characterized by such reciprocal exchange. The trend probably predates the emergence of hominids. In a recent article, Trivers (1971) said,

During the Pleistocene, and probably before, a hominid species would have met the preconditions for the evolution of reciprocal altruism: long life span, low dispersal rate; life in small, mutually dependent, stable, social groups (Lee and DeVore, 1968; Campbell, 1966); and a long period of parental care. It is very likely that dominance relations were of the relaxed, less linear form characteristic of the baboon (Hall and DeVore, 1965) (p. 45).

As Gouldner (1960) reminded us a decade ago and as new studies on remaining hunter-gatherers reassert (Lee and DeVore, 1968), there is no known human culture that is not marked by reciprocal help in times of danger and trouble, by food sharing, by communal nurture for the young or disabled, and by the sharing of knowledge and implements for expressing skill. Levi-Strauss (1963) posited such exchanges as the human watershed and classified them into three types: one involving the exchange of symbols and myths and knowledge; another involving the exchange of affectional and affiliative bonds, including the exchange of kin women in marriage to outside groups for political alliances, with this rare resource preserved by an incest taboo; and finally an exchange system for goods and service. The pressures in such primate groups would surely select traits consonant with reciprocity, leading to self-domestication by the selection of those capable of "fitting in". The incessant aggressiveness of the linear pattern would wane gradually.

What accompanies these changes is a marked transformation in ways of managing immaturity. The maternal buffering and protection of the young not only lengthens materially but undergoes qualitative changes. Several of these have been mentioned: a much prolonged period dominated by play; increased participation in play by adults, especially, though not exclusively, by the mother; decline in the use of punishment and threat as modes of inducting the young into the pattern of species-typical interactions. The most important, I believe, is the appearance of a pattern involving an enormous amount of observation of adult behaviour by the young, with incorporation of what has been learned into a pattern of play (Dolhinow and Bishop, 1970; Hamburg, 1968; Hayes and Hayes, 1952; Köhler, 1926; Reynolds, 1965; Rumbaugh, 1970; Van Lawick-Goodall, 1968; Yerkes and Yerkes, 1929)². Though psychologists are chary about using the term imitation because of the difficulty of defining it, virtually all primatologists comment on the enormous increase in imitation found in chimpanzees in contrast to Old World monkeys (where there is genuine doubt whether imitation in any commonsense meaning of the term occurs at all). After its first appearance at about seventeen months of age, this pattern of observing and imitating takes up much of the time of infants and young juveniles—watching social interaction, watching the care of the young, watching copulation, watching agonistic displays, watching instrumental or tool behaviour. Such observation requires free attention on the part of the young and often the opportunity for the young to imitate; thus the young is not precluded from choosing to do so.

²It should be noted carefully that in certain crucial ways, both mountain and lowland gorilla are exceptions to what is described here. For some interesting speculations about the lack of curiosity and imitativeness in the gorilla as related to his undemanding habitat and food supply as well as to his lack of need for cooperative efforts, see Yerkes and Yerkes (1929), Rumbaugh (1970), and particularly Reynolds (1965).
young; and, indeed, the incorporation of observed behaviour in play occurs most usually during the more relaxed periods in the life of the group. It was Köhler (1926), in his classic *The mentality of apes*, who commented initially on the intelligent rather than the mechanical or slavish nature of imitative behaviour in anthropoids—how the sight of another animal solving a problem is used not to mimic but as a basis for guiding the observer’s own problem solving or goal striving. He used the term “serious play” (p. 157), and the literature since the early 1920s bears him out (e.g. Dolhinow and Bishop, 1970; Hamburg, 1968). In a word, the chimpanzee adult serves not only as a buffer or protector or “shaper” for the young but as a model—though there is no indication of any intentional modelling or of behaviour that is specifically “demonstrational”.

To summarize briefly, the emergence of a more flexible form of social bonding in primate groups seems to be accompanied by the emergence of a new capacity for learning by observation. Such learning indeed may be necessary if not sufficient for transmission of culture. But that gets ahead of the argument still to be made; for there is still an enormous gap to be accounted for between the behaviour of a grouping of great apes, however flexible, and the mode of structuring of a human society, no matter how simple it may be.

**OBSERVATIONAL LEARNING**

There are many facets to observational learning (I cautiously continue to avoid the term *imitation*). There is ample evidence that many mammals considerably less evolved than primates can benefit from exposure to another animal carrying out a task; for example, the classic study of cats by Herbert and Harsh (1944) demonstrates improvement in escape from a puzzle box by cats who have seen other animals escape—and the more so if the cats observed were still inexpert at the task. Whether they are learning the possibility of getting out of the box, the means for doing so (by displacing a bar), or whatever, observation helps. So too with *Macaca fuscata*, the Japanese macaque, where the young animals learn to eat what the mother eats by eating what she leaves (Itani, 1958; Kawamura, 1959); or the naive, cage-reared *patus* monkey transported to a habitat and released in a natural troop, who learns from the group by following it in search of food.

But this is quite different from the sort of “serious play” to which Köhler (1926) referred. Consider an example:

I would call the following behavior of a chimpanzee imitation of the “serious play” type. On the playground a man has painted a wooden pole in white color. After the work is done he goes away leaving behind a pot of white paint and a beautiful brush. I observe the only chimpanzee who is present, hiding my face behind my hands, as if I were not paying attention to him. The ape for a while gives much attention to me before approaching the brush and the paint because he has learned that misuse of our things may have serious consequences. But very soon, encouraged by my attitude, he takes the brush, puts it into the pot of color and paints a big stone which happens to be in the place, beautifully white. The whole time the ape behaved completely seriously. So did others when imitating the washing of laundry or the use of a borer (pp. 156–157).

I consider such behaviour to be dependent on two important prerequisites, both amenable to experimental analysis:

*The first is the ability to differentiate or abstract oneself from a task;* to turn around on one’s own performance and, so to speak, see oneself, one’s own performance as differentiated from another. This involves self-recognition in which one, in some way, is able to model one’s own performance on some selected feature of another’s performance. This phenomenon in linguistics is known as *deixis*; as in learning that when I say *I*, it is not the same as when you say *I*, or that *in front of me* is not the same as *in front of you* or *in front of the car* (cf. Miller and Johnson-Laird). It is a deep problem in language learning, and though it seems cumbersome and abstract in a discussion of hominid evolution, it may be amenable to demonstration. Indeed, I believe that the excellent study by Gallup (1970) indicates that there is a large gap between such Old World monkeys as the stump-tailed macaque and the chimpanzee: the latter can recognize his mirror image and guide self-directed behaviour by it (e.g. inspecting by touch a spot on the forehead seen in the mirror); the former cannot. The macaque, as a matter of fact, seems able only to attack or threaten its’ mirror image or to ignore it. These findings are surely not proof of the emergence of deictic capacities in the ape, but they do suggest a crucial trend for guiding one’s own behaviour by feedback other than, so to speak, from action proper. Learning by observation is one instance of that class.

