too much of enactive representation—developmentally prior to ikonic representation and not so salient to the child as it once was before he came into the world of imagery—to undo entirely what ikonic representation is doing? An enactive message, "It *feels* the same" (as one child told us), pitted against a most compelling "But it *looks* different," may have a poor chance of survival in the ikonic child. The same thing is perhaps true with respect to a verbal message by itself. But when both enactive and verbal messages are saying "same" and perception alone is signaling a difference, the two win out over the one. Thus it is only when we marshal both enactive and symbolic forces against the ikonic that the ikonic finally gives way. It is when the child is both saying and doing that he learns not to believe fully what he is seeing. Except for the interaction among different modes of representation, learning could not occur.

An interesting question, one that we can only raise here and leave open for future inquiry, is just how labeling works. The verbal labels must in effect be giving the child a "conservation" message in the symbolic medium. But the form this message takes is not nearly so obvious to us as the ikonic message, "It looks different," or even the enactive message, "It feels the same," or (perhaps also) "I can make it the same." Because the child usually does not use the labels we give him in his explanations of conservation, it is difficult to determine by what process the "message" gets to its destination. As we have seen, the process does *not* seem to be a matter of activating the logical operation of compensation, which is then used to deduce conservation. It would be worth while to investigate whether words which do not specifically label the compensating attributes would work as well as these labels have. Perhaps the process is simply a matter of providing the child with many different words with which to describe the same clay, thus forcing him to think of the clay in many different ways. Certainly, once he can think of the same clay in a multiplicity of shapes, he is well on the way to conservation.

Perhaps the psychology of conservation (in contrast to its so-called logic) is a recognition that the same thing can take many guises and still be the same thing. One can achieve the insight enactively—by using the same stick in different ways for different ends—or symbolically, by the powerful devices of periphrases and relabeling. It is perception and imagery that most succumb to the error of taking a change in appearance to signal a change in identity.

CHAPTER II

On Culture and Conservation

Patricia Marks Greenfield[1]

Both too much and too little have been said about "primitive mind"—too much in that the descriptions given us by anthropologists have been for the most part rather global generalizations based on inference from language, myth, ritual, and social life. Such accounts are not founded upon the observation of "mind in action," upon an analysis of behavior in concrete situations. So, we know very little indeed about "primitive minds" at work, and their operation remains largely to be explored. In fact, it is not unreasonable to ask in what sense the label "primitive" is even applicable to the thinking of non-Western peoples.

What has been implicit in the work of such anthropologists as Boas,

[1] I am grateful to M. Papa Diaw of the American Cultural Center, Dakar, for his generous Wolof lessons. I am also indebted to Dr. and Mrs. Robert Lagacé of the Yale Human Relations Area Files, who helped me to continue in their village of Taiba N'Diaye. M. Abdoulaye Sar assisted in the village, and Mlle. Secundine Sané served as recorder throughout all the experiments. M. Abdoulaye M'Bodj, Instituteur à la Direction des Inspections du premier et du deuxième Degré at the Senegalese Ministry of Education, deserves appreciation for making it possible for me to work in the elementary schools. I would also like to thank Mr. H. Hoffman and Mr. Thomas Zalla, of the American Peace Corps in Senegal for their kind help.

The research was carried on under the auspices of the Institut d'Etudes pédagogiques of the University of Dakar, Senegal. Mme. Simone Valantin of the Institut and M. Serge Sauvageot of the Institut français de l'Afrique noir (IFAN) were of particular help. A grant from the Ford Foundation made the work possible. The research here reported is also reported in a doctoral dissertation submitted to the Department of Social Relations at Harvard (cf. Greenfield, 1966).

Durkheim, Mauss, Mead, and Whorf is the assumption that different modes of thinking are characteristic of different cultures. It is a bold hypothesis that variations in cognitive functioning are formed by cultural influences. Unfortunately, from the point of view of testing the hypothesis, the study of intellectual development has been confined almost entirely to members of our own Western societies. Our richest picture of cognitive development, that drawn by Jean Piaget, is based entirely on experiments in which age alone is varied. In his view, cognitive maturation is made to appear like a biologically determined and universal sequence. While Piaget admits that environmental influences play a role, the admission is *pro forma,* and inventive experiments remain confined to American and European children, usually middle class children at that. Where Piaget's work has been extended to non-Western societies, the emphasis has been almost entirely quantitative. Such work has been confined largely to timetable studies, to the time "lag" in the development of "foreign" children in contrast to children in Geneva or Pittsburgh or London (Flavell [1963]). Qualitative differences between Western thinking and that of traditional societies have rarely been explored. Psychologists, when they have gone abroad, have usually approached their work in other cultures as though they were dealing with familiar phenomena, present in greater or lesser quantity (usually lesser). Hence the equation of "primitive" adult with "civilized" child.

Cambridge has steadily disagreed with Geneva on the fundamental "how" of intellectual growth. Our own work has emphasized the role of internalized, culturally transmitted technologies. One way of exploring this role is to establish the manner in which an enriched (or impoverished) environment affects growth. This approach uses instruction in its broadest sense as its instrument of exploration. A second approach is to study development in societies in which the culturally given "technologies" are radically different from our own, with the hope of finding and analyzing differences in cognitive functioning. This is the major strategy of the research reported in this chapter, though we shall at the same time study the effect of instruction on children in the different cultures.

The experiments to be described were done in Senegal, the westernmost tip of former French West Africa. The subjects were Wolof, members of the country's dominant ethnic group. The Wolofs, who are Moslem, constitute over one-third of Senegal's total population of 2,300,000. The basic experiment was the familiar one developed by Piaget to study the conservation of quantity and is described in

Chapter 9. It consisted in equating the quantity of water in two identical beakers, then pouring the contents of one beaker into one of a different size and inquiring whether the amount of water is now the same. Particulars will be set forth in a later section. For theoretical purposes the experiments could have been done almost anywhere. Many other preliterate traditional societies would provide as dramatic a contrast with our own milieu as this one did.

The Wolof group was selected from those found in Senegal largely because its children are to be found not only in the French-style schools of Dakar, the cosmopolitan capital city, but also out in the bush, sometimes receiving the beginnings of a French education, more often not.

The children were constituted into nine groups, the better to discern the effect of cultural differences: three degrees of urbanization and education were represented, with three age levels within each. As in all underdeveloped countries, the contrast between urban and rural life is enormous in Senegal, independent only since 1960. In the city one finds the accoutrements of Western industrial life; in the rural village, no matter how close, there is virtually none. School itself represents a new world of French culture and the written word, a world in almost dizzying contrast to the oral traditions of traditional West African society.

The cultural milieu of our first group, the rural unschooled children, had neither schools nor urban influence. Their setting was Taiba N'Diaye, a traditional Wolof village of about a thousand people. Its economy, like that of the whole country, is based on oil-producing peanut cultivation, although millet is grown for local consumption. Still, undernourishment is the general rule. Socially, residentially, and economically, the village is divided into fifty-nine compounds, each surrounded by a wooden palisade and inhabited by an extended family unit. Within each compound are several small, round thatched huts inhabited by various members of a patrilocal family.

The village, located in the Cayar region of Senegal, is fifty miles by a good road from the country's coastal capital. It is found in the midst of bush, Senegal's dominant rural landscape. Flat expanses of grass are broken only by scattered baobab trees. The grass is mostly brown and dead during the cool, dry season (November through June). The landscape returns to green after the first rain, when the year's cultivation begins. The two sharply divided seasons are typical of the subtropical climate which covers most of the country.

Although the village has an elementary school, the children of our

first group had never attended it. As already noted, they were subdivided into three ages: six to seven, eight to nine, and eleven to thirteen (seventeen, twenty, and twelve children respectively). Our age data are, alas, approximate. African children, especially in the bush, have only the vaguest idea of how old they are in terms of years; and parents stop counting age after a child receives his Moslem baptism, which happens on the eighth day after birth. Fortunately for us, however, the French government a number of years ago instituted civil status for all with its prerequisite census, a source from which reasonable age estimates can be obtained for children born since 1950. Any child not on the census rolls of Taiba N'Diaye was automatically eliminated from the study. Still, the census is far from perfect, and it is probably more accurate to say that our age data are accurate on the average, rather than in the particular case.

The cultural setting of the second major group—rural school children—was identical with that of the first with respect to the rural Wolof milieu in which its members lived. In fact, many of the children came from the same village of Taiba N'Diaye, and in at least ten cases from the same families. These children, however, unlike the first, were receiving a French-style education. Taiba N'Diaye's own school provided the two oldest groups of children, who were in the third and sixth grades. These groups (twenty and twenty-four children respectively) matched the two oldest unschooled rural groups. To find a group corresponding to the youngest unschooled children, it was necessary to go to a very similar Wolof village nearby where the school included a first-grade class. Twenty-three first-grade children from Méouane participated in the experiment.

Finally, the cultural milieu of the third group was characterized by the presence of both aspects of Western culture, urban setting and schooling. This group came from Dakar, the cosmopolitan capital of Senegal and the former capital of French West Africa. The children in this group came from three of the city's public schools. As with the rural-school children, the Dakar group was selected from the first, third, and sixth grades. Thus the two school groups were matched exactly with respect to the number of years of schooling as well as approximate age. Grade level and age are only roughly correlated in Senegal because of the vagaries which result from attempting the relatively sudden conversion to literacy of an entire population. For this reason, the ages of the school groups were more variable than those of the unschooled groups, and at least some of the school groups had a slightly higher average age. (There were twenty-three first-grade children, twenty-two third-grade, and twenty sixth-grade.)

According to a Wolof informant, children in the bush are *not* chosen to go to school on the basis of their intelligence. In fact, if a child shows promise at the Koranic school to which all boys and girls are first sent, he may be kept there and never sent to the national school. Such a selection factor would preclude an imbalance of native intelligence in favor of the school group. In general, certain families elect to send their children to school. If one child is sent, all usually go, except that girls, in line with the Moslem attitude toward women, are often not sent to school at all. Thus, there is no reason to believe that the rural children in school and out were not equivalent with respect to native endowment, and we can confidently attribute differences between the two groups to the school experience itself. Traditionally, school attendance has been linked with caste membership, with low-caste members of the society being the most willing to give their children a French education. In this village, however, school attendance was not related to caste.

The academic program is based on a French model and, as in France, is under the central control of the Ministry of Education. Indeed, the curriculum is specified in such minute detail by a booklet entitled *L'Education sénégalaise* that, for all practical purposes, our two school groups were having the same educational experience; and consequently the differences between the two groups must therefore be attributed to other distinguishing features of urban and rural milieu.

The school children went through the experiments individually at their school. Though every effort was made to hold things constant from school to school, there were some inevitable and considerable variations. In one city school the principal occupied the office adjoining the room in which the experiments were being carried out, and his callers periodically passed through the room, unannounced except by the long compulsory series of Wolof salutations. In the bush schools, at the other extreme, privacy was fairly complete, but the exigencies of space were such that the experimenting was done outdoors rather than in. Sampling in general was systematic. In a given school class every *n*th child would be taken from the roll in order to arrive at a sample size close to the target of twenty children per subgroup.

The unschooled bush children were examined at the author's compound in the village, one much like all the others. Its combined dining-room-and-kitchen building served as the experimental room, and a rough thatched shelter in the middle of the compound provided a "waiting room" for the next subject, who was usually accompanied by a good number of curious children from his own extended family. While an

official document from the Minister of Education aided us in securing school children as subjects, it was necessary to obtain permission from every family head individually so that the children under his jurisdiction might participate. Although none refused, there was an initial suspicion that an attempt was being made to conscript their children into school. For these children, the sampling unit was the residential compound, and the selection of children within a compound was made on a systematic basis from among those enumerated in the census rolls.