The second prerequisite for observation learning is a form of skill I now examine: *construction of an action pattern by the appropriate sequencing of a set of constituent subroutines to match a model* (Lashley, 1951). Observing the development of skilled, visually directed manipulatory activity in human infants and children, one is struck repeatedly by the extent to which such activity grows from the mastery of specific acts, the gradual perfecting of these acts into what may be called a modular form, and the combining of these into higher order, longer

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range sequences. Flexible skilled action may almost be conceived of as the construction of a sequence of constituent acts to achieve an objective (usually a change in the environment) while taking into account local conditions. As the Russian neurophysiologist Bernstein (1967) has put it, one can almost conceive of an initial skilled act as a motoric hypothesis concerning how to change the environment along a desired parameter. The flexibility of skill consists not only of this constructive feature but also of the rich range of "paraphrases" that are possible: for a skilled operator, there are many different ways of skinning a cat; and the word paraphrase is not amiss, for there is in this sense something language-like about skill, the kind of substitution rules that permit the achievement of the same objective (meaning) by alternative means.

If one compares the manipulatory activity of a child (or of a young chimpanzee) and a prosimian, such as a loris, the most striking difference is precisely the extent to which manual activity of human and chimpanzee is constructed of components to meet the properties of the task. The wide range of combinations in the use of the component gestures that go into the making of the final prehension—relatively independent movement of fingers, of hand, of wrist, etc.—is striking. But as Bishop (1964) pointed out, prosimians use virtually the same grip for a variety of activities: taking hold of a branch, grooming, taking a piece of fruit, etc. My own informal observation on slow lorises confirms this. The grip is adapted to the task by changing the orientation of the whole hand, by altering speed or force, etc. Napier (1962) has noted how the development of flexibility is facilitated morphologically by the evolutionary selection of phalangeal flexibility, and change in the hamate and trapezium with emergence of power and precision grips, but I part company with Napier in that it is not so much a change of manual morphology that separates baboon from ape from man, but the nature of the programme that controls the use of the hands.

Imitation as "serious play"—incorporating what is observed into behaviour that is not mere mimicry but is directed intelligently to an end—must of course depend on "matching to model!", on constructing behaviour in the manner we have just examined, and must be concerned with the kind of deictic anchoring that permits one to distinguish and relate what is analogous in my behaviour and in that of another member of the species.

**EFFECT OF TOOLS**

We must consider now the question of tools and their use, and what effect this evolutionary step may have had on the management of immaturity. We might begin with its first emergence in chimpanzees, but before we do, it is worth considering initially a speculation by DeVore (1965) on the emergence of bipedalism and the freeing of hands. According to this speculation, and it can be nothing more, two contradictory selection pressures operated on the emerging protohominid. The first was for bipedal locomotion and easy standing, freeing the hands. The second was for a larger brain to provide the more flexible programming for the hands (as discussed above). Bipedalism, involving stronger impact on the pelvic girdle, led to selection of a smaller bony aperture of the birth canal to assure greater structural strength of the pelvis. If a bigger brained creature is to get through a smaller canal, there is required, of course, a smaller initial brain size and, therefore, greater initial immaturity (the human brain grows from approximately 335 to 1300 cm³ during development). To assure the larger brain, the argument goes, there had also to be a recession in such aelike features as a heavy prognathous jaw as a base for effective dentition. *En route*, there is a critical point where the basic adaptation of the hominid must change.

So we may begin with the fact that tool using at its first appearance in apes comes before that point: it is an optional and not an obligatory adaptation. Chimpanzee survival does not depend on the use of sticks for fishing termites or on the use of crushed leaves as drinking or grooming sponges. As Jane Lancaster (1968) put it in a closely reasoned article on tool use, there is "a major change from the kind of tool use that is incidental to the life of a chimpanzee to the kind that is absolutely essential for survival of the human individual" (p. 62). Yet, in spite of the absence of "obligatory pressures", chimpanzees use tools optionally in an extraordinary variety of ways: for eating, drinking, self-cleaning, agonistic displays, constructing sleeping platforms, etc. Nor is it some accident of morphology: "the hands of monkeys and apes are equally suited to picking up a stick and making poking or scratching movements with it but differences in the brain make these much more likely behaviour patterns for the chimpanzee" (p. 61).

I would like to make the rather unorthodox suggestion that in order for tool using to develop, it was essential to have a long period of optional, pressure-free opportunity for combinatorial activity. By its very nature, tool using (or the incorporation of objects into skilled activity) required a chance to achieve the kind of wide variation upon which selection could operate.

4 For an excellent account of the changes that occur during this enlargement, making possible greater flexibility of connection and possibly better memory storage, see Altman (1967). Some of the same changes during this period of expansion also occur as a result of challenging environments (Bennet et al., 1964), and in the course of phylogeny (Altman, 1967).
Dolhinow and Bishop (1970) made the point most directly. Commenting first that “many special skills and behaviours important in the life of the individual are developed and practised in playful activity long before they are used in adult life” (p. 142); they then note that play “occurs only in an atmosphere of familiarity, emotional reassurance, and lack of tension or danger” (p. 142). Schiller (1952) reported, “with no incentive the chimpanzee displayed a higher variety of handling objects than under the pressure of a lure which they attempted to obtain” (p. 186). He reported, actually, that attempting to direct play by reinforcing chimpanzees for play behaviour had the effect of inhibiting play.

FUNCTIONS OF PLAY

Play appears to serve several centrally important functions. First, it is a means of minimizing the consequences of one’s actions and of learning, therefore, in a less risky situation. This is particularly true of social play, where, by adopting a play face or a “galumphing gait” (Millar, 1968) or some other form of metacommunication (Dolhinow and Bishop, 1970), the young animal signals his intent to play. Now, so to speak, he can test limits with relative impunity: “There are many rules of what can and cannot be done in a troop, and most of these are learned early in life, when the consequences of violating them are less severe than later on” (Dolhinow and Bishop, 1970, p. 148).

Second, play provides an excellent opportunity to try combinations of behaviour that would, under functional pressure, never be tried. The tendency to manipulate sticks, to lick the ends, to poke them into any available hole are responses that occur over and over again in captive chimpanzees. These responses are not necessarily organized into the efficient use of sticks to probe for objects, but they probably form the basis of complex motor patterns such as terming (Lancaster, 1969, p. 61).

Or in Van Lawick-Goodall’s (1968) account:

With the fruit, Figan devised a game of his own: lying on his back, he spins a *Strychnos* ball round and round, balancing it on his hands and kicking gently with his feet, like a circus bear. . . . Toys like this are not always at hand, but then the youngsters seem just as content to play with stones, leaves, or twigs. They may throw them, rub them over their bodies, pull leaves off stems, break and bend twigs, or poke them into holes in the ground. This form of play may be of tremendous importance in developing dexterity in manipulating objects. As the chimps grow older this skill becomes invaluable not only in routine activities such as nest-making and food-gathering, but also in the most specialized field of tool use (pp. 36-37).