The experimental situation, in so far as it consists of an interview of one child by one adult, is unheard of in the traditional culture, where almost everything occurs in groups, and adults command rather than seek the opinions of children. The children, nevertheless, whether attending school or not, seemed at home with the tasks, and many seemed to be enjoying themselves thoroughly. Although they talked much less than Western children do and restricted themselves to answering questions, their patience was monumental and, correlatively, their attention span seemed to surpass by far that of American children.

The author carried out all the experiments in the Wolof language. A young Senegalese girl served as recorder, taking verbatim transcripts of the children's responses in a highly individualized phonetic system, for Wolof is an oral language and the recorder was not a linguist.

The exact conservation task was based on the most unambiguous translation of the American and Swiss procedure as could be formulated in Wolof. Although the school children were at various stages in learning French, the language of all formal instruction, the use of French in the experiments would have annulled their value by destroying the comparability of the groups. Among the subgroups of the school sample, for instance, the developmental progress between the first and sixth grades which is simply due to an increased ability to understand and express oneself in French would be indistinguishable from that due to an actual shift in modes of thought. Moreover, the school groups responding in French would in no way be comparable either to their unschooled Senegalese comrades or to their European counterparts, both of whom would have the advantage of being interrogated in their native tongue. At least one previous study of conservation in Africa suffered from this methodological flaw (Flavell [1963]).

In the basic conservation task (pretest, Figure 1) a child was presented with two identical beakers partly filled with water.

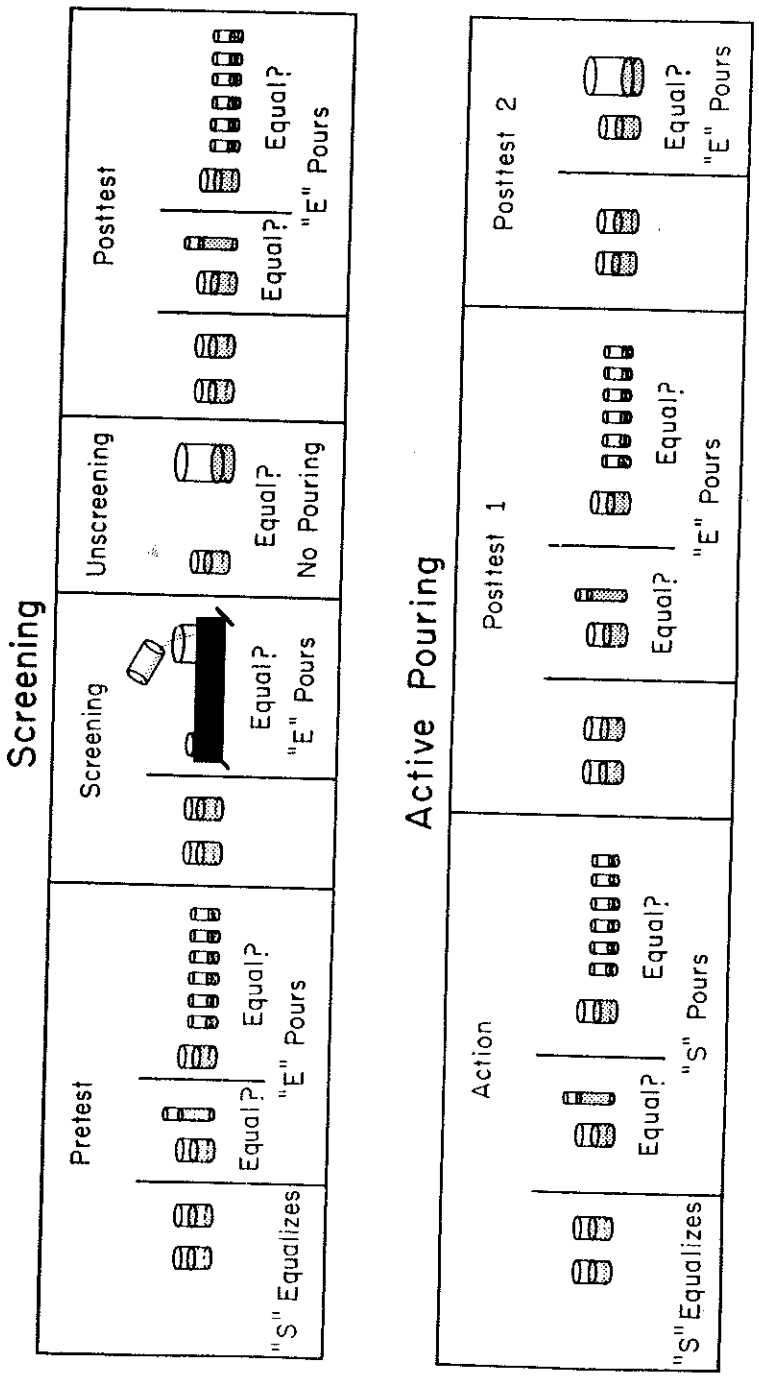

Figure 1. Procedures used in experiments.

The child equalized the water levels of the two beakers. The water of one of the beakers was subsequently transferred to a second longer, thinner beaker, causing the water level to rise, of course. The child was then asked whether the two beakers still had the same amount of water. In the second part of the experiment six shorter, thinner beakers replaced the long, thin one, and this time the water was divided among the six. The child compared the water in the original beaker with the total contents of the six small ones and judged whether or not the amounts were equal.

A major linguistic difficulty that had to be overcome was the inherent ambiguity in the Wolof language surrounding the two words for "equal" (*tolo* and *yem*). Both have the double sense of equal level and equal amount. Since the correct solution of the conservation problem depends on recognizing the distinction between these two "equalities," the cognitive implications of this linguistic difficulty are substantial.

Adult Wolofs agreed, however, that the version finally used referred unambiguously to the quantity rather than the level of water. In Wolof, the key conservation question was asked this way:

> Ndah sa verre bi ak suma verre bi nyo yemle ndoh; wala suma verre bi mo upa ndoh; wala sa verre bi mo upa ndoh?