And even in captivity, this same tendency to incorporate objects into manipulative pattern goes on undiminished, as one may judge from this report by Caroline Loizos (1967) of a young female chimpanzee habituating to and then “mastering in play” a tennis ball:

I bounce a tennis ball in front of the cage several times so that she hears as well as sees it and place it inside on the floor. She backs away, watching ball fixedly—approaches with pouted lips, pats it—it rolls. She backs hurriedly to the wall. Hair erection . . . J. pokes it at from a distance, arm maximally extended, watching intently; looks at me; pokes ball and immediately sniffs finger. . . . She dabs at ball and misses; sniffs fingers; she backs away and circles ball from a distance of several feet, watching it intently. Sits and watches ball . . . (pause of several minutes) . . . walks around ball. J. walks past the ball again even closer but quite hurriedly. She lifts some of the woodwool in the cage to peer at the ball from a new angle, approaches ball by sliding forward on stomach with arms and legs tucked underneath her, so that protruded lips are very close to ball without actually touching it. Withdraws. Pokes a finger towards it and sniffs finger . . . returns to ball, again slides forward on stomach with protruded lips without actually connecting. Pokes with extended forefinger, connects and it moves; she scurries backwards; more dabs at it with forefinger and it moves again (but not far because of the woodwool in that area of the cage). J. dabs, ball rolls and she follows, but jumps back in a hurry as it hits the far wall. She rolls the ball on the spot with her finger resting on it, then rolls it forward, watching intently the whole time. She dabs again—arm movement now more exaggerated, flung upwards at end of movement. Tries to pick ball up between thumb and forefinger very gingerly . . . fails. Rolls it towards her, sniffs with lowered head. Picks it up and places it in front of her—just touches it with lips—pushes it into straw with right forefinger—touches it with lower lip pushed out, pokes, flicking up hand at end of movement, but backs away as it rolls towards her. Bites at own thumb. Dabs at it with lips, pulls it towards her and backs away. Examines own lip, squinting down, where it touched ball. Picks it at with forefinger and covers ball as it rolls (walking on all fours, with head down to watch ball as it rolls along at a point approximately under her belly). Pushes with outside knuckles. Stamps on it, dabbing at it with foot. Sits on it, rolls it with foot; carries it gingerly with hand and puts it on shelf, climbing up to sit beside it. It drops down—she holds it in one hand and pats it increasingly hard with the other. Holds it in right hand, picks at stripe on ball with her left. Rolls it between two hands. Rolls it between hand and shelf. Holds and pats; bangs it on shelf: Holds and *bites*, examining ball after each bite. Ball drops from shelf and she puts it at it on ground with right hand. Lies on her back, balances ball on foot, holding it there with hands; sits up, holds ball under chin and rolls it two or three times round back of neck and under chin. It rolls away and she chases it immediately and brings it back to shelf. Lies on back and holds it on feet. Presses it
Various writers (Dolhinow and Bishop, 1970; Loizos, 1967; Van Lawick-Goodall, 1968) are convinced that the mastery of complex tool skills among subhuman anthropoids depends not only on observation learning but also on whether or not they take place in the close setting of the infant–mother interaction. Reference was made in passing to one of the infants in the Gombe Stream Reserve, Merlin, who lost his mother at age three and was “taken over” by older siblings. He mastered neither termite nor nest building, skills that apparently require repeated observation.

Van Lawick-Goodall (1968) made it clear in her detailed reporting why such repeated opportunity to observe and play is necessary; mastery of a complex skill like termite or nest building is a complex process of mastering features of the task—a non-mimicking approach—and then combining the mastered features. There is, for example, mastery of pushing a stick or grass into an opening, though initially this will be done without regard to appropriate rigidity of the probe or appropriate diameter, or appropriate length. It will be played with as a part skill once mastered—as Flint (2-8 years who had started at play termite) pushing a grass stalk through the hairs of his leg. And sheer repetition will provide the familiar routinization that permits an act to be combined with other acts to meet the complex requirement of a stick of a particular diameter and rigidity, pushed in a particular way, withdrawn at a particular angle at a certain speed, etc. A comparable set of observations on human infants by Wood et al. shows the importance of skill to three-five-year-olds in enabling them to benefit from demonstrations of how to put together an interlocking set of blocks to make a pyramid. Unless the child can master the subroutines, the demonstration of the whole task is about as helpful as a demonstration by an accomplished skier is to a beginner. As with the young chimps, so too with the young children: they take selectively from the demonstration those features of performance that are within the range of their capacity for constructing skilled acts. They are helped, but the process is slow.

One very crucial feature of tool skills in chimpanzees as in humans is the trying out of variants of the new skill in different contexts. Once Köhler’s (1926) ape Sultan had “learned” to use a stick to draw in food, he tried using it very soon for poking other animals, for digging, and for dipping it through an opening in a cesspool. Once Rana had learned to climb up stacked boxes to get a suspended piece of fruit, she rapidly tried her new climbing routine on a ladder, a board, a keeper, and Köhler himself—most often forgetting the fruit in preference for the combinatory activity per se. Nor is this a response to the boredom of captivity, since the same variant exploration is to be found in the Gombe Stream animals studied by Van Lawick-Goodall (1968)—one of the most ingenious instances being the use of a twig as an olfactory probe by the juvenile female Fifi, an accomplished termite:

On three occasions (she) pushed a long grass stalk right into my trouser pocket, subsequently sniffing the end, when I prevented her feeling there with her hand for a banana. Each time there was in fact a banana there, and she followed me whimpering until I gave it to her (p. 206).

It is probably this “push to variation” (rather than fixation by positive reinforcement) that gives chimpanzee manipulation such widespread efficacy—such opportunism as dipping sticks into beehives for honey (Merfield and Miller, 1956), using sticks for clubbing lizards and rodents (Köhler, 1926), and using branches for striking at or throwing at big felines (Kortland and Koöij, 1963). The ecological significance of this wide potential repertory is attested to by observations of Kortland and his collaborators (Kortland, 1965; Kortland and Koöij, 1963; Kortland and van Zon, 1969). They have reported striking differences between forest-dwelling chimpanzees from the rain forest of the Congo and Guinea and those from the Guinea savanna. An animated, dummy leopard was placed in the path of the chimpanzees. Forest apes broke and brandished branches and swung them in horizontal orbit at the dummy. The only hit was by one animal, punching the dummy in the face from in front. Savanna apes warmed up with such sabre rattling, but then attacked the dummy from the rear with strong vertical blows with the heaviest available branch and scored violent hits—“showing both tactical cooperation between the actual assailants and vocal support by the onlookers” (Kortland and van Zon, 1969, p. 12). These authors suggest that open country prevents arboreal escape and thus poses for the animals a problem in tool manipulation that calls for great flexibility in adapting tools to local constraints.

The play aspect of tool use (and, indeed, complex problem solving in general) is underlined by the animal’s loss of interest in the goal of the act being performed and by its preoccupation with means—also a characteristic of human children (Bruner and Koslowski, 1972).
Consider the following episode:

Hebb recounted how a chimpanzee he tested solved problems for banana slice incentives. On one particular day, she arranged the banana slice rewards in a row instead of eating them! Apparently, she had solved the problems for their own sake. "I was out of bananas, but I offered her another problem... she solved the problem: opened the correct box and put a slice of banana into it. I took it out and then set the box again... I ended up with thirty slices of banana" (Rumbaugh, 1970, p. 56).

A far cry from reinforcement in any conventional sense!

Köhler’s (1926) account contains an interesting happening. He gave a handful of straw to one animal who tried to use it to draw in an out-of-reach piece of fruit. Finding the straw too flexible, the animal doubled it up, but it was too short, so he abandoned the effort. Modification is systematic, most often directed to features relevant to the task, and is combinatorial. It follows first constructions or first efforts at copying a model. But it appears first in play, not in problem solving.

PLAY IN RELATION TO TOOL USE

I have described these play activities at great length because I believe them to be crucial to the evolution of tool using—steps that help free the organism from the immediate requirements of his task. Play, given its concomitant freedom from reinforcement and its setting in a relatively pressureless environment, can produce the flexibility that makes tool using possible. At least two laboratory studies, one by Birch (1945) and the other by Schiller (1952), indicate the necessity of initial play with materials in order for them to be converted to instrumental ends. They both used problems involving the raking in of food with sticks of varying length—before and after an opportunity to play with sticks. Few succeeded before play. Observed during play, Birch’s animals were seen to explore increasingly over three days the capacity of the sticks to lengthen an arm. When put back into the test situation, all of these animals solved the problem within half a minute. Perhaps, as Loizos (1967) has suggested, it is the very exaggeration and lack of economy of play that encourage extension of the limits.