A literal translation into English yields the following:

> Does this glass of yours and this glass of mine have equal water; or does this glass of mine have more water; or does this glass of yours have more water?

An interesting problem arose when it came to asking the unschooled children to justify their answers to this question. A previous experiment had shown that whereas the question, "Why do you *think* or *say* that thus and such is true?" would meet with uncomprehending silence, the question, "Why *is* thus and such true?" could often be answered quite easily. So the question asked of American children,"Why do you *think* this glass has more (or equal) water?" was modified to, "Why *does* this glass have more (or equal) water?"[2] It would seem that the unschooled Wolof children are lacking in Western self-consciousness: they do not distinguish between their own thought or a statement about something and the thing itself. Thought and the object of thought seem to be one. Consequently, the idea

[2] The question actually asked was, "Lu tah nyo yem?" (literally, "What reason they are equal?") or "Lu tah bi mo upa bi?" ("What reason this one has more than his one?")

of explaining a *statement* is meaningless; it is the external event that is to be explained. The relativistic notion that events can vary according to the point of view may therefore be absent to a greater degree than in Western culture.

THE PATTERN OF CONSERVATION

The development of the conservation of a continuous quantity, as a maturational achievement, is said by Piaget to be but one manifestation of more general and fundamental changes that occur in the course of cognitive growth. The first question we must ask is whether conservation does in fact develop among the Senegalese and whether this development relates to chronological age.

The achievement of conservation was said to be present when a child gave equality responses to both quantity comparisons with the standard beaker, that involving the long, thin beaker and that involving the six small beakers. A child who changed his mind was given credit for his final answer. The data on conservation are presented graphically in Figure 2. The most striking thing here is the one point at which conservation *ceases*, for all practical purposes, to be related to age. The oldest unschooled bush children (eleven- to thirteen-year-olds) show no significant increase in conservation over the eight- and

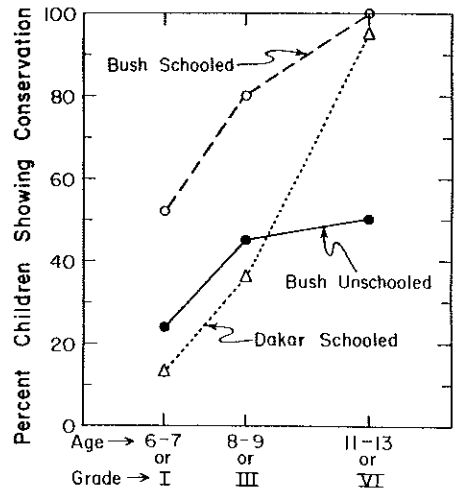

Figure 2. Percent of children of different backgrounds and ages exhibiting conservation of a continuous quantity.

nine-year-olds. Only half of the unschooled bush children attain conservation at this late age. It is possible, of course, that development is simply slower without school, so that an adult group might manifest 100 percent conservation behavior. Other results, however, obtained both from these subjects and from subjects in other cultures do not make it seem likely. A study of conceptualizing was done with unschooled adults (see Chapter 13) when we found that eleven- to thirteen-year-old children had responded in essentially the same manner as the eight- and nine-year-old group. No further changes in the pattern of conceptual thought were observed in the adults, save for a decrease in the variability of response from subject to subject. That experiment and this one suggest that, without school, intellectual development, defined as *any* qualitative change, ceases shortly after age nine. An investigator in Niger has made the same observation among unschooled African children on a completely different type of activity—drawing.[3] And another investigator who worked with conservation tasks (albeit different ones) found no difference between minimally schooled Chinese adolescent boys and a matched group of adults in Hong Kong in the percentage of subjects with conservation Goodnow (1962). It would appear at first glance that the technologies and skills absorbed from the school experience may indeed strongly affect the question of whether some children in Senegal (and perhaps elsewhere) even achieve conservation of a continuous quantity.

In contrast, the school children of bush and town yield the familiar developmental sequence, with conservation virtually always attained by the sixth grade. Note one point. The interviews were all in Wolof, as mentioned; but schooling is in French. It is interesting that the skills being learned in French do in fact carry over into thinking and speaking in Wolof. Bush school children, indeed, are almost indistinguishable from American or Swiss children. The studies reported elsewhere in this book, using much the same procedure as was used in Senegal, report conservation in half the children at ages six and seven (first and second grade) among American children. Other investigators have reported 75 percent conservation behavior at age eight (third grade) (Flavell, 1963). Bush school children show 52 percent conservation in the first grade (probably an average age of eight) and 80 percent in the third grade (average age between nine and ten). In terms of grade level, the Senegalese figures are close to being identical to the Western ones, although the Wolof children are behind in terms of chronological age. The parallel findings certainly cast

[3] Evelyn Pierre, personal communication.

strong doubts on any simple maturational notion of development. Rural Wolof children exposed to a certain set of cultural influences, namely, the school, differ more from other rural Wolof children raised without school than they do from European children. As the two groups of Wolof children are from the same gene pool, whereas the Europeans represent a nonoverlapping gene pool, this finding casts deep doubt on any biological-genetic point of view.

As for the performance of the Dakar school children, it is markedly inferior to that of the bush children in terms of the proportion of children showing conservation, until the sixth grade, when the two school groups are virtually indistinguishable in this respect and the unschooled group falls dramatically behind. We could attribute this difference to the globally disrupting effect of urbanization. Yet a look at the reasoning behind the children's amount judgments indicates that such an explanation is not only too general to have much explanatory value, but is also untrue. In any case, we cannot talk about these children's lives as being "disrupted" by urban influences, for the overwhelming majority were born in Dakar and have been children of the city from the start. So let us go on to the children's reasoning, which is in any case more interesting than the percent attaining conservation at each age.

There are basically three types of justification. These can be ordered according to how much they reflect *directly perceptible* features of the current situation. First, *perceptual* reasons do so to the highest degree. This class of reason refers to the features of the display in front of the child; it includes any description of the beakers and their contents. Perceptual reasons can be classified according to analyticity and complexity. In addition, one type of perceptual reason expresses a conflict between the appearance ("It looks like more") and the reality ("But it's really the same") of the situation. This type of reason occurred in the conservation responses of American children (Chapter 9), but did not manifest itself in the African protocols. If any conflict between the "appearance" and "reality" of the situation exists for these African children, it is expressed in different ways. In fact, previous pilot work at the Institut d'Etudes Pédagogiques at the University of Dakar had indicated that there is no conventional way of translating into Wolof the question oriented towards an appearance-reality conflict—"Is the water in the second glass 'really' different or does it 'just look' different?"—and that when the translation is made the children do not understand what it means.

Second, *direct-action* reasons refer to the act of pouring the water from one of the standard beakers into a test beaker (or bea-

kers). Note that these reasons are still rather closely tied to the situation, for the act actually takes place in the experiment and is the most recently observed physical action. Nevertheless, a direct-action reason can also be considered a Piagetian operation. Piaget states that an operation is an action that is both *internal* and *reversible*. We shall keep only the former part of the definition, leaving the latter for empirical investigation and later discussion. Still, it is an open question whether the direct action has in fact been internalized. If so it has been retained *exactly as it happened.*

The third category of reasons is called *transformational.* These reasons go beyond the "givens" of the present situation and represent a transformation of that situation in the child's head. For this reason they are truly "operational" in Piaget's sense, for they are by definition the products of *internalized* (or mental) *action.* In the present experiment, the transformations utilized in reasoning were of two main sorts: action and identity. The action transformations were sometimes inverse, also called negative or reverse ("If you were to pour it back . . ."), sometimes correlative ("If you were to pour the other one . . ."). These action transformations will be called *indirect-action* reasons, so as to emphasize the fact that they are not directly observed in the experiment. Note that the correlative action creates a *hypothetical* state of equality in the two sets of test beakers (for example, two long, thin beakers) while the inverse action recreates the *initial* state of equality in the two standard beakers. The inverse thus reestablishes the original state produced by the first equalizing operation. Reference to the original state of the system, in this case the state of equality in the two standard beakers, constitutes the third and most important type of transformation argument, the *identity* reason (for example, "This one [full standard beaker] and this one [empty standard beaker] had equal water"). Identity is the "null" transformation: nothing is changed. Logically, the identity argument is the most basic, because it is in fact the initial equalizing operation that determines the correct answer to the conservation problem. But logical primacy cannot be automatically equated with psychological primacy, as Piaget is wont to do; therefore let us examine the psychological status of the identity argument.

In America, younger children rely much more heavily on perceptual reasons than do older children. This is also dramatically the case among the Wolof school children (Figure 3). Indeed, we find a drop from 79 percent perceptual reasons in the first grade of the bush school and 63 percent in the first grade of the Dakar school to 27 percent in both sixth grades. But the unschooled bush children, iden-

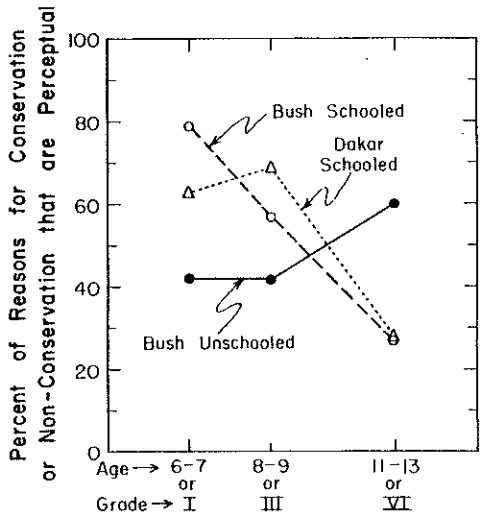

Figure 3. Percent of reasons for conservation or nonconservation that are perceptual.

tical to the bush school children in every respect save one, use *more* perceptual reasons as they grow older. Yet note that the unschooled children start out less perceptually oriented than those in school. It seems, then, that the *first* effect of schooling is to increase their analytic attention to the perceptible features of situations such as our experiment, and that this effect is then followed by a systematic and drastic reduction in the importance of such features. This result finds an interesting parallel in the American children, who, in developing the relational idea of a proportion (Chapter 8), first become *more* perceptual with age, in the sense of learning to utilize more than one perceptible attribute at a time. Only after this stage do they unify these attributes by means of the "fraction" schema. This simpler, more symbolic "theory" in turn eliminates the need for the plural perceptual reasons out of which it arose.

Let us now look at reasons in relation to conservation judgments. Do Wolof children fail to conserve for the same reasons as Western children, and do they attain conservation by the same paths? In most cases the Wolof children use a transformational or direct-action reason as the basis for justifying conservation, just as American children do (Chapter 9). However, direct action assumes greater importance in the conservation reasoning of these children than it did in the Ameri-

can children's proconservation arguments. Price-Williams (1961), working with Tiv children in Nigeria, also found that justifications for equality judgments were in terms of action. The over-all totals of the reasons used by all one hundred eighty-one children studied were:

40 percent based on perceptible features,
16 percent based on direct action,
44 percent based on transformation (identity and indirect action).

In support of nonconservation, they were:

78 percent based on perceptible features,
20 percent based on direct action,
2 percent are transformations.[4]

These figures indicate that transformation reasons are a sufficient, if not a necessary, condition for conservation. A closer look at the actual transformation arguments reveals that 95 percent of them contain a reference to the identity "transformation." Therefore, we may conclude that the identity argument is not only *logically* but also *psychologically* sufficient for a conservation judgment. On the other hand, the psychological results do not confirm the logical idea that an identity reason is also *necessary* to conservation of amount.