Looked at logically, play has two crucial formal patterns: one consists of a function and its arguments; the other, an argument and the functions into which it can fit. A ball or a stick are fitted into as many acts as possible; or an act, climbing, is performed on as many objects to which it can be applied appropriately. This pattern, I would speculate, is close to one of the universal structures of language, predication, which is organized in terms of topic and comment:

John has a hat
John is a man
John jumps the fence, or
Brush the hat
Wear the hat
Toss the hat.

It is interesting that the language play after “lights out” of the three-year-old, reported by Ruth Weir (1962) in her remarkable book Language in the crib, takes precisely such a form. And I will not be the first to comment that the simultaneous appearance in man of language and tool using suggests that the two may derive from some common programming capacities of the enlarging hominid nervous system.

Another feature of play that is crucial to tool use is the feature referred to by Barsh (1972) as dissociation—“the ability to anticipate the potential component parts of an object” for use in a new arrangement. It is a question that occupied Köhler (1926) in terms of the ability of his animals to “dissolve visual wholes” of great visual firmness. A Russian investigator, Khroustov (1968), performed a most elegant experiment on tool using in a chimpanzee, showing to what degree these animals are capable of dissociation. Fruit was to be extracted from a narrow tube, and sticks of appropriate diameter were provided. The animal succeeded, and knowing the capability of the species, we are not surprised. The experimenter then provided a wood plaque too wide for the job. After inspecting it, the animal broke it along the grain to obtain a stick of appropriate size. Khroustov then painted a false set of grain lines on a plaque at right angles to the true grain. The animal, using them to guide a first splintering attempt and failing, looked more closely for the true grain and used it.

To summarize once again, the great ape possesses manipulative subroutines that are practised, perfected, and varied in play. These are then put together clumsily and selectively to meet the requirements of more extended tasks, very often in response to observing an adult in a stable and relaxed setting. The imitation observed is akin to imitation by a child of an adult speech model: the child’s output is not a copy of the adult’s; it has its own form even though it is designed to fill the same function. These initial acts are then modified in a systematic manner to fulfill further requirements of the task. The acts themselves have a self-rewarding character. They are varied systematically, almost as if in play to test the limits of a new skill. A baboon living in the same habitat as the chimpanzee is as eager to eat termites as is the latter; yet he shows none of these capacities even though he is seen to observe the
chimpanzee exercising them often. He too is equipped with a good pair of hands. Note that there is an association between play and tool use, and that the natural selection of one, tools, led to the selection of the other as well, in the evolution of the hominids and man.

ADULTS AS MODELS

Neither among chimpanzees nor in the infinitely more evolved society of hunter-gatherers is there much direct intervention by adults in the learning of the young. They serve principally as models and as sources of the necessary affection (Bruner, 1965). Among the primates, there is very little intentional pedagogy of any kind. Hinde (1971) recently reviewed the literature and concluded as follows:

On the whole, the mothers of nonhuman primates seem not to teach their infants. In a number of species, a mother has been seen to move a little away from her infant and then to wait while it crawled after her (e.g. Howler monkeys; Carpenter, 1934; rhesus, Hinde et al., 1964; gorilla, Schaller, 1963; chimpanzees, van Lawick-Goodall, 1968): this has the effect of encouraging the infant to walk, but can hardly be called teaching. However, it is clear that infants learn a great deal from their mothers, especially in the context of avoidance and food-getting behavior. Even avoidance of snakes differs between laboratory and wild-reared monkeys and may depend in part on parental example (Joslin et al., 1964). It has been shown in the laboratory that monkeys can learn to avoid situations or responses that are seen to cause pain to other individuals (Child, 1938; Hansen and Mason, 1962; Hall, 1968), and to accept food that other individuals are seen to take (Weiskrantz and Cowey, 1963). In nature, the infant's proximity to its mother ensures that it becomes rapidly conditioned by her fear responses (e.g. Baldwin, 1969) and that its feeding behavior is influenced by her (e.g. Baldwin, 1969). In the patas monkey (Hall and DeVore, 1965), Japanese macaque (Macaca fuscata) (Kwamura, 1969), and chimpanzee (van Lawick-Goodall, 1968), the young eat fragments that their mothers drop, as well as being especially likely to feed at the same food sources. Although by the time they are one year old, Japanese macaques are acquainted with all the types of food used by the troop, it is difficult to make them take new types of food in the laboratory. Apparently learning from the mother is normally important (Kawamura, 1959). Schaller (1963) records an infant gorilla removing food from its mother's mouth and eating it, and one case of a mother breaking off a stem for its infant to eat. Imitation, principally of the mother, is important for the development of tool-using behavior in wild-living chimpanzees (Goodall, 1964; van Lawick-Goodall, 1968); and the development of actions by imitation has also been recorded in hand-reared individuals (Hayes and Hayes, 1952; Kellogg, 1968). In the latter case, the actions may be used for social communication (Gardner and Gardner, 1971).

In squirrel monkeys, food-catching skill is learned by younger juveniles from older ones, rather than from their mothers (Baldwin, 1969). However, it is by no means always the younger animals that learn food habits from older ones. Under natural conditions, young animals investigate new objects more than do older individuals, and this may lead to a transfer of feeding habits from younger to older animals. Thus, among the Japanese macaques, new foods tended to be accepted first by juveniles, and their use then diffused through the colony via their mothers and then the mothers' younger offspring and consorts (Itani, 1958). Although diffusion sometimes occurs in the opposite direction (Frisch, 1968), kinship ties are probably always important (Kawamura, 1959; Tsumori, 1967) (p. 32).

There may, however, be something like “tutor proneness” among the young—an increased eagerness to learn from adults. One study now in progress suggests how such tutor proneness may come about. Rumbaugh et al. (1972) are training chimpanzees and orang-utans under the following conditions. One group receives tutoring modelling on a variety of tasks; each task is presented on each new encounter in the form of a new embodiment of the problem. A second group gets the same problems, but each time in the same form, so that this group is essentially repeating. The third group is presented with the materials used by the others, but the human tutor model neither presents them as tasks nor models the solutions as in the first two instances. The tasks are mechanical puzzles, packing fitted containers within each other, searching for a hidden object, transporting an object to another part of the room, extracting candy from a container, etc. The reward is some combination of task completion and the tutor’s approval. A preliminary finding of this work-in-progress is of particular interest. The apes in the more challenging first condition are the ones most likely to wait for the tutor to provide a clue before beginning on their own.