As for reversibility, that is, the possibility of inverse action, it is secondary to the identity element in two ways. First, it usually does not appear as a reason in isolation, but is accompanied by an identity argument (for example, "If you were to pour this water [long, thin beaker], here this one [full standard beaker] and this one [empty standard beaker] would be equal"), whereas identity alone often appears as an argument for conservation. Thus, it would seem that identity is a necessary condition for the use of reversible action as a conservation argument. One could say that reversibility without identity yields the kind of result obtained by Carey (Chapter 9): a change in level obtained by pouring the liquid into a beaker of a different shape is seen as reversible; but, although the young child may realize that the change is temporary, it is no less "real" to him, for the change in level implies a correlative change in quantity. In brief, Carey finds reversibility without conservation.

Second, it is *identity* rather than *reverse* transformations that cause direct-action reasons to be associated with an "operational" or correct

[4] Seventy-eight percent of the children contributed two reasons, corresponding to the two parts of the conservation task. Only three out of the one hundred eighty-one children gave as many as four reasons, the maximum number possible.

solution to the conservation problem. In other words, direct-action reasons are *always* in support of conservation when they contain an identity element. When they do not, they frequently support an incorrect judgment. Reverse action, in contrast, is rarely even associated with direct-action reasons. In consequence, it seems more accurate to say that it is identity, and not reversibility, that turns actions into operations, at least in the conservation situation.

One final observation concerning the role of identity in conservation. As action reasons become more operational, both in the sense of supporting conservation judgments and in the sense of being more internal (that is, indirect), identity arguments increase in a rather dramatic correlation (Table 1). Thus identity would seem to be an accurate index of operationality defined according to these two Piagetian criteria.

Before leaving the discussion of reasons in support of conservation judgments, we must point out an interesting difference between American and Wolof justifications. The older American children participating in Frank's screening experiment sometimes spontaneously remark upon the *necessity* of equality (e.g., "It must be the same"). There is not one instance of such an appeal to necessity among all the Wolof children, although the language does contain the requisite vocabulary.

Turning now from equality to inequality judgments, we see that the general picture of nonconservation reasoning is also very similar to that found in the United States, for the overwhelming conservation block is a perceptual one. The Wolofs deviate from the American pattern in one major respect, however: there is a significant minority (20 percent) of inequality judgments that are supported by *direct action* reasons. That is, Wolof children often say things like, "There is more in this glass because you poured it." American children only use such reasons to support a conservation position, although Piaget (1952) reports one instance of an action reason for a nonconservation

TABLE 1
Percentage of Action Reasons That Include a Reference to the Identity Justification

	Direct-Action Reasons for Nonconservation	Direct-Action Reasons for Conservation	Indirect-Action Reasons for Conservation
Reference to identity	0%	47%	75%
Number of reasons	19	75	20

response in a four-year-old. This seemingly bizarre reasoning did not come as a complete surprise, since pretests conducted in the Senegalese bush in 1963 by Bruner and Valantin had underlined the importance of definition by action. They had found that one glass would be called "the same" as another by virtue of the fact that each had "been poured into." But here was something different: inequality based on an action.

It could not be simply a matter of equating actions rather than amounts of water, for different children gave the same action answer in the same situation, sometimes to justify a judgment of equality and sometimes to justify a verdict of inequality. A control procedure also cast doubt on the idea that equality would be based on identical actions when the quantities of water were different. More likely, the children are utilizing *action* reasons to explain a *perceptual* discrepancy between the appearance of the water in the two glasses. The contrast between the initial appearance of equal quantities of water and the later appearance of inequality is perhaps resolved by recourse to the experimenter's action. It is that form of "magical" thinking in which natural phenomena are explained by attributing special powers to intervening human agents.

School suppresses such thinking with astonishing absoluteness. There is *not one instance* of such reasoning among the children who have been in school seven months or more. Urban life itself exerts no influence in this direction, for among the first-graders in Dakar (who had completed no more than four months of school at the time of the experiment) one finds the most "magical" reasoning of all—80 percent of these children's action reasons are of this type.[5] So, Wolof children who have not been to school differ from American children in the reason why they do not have conservation. Their reasons reflect less "perceptual seduction" than "seduction by the experimenter's actions."

As just described, direct actions are less likely than indirect actions to bear the mark of an operation (internalization), for their origin is to be found in external physical action. And note that it is also *direct-* rather than *indirect*-action reasons that are used by the unschooled children to support inequality judgments. This finding is in line with Piaget's general point that conservation demands internalized operations.

[5] These children had had less schooling than the first grade bush children, as they had to wait several months for their parents to construct a classroom. In fact, the few months of schooling they had received were probably ineffectual because of conditions of extreme overcrowding and disorganization.

In Senegal, as in the United States, perceptual reasons support both conservation and nonconservation judgments. Although perceptual reasons are relatively infrequent among both the youngest unschooled children and the oldest school children, the former group uses them to support *nonconservation*, the latter, *conservation*. Can we then find an observable difference between the two types of perceptual reason, a difference that will set off the thinking of Senegalese children who have conservation from those who do not? It would seem so. When perceptual reasons reflect attention to *several* perceptible aspects of the conservation situation, they are likely to back up a conservation position; when they indicate that the child is centering on only one aspect of the situation, they are likely to go along with nonconservation. However, the two perceptible aspects do not have to be the two dimensions of height and width that Piaget claims are of crucial importance to conservation through compensation. In fact, a reference to the *same* dimension of two *beakers* is more effective than a reference to two *dimensions* of one or two beakers.

Returning now to the city-school children, we must note that it is precisely in this respect that the younger city-school children fall behind the rural groups. That is, their transformation reasons are associated with conservation about as often as in the bush. But many more of their perceptual reasons are reasons *against* conservation. It turns out that, correlatively, the city children are much less inclined to focus on more than one aspect of the situation when they give perceptual reasons; they more often think in terms of *one* attribute of *one* of the beakers, never mentioning other attributes of the same beaker or the other beakers involved in the experiment. Nor are they inclined to relate two features of the displays even implicitly through the use of a comparative descriptive word—for example, "thinner," "taller." The importance of getting away from a single salient perceptible cue if an American child is to develop conservation was also commented upon in Chapter 9. Thus, the rural-urban difference in the percentage of younger children showing conservation is *not general*, but is concentrated among those children who give perceptual reasons.