Does it then require a certain level of challenge and novelty to create tutor proneness in primates? Schaller (1964) remarked of the gorillas he observed in the Congo:

Why was the Australopithecus, with the brain capacity of a large gorilla, the maker of stone tools, a being with a culture in the human sense, while the free-living gorilla in no way reveals the marvellous potential of its brain? I suspect that the gorilla’s failure to develop further is related to the ease with which it can satisfy its needs in the forest. In its lush realm there is no selective advantage for improvement ... The need for tools ... is more likely in a harsh and marginal habitat where a premium is placed on an alert mind ... (p. 232).
And the same view was voiced by Yerkes and Yerkes (1929) in their classic work on the great apes, as well as by Vernon Reynolds (1965) who, in a penetrating article on the comparative analysis of selection pressures operating on chimpanzees and on gorilla, concluded:

Finally, we may briefly consider the contrast in temperaments between these two anthropoid species. Comparative behavior studies in the past often stressed this difference. Tevis (1921), for instance, wrote, "In mental characteristics there is the widest difference between the two apes that we are considering. The chimpanzee is lively, and at least when young, teachable and tameable. The gorilla, on the other hand, is gloomy and ferocious, and quite untameable" (p. 122). It is possible to suggest an explanation for this contrast between the morose, sullen, placid gorilla, and the lively, excitable chimpanzee. The difference seems to be most clearly related to the difference in social organization and foraging behavior. The herbivorous gorilla is surrounded by food: the more intensively it feeds, the slower it travels; its survival needs are easily met, and it is protected from predators by the presence of powerful males. Here there is no advantage to any form of hyper-activity except in threat displays and the charge of the big male, which is a hyper-aggressive behavior form. Chimpanzee survival, on the other hand, depends heavily on the fluidity of social groups and the ability to communicate the whereabouts of food by intense forms of activity (wild vocalizing and strong drumming). Moving rapidly about the forest, meeting up with new chimpanzees every day, vocalizing and drumming, and locating other chimpanzees by following their calls, are the basic facts of chimpanzee existence. Here an advantage may be seen in having a responsive, expressive, and adaptable temperament. Hyper-activity is the chimpanzee norm in the wild, and it goes with a volatile temperament (p. 704).

But here we encounter a seeming contradiction. The evolutionary trend we have been examining seems to have placed a major emphasis on a combination of developments: a relatively pressure-free environment with its concomitant increase in play, exploration, and observation; and at the same time, a certain challenge in the requirements of adaptation to a habitat. (Play in young gorillas and orang-utans in the wild, by the way, is not nearly as elaborate as in the chimpanzee (cf. Reynolds, 1965; Rodman, 1972; Schaller, 1963; Yerkes and Yerkes, 1929), and in neither of these species is there much challenge from the habitat.)

I believe that Desmond Morris (1964) has a resolution for this apparent dilemma—that, on the one hand, a non-pressureful habitat seems crucial and, on the other, challenge is significant. He made the distinction between two modes of adaptation to habitat, specialist and opportunist—the squirrel versus the rat, certain exclusively forest-dwelling monkeys like the vervet or green versus the adaptable rhesus (cf. Hinde, 1971). Non-specialists depend on high flexibility rather than on morphology or behavioural specialization. Aristarchus said it well and provided Isaiah Berlin (1953) with a famous book title: "The fox knows many things; the hedgehog knows one big thing".

One can only speculate that the evolution of intellectual processes in the primate stock from which man descended was in the direction of opportunism and away from specialism. It could be argued, indeed, that the original stock, as far as intellect goes, was closer to chimpanzee than to either of the contemporary pongids, though Rumaugh (1970) believed that in certain forms of intellectual performance there are striking parallels between man and orang-utan. The argument for opportunism seems in fact essential to account for the rapid fanning out of the evolved species to such a variety of habitats.

INSTRUCTIONAL INTERACTION BETWEEN ADULTS AND YOUNG

What can be said of "instruction" of the young in the protohominids and early man? Alas, nothing definite. But contemporary "simple" societies, hunter-gatherers, provide certain clues. No matter how constraining the ecological conditions, there is among such people an expansion in adult-child instructional interaction, both quantitatively and qualitatively, of a major order. Although one cannot reconstruct the Pleistocene hunter-gatherer by reference to such isolated hunter-gatherers as the contemporary !Kung Bushmen, their practices do suggest something about the magnitude of the change. !Kung adults and children play and dance together, sit together, participate in minor hunting together, join in song and storytelling together. At frequent intervals, moreover, children are the objects of intense rituals presided over by adults—minor, as in the first haircutting, or major, as when a boy kills his first Kudu buck and undergoes the proud but painful process of scarification. Children also are playing constantly at the rituals, with the implements, tools, and weapons of the adult world. However, in tens of thousands of feet of !Kung film prepared by the Marshalls (see Bruner, 1966), one virtually never finds an instance of teaching taking place outside the situation where the behaviour to be learned is relevant. Nobody teaches away from the scene, as in a school setting. Indeed, there is nothing like a school.

Often the adult seems to play the role of inducting the young into novel situations that, without the presence of a protecting and familiar adult, would be frightening—as in extended trekking, in witchcraft
ceremonials, and in many other spheres where the child comes along and participates to the limit that he is able. This induction to the margin of anxiety, I believe, starts very early. A study by Sroufe and Wunsch (1972) provides a hint of just how early that may be. The study sets out to explore what makes human infants laugh. From four months (when laughing first appears in reliable and recognizable form) into the second year of life, the sufficient stimulus for laughter becomes increasingly distal—at first being principally tactile and close visual (e.g. tickle plus looming), with incongruities following later, as when the mother adopts an unusual position such as crawling on all fours. Note, however, that at all ages, the capers most likely to produce laughter when performed by the mother are the ones most likely to produce tears when performed by a stranger. The mother seems able to bring the young, so to speak, to the edge of terror. King (1966) has suggested that this feature of mothering is universal; that among birds as well as mammals, the presence of the mother reduces fear of novel stimuli and provides the assurance necessary for exploratory behaviour. But it is only among humans that the adult introduces the novel, induces the young into new, challenging, and frightening situations—sometimes in a highly ritualistic way, as with the rites de passage.

There is little question that the human young (and the young of the primates generally) are quite ready to be lured by the novel, given even the minimum adult reassurance. "Neophilia" is what Desmond Morris (1967) calls it. Such readiness for novelty may even be attested to by a superiority, at least among the great apes and man, of the young over the old in detecting or extracting the rules and regularities in new situations. At least one laboratory study, Rumbaugh and McCormack (1967), has even found a negative correlation between age and the ability to master learning-set problems—tasks that have a common principle but a new embodiment on each presentation, like "pick the odd one when two are alike and one is different". But note that it is in man only that adults arrange play and ritual for children that capitalize on this tendency.

It is obvious that the play and ritual in which young and adult humans are involved are saturated heavily with symbolism. Though the kind of mastery play I have been at some pains to describe in the preced-

6 Rumbaugh (1970) commented in a recent review of the learning capacities of great apes: "It is frequently observed, however, that an animal who excels in learning when young remains excellent if frequently worked with as it grows to adulthood (at least eight years of age) and beyond. Might it be the case that early experience in some manner determines the avenues along which intelligent behavior will be manifest. If early experiences are with formal test and learning situations, will the animal's adaptability be maximally manifest as an adult in contexts of that order?" (p. 65).
mutually agreed upon. The object of the game is equivalence, just as in the 
food exchange ritual of the adults, and in both cases the outcome or equival­
ence is decided upon by mutual agreement. There is no winner or loser; 
the object is to tie (pp. 183–184).

**USING SYMBOLIC MEANS: LANGUAGE**

Having gone this far into symbolic play, I now turn to language in 
order to be more precise about what is involved when symbolic means 
are used for preparing the human young for culture. Higher primate skill, 
as I have described it, has about it certain languagelike properties. 
Skilled action, like language, has paraphrases and a kind of grammar. 
But there is also a communicative function of language; and it is this 
function, in all probability, that determines many of its design features 
(cf. Hockett, 1960). I have emphasized the similarity between action and 
function, in all probability, that determines many of its design features.
child, the *Funktionslust* (Bühler, 1934), that keeps the child exploring and playing with language. The young chimpanzee's grammar is tied perpetually to action. The nominatives and the attributives of early childhood speech, naming objects and attributing properties to them, are lacking and never seem to appear in Washoe. The evident delight of Matthew (Greenfield et al., 1972) in the use of such nominatives as "airplane", "apple", "piece", and "cow" is quite as important as the fact that these holophrases were used in a context of action. Roger Brown (1970, 1971) has commented that virtually all of the two-sign and three-sign "utterances" in Washoe's use of American sign language were either "emphasizers" of action (Hurry open), "specifiers" of action (Listen dog, at sound of barking), or indicated agents for action (You eat, Roger Washoe tickle). David McNeill (1973) put it concisely: Washoe's grammar can be characterized by the single proposition:

\[ s \ldots p \]

or, "statement that raises a predicated action to a higher level", a grammatical form not spontaneously present in human adult speech. In a word, chimpanzee use of a taught form of human speech is strongly tied to action, beyond which it tends not to go, either spontaneously or by dint of teaching effort.

On the other hand, the development of language in humans not only moves in the direction of becoming itself free of context and accompanying action, it also frees the attention of the user from his immediate surroundings, directing attention to what is being said rather than to what is being done or seen. In the process, language becomes a powerful instrument in selectively directing attention to features of the environment represented by it.

With respect to the first of these, language processing goes on in its very nature at different levels. We process the phonological output of a speaker, interpret his syntax, hold the head words of imbedding phrases until the imbedded phrase is completed and the tail is located to match the head word, etc. At the same time, we direct attention to meanings and to references. The acts of language, argue Miller and Johnson-Laird (see footnote 3, p. 15), by their very performance free attention from control by immediate stimulation in the environment. One might even argue that the requirement of organizing what one experiences into sentence form may impose upon experience itself a certain cast—the classic arguments of Humbolt (1836) and Benjamin Lee Whorf (1956). Once language captures control of attention, the swiftness and subtlety of attention change come to match the swiftness and subtlety of linguistic manoeuvring. Language permits search specifications to be set in such a fashion as to fulfill any question that may be asked. The eye-movement records collected by Yarbus (1967) provide stunning illustration of the tactics of the language user: how, while guiding his eye movements by physical features of a picture of scene, he manages at the same time to pick up the features that answer questions he is entertaining—looking now to pick up the ages of people, now to judge their furniture, now to see what they are doing, etc.

To summarize, then, though language springs from and aids action, it quickly becomes self-contained and free of the context of action. It is a device, moreover, that frees its possessor from the immediacy of the environment not only by pre-emption of attention during language use but by its capacity to direct attention toward those aspects of the environment that are singled out by language.

I have gone into this much detail regarding early language because it is a necessary preliminary to a crucial point about the management of immaturity in human culture. I have commented already on the fact that in simple, hunter-gatherer societies, there is very little formal teaching outside the sphere of action. The child is not drawn aside and told how to do it: he is shown while the action is going on, with language as an auxiliary and as a marker of action—an aid in calling attention to what is going on that is relevant. Over and beyond that, the principal use of language was probably some mix of guiding group action and giving shape to a belief system through myths and incantations, as Susanne Langer (1969) has long proposed. I rather suspect that increasing technology imposed an increasing demand on language to represent and store knowledge in a fashion to be helpful outside the immediate context of original use. L. S. B. Leaky*\(^9\) suggested that once stone instruments came to be made to match a pattern rather than by spontaneous breaking, as in fabricating an Acheulan pebble tool with a single-face edge, *models* could be fashioned and kept. He has found excellent, obsidian-grained hand axes at Olduvai that appear never to have been used; he speculates that they were "models for copy", with a religious significance as well.

But an inert model is a poor thing; it is, in effect, an end state, something to be attained with no intervening instruction concerning means. Language does better than that, and it is interesting to see the extent

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*McNeill also made the cogent point that perhaps (as with Premack, 1971) chimpanzees can be taught a human-like syntax, a not uninteresting point; but they seem not to acquire it as children do, by a process not so much of detailed learning or imitation as of spontaneous constructions of grammatical utterances most often exhibiting initial grammatical rules not present in the adult speech to which they are exposed.

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* L. S. B. Leaky, personal communication, April 1966.
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or, “statement that raises a predicated action to a higher level”, a grammatical form not spontaneously present in human adult speech. In a word, chimpanzee use of a taught form of human speech is strongly tied to action, beyond which it tends not to go, either spontaneously or by dint of teaching effort.

On the other hand, the development of language in humans not only moves in the direction of becoming itself free of context and accompanying action, it also frees the attention of the user from his immediate surroundings, directing attention to what is being said rather than to what is being done or seen. In the process, language becomes a powerful instrument in selectively directing attention to features of the environment represented by it.

With respect to the first of these, language processing goes on in its very nature at different levels. We process the phonological output of a speaker, interpret his syntax, hold the head words of imbedding phrases until the imbedded phrase is completed and the tail is located to match the head word, etc. At the same time, we direct attention to meanings and to references. The acts of language, argue Miller and Johnson-Laird (see footnote 3, p. 15), by their very performance free attention from control by immediate stimulation in the environment. One might even argue that the requirement of organizing what one experiences into sentence form may impose upon experience itself a certain cast—the classic arguments of Humbolt (1836) and Benjamin Lee Whorf (1956). Once language captures control of attention, the swiftness and subtlety of attention change come to match the swiftness and subtlety of linguistic manoeuvring. Language permits search specifications to be set in such a fashion as to fulfill any question that may be asked. The eye-movement records collected by Yarbus (1967) provide stunning illustration of the tactics of the language user: how, while guiding his eye movements by physical features of a picture of scene, he manages at the same time to pick up the features that answer questions he is entertaining—looking now to pick up the ages of people, now to judge their furniture, now to see what they are doing, etc.

To summarize, then, though language springs from and aids action, it quickly becomes self-contained and free of the context of action. It is a device, moreover, that frees its possessor from the immediacy of the environment not only by pre-emption of attention during language use but by its capacity to direct attention toward those aspects of the environment that are singled out by language.

I have gone into this much detail regarding early language because it is a necessary preliminary to a crucial point about the management of immaturity in human culture. I have commented already on the fact that in simple, hunter-gatherer societies, there is very little formal teaching outside the sphere of action. The child is not drawn aside and told how to do it: he is shown while the action is going on, with language as an auxiliary and as a marker of action—an aid in calling attention to what is going on that is relevant. Over and beyond that, the principal use of language was probably some mix of guiding group action and giving shape to a believable system through myths and incantations, as Susanne Langer (1969) has long proposed. I rather suspect that increasing technology imposed an increasing demand on language to represent and store knowledge in a fashion to be helpful outside the immediate context of original use. L. S. B. Leaky\(^{10}\) suggested that once stone instruments came to be made to match a pattern rather than by spontaneous breaking, as in fabricating an Acheulian pebble tool with a single-face edge, \emph{models} could be fashioned and kept. He has found excellent, obsidian-grained hand axes at Olduvai that appear never to have been used; he speculates that they were “models for copy”, with a religious significance as well.