Exposure to the more diverse sensory impressions of the city seems not to make children more perceptual; quite the opposite—their perceptual impressions of the experiment (as reflected in their reasons for judgment) were *less* diverse, *more* restricted to a single impression. We may hypothesize, however, that linguistic conditions produce this poverty of perceptual description in city children. Wolof as spoken in Dakar has become much simplified, owing to its status as

the African *lingua franca* there. And, indeed, the descriptive language of the city children was less varied than that of their rural counterparts, particularly the school children. The importance of symbolic coding in fostering a conflict was discussed in the preceding chapter.

A SCREEN AGAINST PERCEPTIBLE CUES

One of the strategies for discerning what produces a particular reaction is to try to alter it. In the screening studies carried out with American children (Chapter 9), it was argued that conservation depends for its attainment on the development of a sense of conflict between how things appeared and how they "really were." If such were the case, the argument continued, one should hasten conservation by shielding the child from initial exposure to the perceptible inequalities by carrying out the pouring with beakers behind a screen. This is to say, one would first show the identical beakers with an equal amount of water in them. Then the contents of one of the beakers would be poured into a taller, wider beaker—with all beakers covered almost to their tops by an opaque screen. This procedure worked in the United States and, indeed, it succeeded strikingly in getting the children to say that the same amount of water was present in both beakers, not only while the screen was in place but also after it was removed. The screen was a success, pedagogically.

Would the same procedure prove successful among children whose language indicates little concern with noting and reconciling self-consciously the differences between appearance and reality? It would seem unlikely. In any case, a screening procedure similar to that used in Massachusetts was employed in Senegal (see Figure 1), including a request for the reasons for amount judgments both before and after the removal of the screen (see pp. 193 ff).

As for gross results, only 30 percent of the eighty-one Wolof children who did not have conservation on the pretest discussed before showed an improved performance on the posttest, in contrast to 61 percent improvement among comparable American children. These results are in terms of shifts among three categories of response: (1) *conservation,* which means an equality reaction on both parts of the pretest; (2) *fluctuation,* or giving a conservation response to one part of the pretest and a nonconservation response to the other; and (3) *nonconservation,* with inequality answers on both parts of the pretest.

While screening was not totally ineffective with the Wolof children, the effect was trivial on closer inspection. For it turned out to be nothing more than a threshold phenomenon. What screening did was

to induce conservation in those children who were already on the verge of conservation, as indicated by their fluctuation on the pretest. Those who had shown no previous signs of conservation were helped little. The change wrought in the fluctuating subjects was virtually the same as with American children: in Massachusetts 65 percent of such subjects were moved to conservation, as compared with 55 percent in Senegal. In addition, 73 percent of the American children who had shown no conservation on the pretest showed improvement (either to fluctuation or conservation) on the posttest. In Senegal, only 13 percent of the comparable group of thirty-eight Wolof children improved on the posttest; and only one of them moved all the way from nonconservation to conservation. In sharp contrast, 36 percent of the children giving nonconservation judgments in Massachusetts moved all the way to conservation on the posttest as a result of screening. In short, if a Senegalese child was not already uncertain on the pretest, he was not likely to be helped by the screening procedure. The same was not true of the American children. The data are summed up in Table 2.

It would be helpful to relate that one could easily tell on the basis of the reasons proffered during the pretest which fluctuating subjects would be moved toward conservation by screening. Alas, the number of subjects shrinks as one seeks to isolate justification patterns. However, some suggestive results can be given. The first is that, if the subjects show any tendency to justify incorrect judgments in the lan-

TABLE 2
Percentage of American and Senegalese Children Who Showed Various Degrees of Improvement from Pretest to Posttest as a Result of Screening Experience

Posttest	Pretest: No Conservation		Pretest: Fluctuation	
	United States	Senegal	United States	Senegal
No conservation	27%	87%	12%	7%
Fluctuation	37	10	23	38
Conservation	36	3	65	55
	100%	100%	100%	100%
Number of children	11	38	17	42

guage of identity, they are certain to be in the conservation group after screening. At the other extreme, those fluctuating subjects who show any sign of action-magic in their justification are almost sure not to benefit from screening. Finally, fluctuating subjects who use any form of perceptual analysis to back up incorrect quantity judgments are more likely to benefit from the screen than those who use nonanalytic perceptual arguments in the same situation. Perceptual analysis involves any effort to describe particular attributes of the water or of the beakers.

In the main, however, we are prepared to believe that screening was of very little help to those who had not yet achieved conservation and that the help it afforded the fluctuaters was nonspecific, the result of an opportunity to practice. It is doubtful whether much is due to special features of the screening technique itself. Other findings support this conclusion. For example, screening does not affect the reasons given by Wolof children without conservation either after unscreening or in the later posttest. Most notably, *perceptual* reasons are not reduced one whit, *even during the time that the water level is hidden by the screen.* In Massachusetts, on the other hand, there is a sharp decline in perceptual reasons with the introduction of the screen (in all age groups) and a further decline in perceptual reasons on the posttest (among all but the youngest group).

What is there in Wolof thinking that renders screening so ineffective as an instructional technique? Certainly, it would appear that school children, particularly Dakar school children, have perceptual barriers to conservation just as American children do. It might be that the screen does indeed shield them from a quick misleading ikonic rendering of the situation (Chapter 9, p. 199), but that the symbolic representation substituted for the perceptual image and designed to serve as a guide for organizing their perceptions in a new way (Chapter 9, p. 201) actually organizes these perceptions by means of a conceptual framework foreign to their thinking. This important pedagogical point will be more fully documented following the presentation of some additional relevant data.