But an inert model is a poor thing; it is, in effect, an end state, something to be attained with no intervening instruction concerning means. Language does better than that, and it is interesting to see the extent
to which magic becomes mixed with practice and imitation in a primitive
technology. A good example is afforded by the boat building and interisland navigation of the pre-literate Puluwat Islanders in the Marshalls, recently described in rich detail by Gladwin (1970) in a book entitled East is a big bird. Theirs is a system in which East is marked by Altair at horizon elevation, distance by a commonsense speed-estimating method, with distance “logged” by noting the supposed parallax of islands at different distances over the horizon. Final homing on an island is accomplished by noting the direction of end-of-day nesting flights of boobies and frigate birds. And the lot is peppered with sundry other movements and activities of the practical 

Frameworks of the system can be tied together means and ends. The framework of the system can be told; however, without language it would be impossible, for the ingredients of the system involve reference to the absent or invisible, to the possible, to the conditional, and even (I suspect) to the knowingly false (the white lies all navigators must tell to keep the trustful sailors trusting). There must have been hunting among human beings the medium for passing on knowledge. And, of course, the emergence of written language—a very recent innovation from an evolutionary point of view—gives this tendency still further amplification. Once this mode of transmitting knowledge has become established, the conditions for the invention of school—a place where teaching occurs—are present. School is a very recent development in evolutionary terms, even in historical terms. I explore now some of the consequences of these developments for our mode of dealing with, informing, and shaping the immature.

FROM “KNOWING HOW” TO “KNOWING THAT”

As soon as schools, pedagogues, and the storing of decontextualized information received legitimacy—and it was probably the written word that accomplished this legitimization—the emphasis shifted from knowing how to knowing that. Even growth becomes redefined in accordance with the shift—the adult “having” more knowledge, that is, “knowing about” more things. We have even come to define the needs of infancy in these terms, as “the need for experience” (rather than, as Bowlby, 1969, noted, in terms of the need for love and for predictability). Knowledge in some way becomes a central desideratum. And when, as in the United States, attention turns to the children of the underprivileged and the exploited, their difficulty is likely to be, and indeed in this case was, attributed to “cultural deprivation”. Hence, an “enriched environment” was prescribed much as if the issue wereavitaminosis. Dewey (1916) referred early to this diagnosis as the cold-storage” ideal of knowledge and, of course, attacked it vigorously. But this is too simple, for in fact there is great power inherent in decontextualized knowledge—knowledge represented in a form that is relatively free from the uses to which it is to be put or to which it has been put in the past. It is not too serious an oversimplification to say that it is precisely such a process of reorganizing knowledge into formal systems that frees it of functional fixedness. By using a system of notation that redefines functional requirements in formal terms, far greater flexibility can be achieved. Rather than thinking in terms of “hammers”, with all of their associated conventionalized imagery, one thinks instead in terms of force to be applied in excess of a certain level of resistance to be overcome. It is, in effect, the way of science to render the problem into this form in order to make the solving of particular problems mere instances of much simpler general problems and thereby to increase the range of applicability of knowledge. Why should the Puluwat navigator struggle with such a set of complexities as I have described, when all it gets him is competence over a few hundred miles of ocean, and a shaky competence at that! He would be more accurate and more general, as well as more flexible, if he learned to take the elevation of a heavenly body, note the time, and reduce the sight to the easily solved spherical triangle of the western navigator. Such a system would serve him anywhere.

But there are two problems (at least!) in this ideal of efficient formal knowledge rather than implicit knowledge, to use Polanyi’s (1958) phrase. The first grows out of the point already made about skill and its de-emphasis. That de-emphasis comes out of what I believe to be a misplaced confidence in the ease with which we go from knowing that to knowing how. It is not easy; it is a deep and perplexing problem. Let me call it the effectiveness problem. Just as deep is a second problem: it may well be that the message of decontextualization and formal structure is implicitly antifantasy and antiplay: call this the engagement
problem. The two together—effectiveness and engagement—bring us to
the heart of the matter.

With respect to effectiveness, it is probably a reasonable hypothesis
that as technology advances, the effector and the energy components
of industrial activity become increasingly remote from human empathy;
nor the arm nor the hand any longer give the models for energy or
for articifying. Energy and the tool kit become, for planning purposes,
black boxes, and the major human functions are control and the organi-
ization of work. There is a spiral. It becomes possible to talk about
the conduct of work almost without reference to skill or voca­tion—wheat
production and steel production and gross national product and
energy production and balance of payments. With work and competence
presented in that mode, the young become more and more remote from
the nature of the effort involved in running a society. Vocation, comp­
ience, skill, a sense of place in the system—these become more and
more difficult for the young to fathom—or, for that matter, for the adult.
It is difficult for the child to say what he will do or what he will “be” as
an adult. Effectiveness becomes elusive.

For while the new technological complexity produces an enormous
increase in production processes and distribution processes, it produces
no increase either in the number or in the clarity of comprehensible
tinctions. Production and distribution, in high technology, do not
provide an operator with an opportunity to carry through from the
initiation of a recognizable problem to its completion, or to see plainly
how his task relates to the cycle from task initiation to task completion.
Intrinsic structure and reward are removed. The result is what Norbert
Wiener (1950) long ago called “work unfit for human production”. The
industrial revolution removed the worker from the home. Its techno-
ological elaboration made the worker’s work away from home incom-
prehensible to the young and the uninitiated—the latter, often a worker
himself. The greatest tribute to technique decontextualized from voca-
tion, carried to an extreme where it becomes fascinating, is the Whole
earth catalogue. Even the counterculture reaches a point where it is
without vocations but offers only spontaneity as a contrast to over-
rationalized “vocationless” work.

School, separated from work which itself has grown difficult to
understand, becomes its own world. As McLuhan (1964) insists, it
becomes a medium and has its own message, regardless of what is
taught. The message is its irrelevance to work, to adult life. For those
who wish to pursue knowledge for its own sake, this is not upsetting.
But for those who do not or cannot, school provides no guide—only
knowledge, the relevance of which is clear neither to students nor to
teachers. These are the conditions for alienation and confusion. I would
urge that when adult models become incomprehensible, they lose the
power either to guide or to inspire. I do not mean to settle the question
here as to whether present adult models are in fact totally relevant to the
problems of those entering society now. I will, however, return to it
later.

Bronfenbrenner (1970) in his book on child rearing commented on
the accelerating trend toward generational separation in technical
cultures. The self-sealing peer culture, the denigration of adult ideal
figures, the counter-culture committed to protest and romanticized
ideals—these are by now familiar instruments of separation. But I
believe them to be symptoms of the struggle to adjust to a social—
technical order that changes at a rate faster than comprehension of it
can be achieved and widely transmitted. This, you recall, is the problem
with which we started: how can a system for preparing the immature
for entry into the society deal with a future that is increasingly difficult
to predict within a single lifetime? Many of the means for inducting the
young into the social group, a heritage of the evolution of man’s capacity
for culture, appear to become ineffective under such conditions when
such rapid change becomes the rule. Observation and imitative play,
demonstration in context of skilled problem solving, induced tutor
proneness, an effective microcosm in the form of an extended family
or a habitat group, and the concept of vocation—are all seemingly
threatened. Yet, I wonder.

I do not propose to become gloomy. Surely human culture and our
species are in deep trouble, not the least of which is loss of heart. But
much of the trouble is real: we are degrading the biosphere, failing to
cope with population, permitting technology to degrade individuality,
and failing to plan. Many of the experimental and often radical efforts
of the young represent, I believe, new variants of ancient, biologically
rooted modes by which the young characteristically work through to
maturity. And a great many of these efforts are in response to the new
conditions we have been at such pains to describe—a rate of change
faster than can be transmitted intergenerationally with concomitant
likelihood of disastrous consequences. Let me conclude with a closer
analysis of this point and, in so doing, come to what was referred to
above as the problem of engagement.

PROBLEM OF ENGAGEMENT

A great many of the world’s schools are conventional and dull places.
They do not foster much productive play and little of what Jeremy
Bentham (1840), in his *Theory of legislation*, called “deep play” and condemned as irrational and in violation of the utilitarian ideal. By deep play, Bentham meant play in which the stakes are so high that it is irrational for men to engage in it at all—a situation in which the marginal utility of what one stands to win is clearly less than the marginal disutility of what one stands to lose. Bentham proposed, good utilitarian that he was, that such play should be outlawed. But as the anthropologist Geertz (1972) commented in his close analysis of cockfighting in Bali, “despite the logical force of Bentham’s analysis men engage in such play, both passionately and often, and even in the face of law’s revenge” (p. 15). Deep play is playing with fire. It is the kind of serious play that tidy and even permissive institutions for educating the young cannot live with happily, for their mandate from the society requires them to carry out their work with due regard for minimizing chagrin concerning outcomes achieved. And deep play is a poor vehicle for that.

What strikes me about the decade just past is the enormous increase in the depth of play in adolescence and, by reflection downward into lower age groups, among the young. Willingness to risk future preferment by dropping out of the system that is designed to qualify one for the future, in return for a season of communal mutuality—surely the balance of utility to disutility is not Benthamite. Such wagers are highly dangerous for the lives of the individuals involved in them. (Note that Russian roulette is the worst bargain to be had in deep play.) When one finds deep play, the inference must be that there are deep and unresolved problems in the culture. There always are, but that does not mean that one should not look carefully at what these are and what they signify for the future. There is ample reason to believe that the present forms of deep play point to a thwarted, backed-up need for defining competence, both individually and socially, to oneself and to others. Recall that in most previous cultural eras, adults provided challenge and excitement and a certain sense of muted terror for the young by induction into rituals and skills that had momentous consequences. Engagement was built into the system. One knew the steps to growing up, both ritually and in terms of skill.

If adult life ceases to be comprehensible, or begins to be less a challenge than a drag, then engagement is lost—but only for a while. I have the impression of something new emerging. What takes the place of the deposed, incomprehensible, or worn-out competence figure, the classical adult image of skill? At first, of course, protest—withdrawal figures will—the pop figures of rock and the Timothy Leary prophets who offer an intravenous version of competence via subjectivity. I believe that gradually there is emerging a new form of role bearer—the intermediate generation—adolescents and young adults who take over the role of acting as models. They exist visibly in context. Their skills and vocation are proclaimed, miniaturized to appropriate size, and personalized. I should like to propose that such an intermediate generation is a response to the crisis of a change rate that goes faster than we can transmit from generation to generation.

Lest we go too rapidly, consider the pointlessness of an intergeneration in a society with continuity. Turnbull’s (1961) account of a Pygmy group in Africa serves well:

When a hunting party goes off there are always people left in the camp—usually some of the older men and women, some children, and perhaps one or two younger men and women. The children always have their own playground, called bopi, a few yards off from the main camp.

There were always trees for the youngsters to climb, and this is one of the main sports even for those not yet old enough to walk properly. The great game is for half a dozen or more children to climb to the top of a young tree, bending it down until its top touches the ground. They then all leap off at once, and if anyone is too slow he goes flying back upward as the tree springs upright, to the jeers and laughter of his friends.

Like children everywhere, Pygmy children love to imitate their adult idols. This is the beginning of their schooling, for the adults will always encourage and help them. What else is there for them to learn except to grow into good adults? So a fond father will make a tiny bow for his son, and arrows of soft wood with blunt points. He may also give him a strip of a hunting net. A mother will delight herself and her daughter by weaving a miniature carrying basket. At an early age, boys and girls are “playing house” ...

They will also play at hunting, the boys stretching out their little bits of net while the girls beat the ground with bunches of leaves and drive some poor tired old frog in toward the boys ... And one day they find that the games they have been playing are not games any longer, but the real thing, for they have become adults. Their hunting is now real hunting; their games they have been playing are not the real thing, and famous hunters their life is still full of fun and laughter (pp. 128–129).

The transition is gradual, its excitement increased from time to time by rituals. But technological societies move away from such gradualism as they become increasingly developed. Indeed, the Protestant ethic made very early a sharp separation between what one does when young and what one does later, with the transition very sharply defined. In the western tradition there grew a puritan separation of the “works of the
adult” and “the play of the babes”. But it was clear to both sides what the two were about. Now “the play of the babes” has become separate from, dissociated from, the adult community and not understood by that community any better than the young comprehend or accept the ideals of the adult community.

A place is made automatically, perhaps for the first time in our cultural tradition, for an intermediate generation, with power to model new forms of behaviour. Their power comes precisely, I think, from the fact that they offer deep play, that irresistible charisma that so disturbed the tidy Jeremy Bentham. They are modelling new life styles to fit better what is perceived as the new and changing conditions, new changes that they claim to be able to see—perhaps rightly, perhaps not—more clearly than those who had adapted to something still earlier. The great question is whether the intermediate generation can reduce the uncertainty of growing up under conditions of unpredictable change, can serve as mentors as well as charismatic vendors of deep play, and as purveyors of effectiveness as well as of engagement.

I do not think that intermediate models are a transitory phenomenon. I believe that we would do well to recognize the new phenomenon and to incorporate it, even make it easier for the young adult and later juvenile to get more expert at it. Nobody can offer a blueprint on how to change but, rather, using man’s natural modes of adapting to render change both as intelligent and as stable as possible.

REFERENCES


The Study of Primate Infancy

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LET ME BEGIN with the conclusions. There are only two: simple, and I hope, very obvious. First, that a detailed comparison between human infants and infant primates is feasible. Second, that this comparison should be enlightening.

This paper is in the nature of a research proposal, not a report on work already done. I think that such research will be carried out fairly soon, though not primarily by me—some is already under way. I am particularly glad to be talking to this study group because you may be able to suggest guidelines and priorities for primate research which will be most useful to your own fields of interest.

The paper falls into three parts. First, why detailed cross-species comparisons of infant behaviour have not yet been made. Second, two attempts to relate human infant behaviour to primate studies: neonatal reflexes as part of an adaptive complex of clinging or being carried, and primates' object manipulation as it might relate to Piagetian stages of sensorimotor intelligence. Third, a section on relative rates of development in social, motor, and cognitive (or "adaptive") spheres—not to give any answers, but to show the kind of comparative table I hope the next five years of research will fill in.

When we do identify similar behavioural elements, and describe their functional relations among the primates, I think this will have important repercussions on developmental theory. We will then be able to arrange the elements of behaviour into many different sets of adaptive wholes: the cross-sectional complex that allows an infant of any one age to relate effectively to its environment, or the longitudinal complex which is appropriate to its own species. There will obviously be great differences in the mixes which make up the behavioural complexes of different species at different ages, if only because other primates' motor development is relatively more rapid than humans'. If there turn out to be finer-grained differences between species in social development and in the