As for the Wolof children who do not go to school, it is not so difficult to understand the failure of the screen as an instructional technique, for perceptual difficulties did not seem to be their problem in the first place. They do not justify nonconservation by a perceptual rationale. Action reasons more often serve that purpose. In this group, moreover, perceptual reasons do not decrease as conservation increases with age. Quite the contrary: an increase in perceptual reasons is associated with an increase in conservation. So it seems reasonable to suppose that a procedure designed to eliminate reasons based on perceptible cues would not be particularly relevant for this group. Consequently, a second training technique, specially planned to combat "magical" thinking about action, was developed for unschooled children. The results of this second experiment should also bear upon the question of whether screening was in fact relevant to the difficulties of our group of unschooled children. Consider this second training technique before we draw any final conclusions about the children's reaction to screening itself.

COMBATING ACTION-MAGIC

In this version of the conservation procedure, everything remained basically the same with one exception: the child did all the pouring himself. The rationale was this: the child, while perfectly willing to attribute "magical" powers to an authority figure like the experimenter, would not attribute any special powers to himself. A discrepancy in the apparent amount of water was not so likely to be rationalized as having been produced by adult magical power. Any child, moreover, is bound to have more accurate cause-effect notions with regard to his own action than with regard to the actions of others. The child with little experience in manipulating environmental objects—as would be truer of children in the passive Wolof culture than of children in America—might also be more prone to attribute puzzling changes to extrinsic powers. Experience in producing effects on the physical world might combat this tendency.

As before, the child began by equalizing the water levels in the two standard beakers, pouring into one to match the other. Then, unlike the first procedure, the experimenter told the subject to pour the water from one of the beakers into the long, thin beaker used in the first experiment (Figure 1). He was then asked if the two beakers contained the same amount of water and why. The wording of the two questions was exactly the same as in the previous experiment. After giving his explanation, the child was told to pour the water back into the standard beaker and finally to distribute the water among the six small beakers. Once again, he was asked if the standard beaker and the six small ones contained the same quantity of water and why. The rest of the experiment consisted of two posttests, with the experimenter pouring, to see whether conservation would carry over to the standard situation. The first posttest, exactly like the posttest of the screening experiment, used the same tall, thin beaker and the six small beakers into which the child poured in the first part

of the present experiment. The second posttest substituted a new beaker, the tall, wide one. In this way there was an opportunity to observe whether conservation would prevail in a situation the child had not met while pouring the water himself. (The sequence of events is made clear in the bottom half of Figure 1.)

This "active" version of the conservation experiment can be considered both as a test of conservation and as a training technique for the traditional conservation task. As there was no pretest, we can first of all ask whether the conservation rate and the reasoning when the child pours differ from when the experimenter pours. A comparison with the pretest of the screening experiment yields this information. In the second place, we may ask whether this procedure is effective as a training technique. A comparison of the posttest results of the two training experiments answers this question. A different group of rural unschooled children participated in this experiment, but the two groups were comparable and from the same village. Essentially the same selection procedures were used, but the children doing the "active" version of the conservation test represented only half of the village's extended family units, rather than all of them, as in the first experiment. All the children from a given family who were going to participate in either conservation experiment did so at the same time, so that any contaminating communication was kept to a minimum. Because of the smaller sample in this experiment, the two oldest groups had to be lumped together for purposes of analysis. The formation of a single group of eight- to ten-year-olds seemed perfectly justified by the homogeneity of the pretest conservation results from the two oldest unschooled groups (discussed before) in the screening experiment. There were nine six- and seven-year-olds and eleven eight- and ten-year-olds.

That pouring makes a difference to the unschooled children is evident. Among the younger ones, two-thirds of the group who transfer the water themselves have conservation; only a quarter of the other group had conservation when the experimenter poured. In the older group, the contrast is equally dramatic: 82 percent of those who do the pouring themselves show conservation, as compared with slightly less than half of the group placed in the standard testing situation. So much for the pretest.

The "do-it-yourself" procedure has surprisingly strong effects on later behavior as well. Recall that there are two posttests to compare, each corresponding to a posttest on the screening procedure. The first posttest is comparable to the unscreening. This one is carried out with the same beaker as was used in the "do-it-yourself" condition—the

taller, thinner one and the six small ones. The second posttest involves, as in the screening posttest, a change to a different beaker. The two procedures are compared in Figure 4. As far as the older children are concerned, it turns out that it does not matter which posttest we compare. Active participation by the child is superior to screening as a pedagogical experience. In the older group, all the children show conservation in both posttests. Screening had produced it in only two-thirds of the older children, according to posttest figures.

Among the younger subjects, there is a little backsliding on the first posttest, and no difference between the effectiveness of screening and pouring as training techniques. The young unschooled bush children show an effect comparable to that in the youngest group of American children who succeed under optimal training conditions with screening, but who cannot withstand the misleading cues in the posttest. But on the second posttest, eight of nine of the bush youngsters regain conservation, a proportion considerably higher than the half who had shown it after screening in the earlier study of unschooled children in Taiba N'Diaye. This increase is mostly due to the greater difficulty of maintaining conservation when the water is divided among several beakers, a task that was included on the

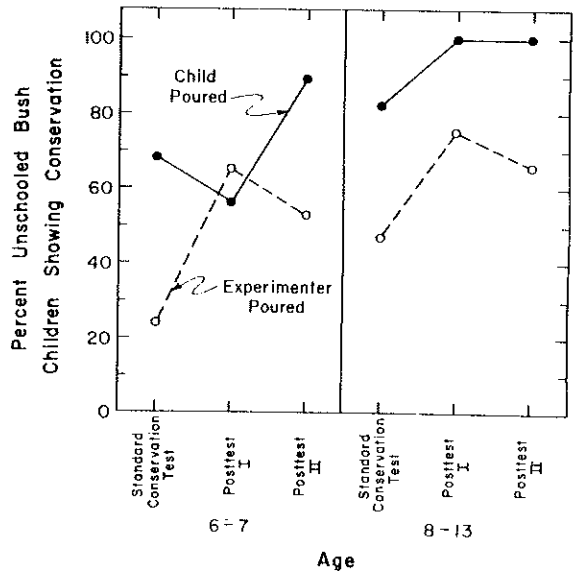

Figure 4. Percent of bush unschooled children showing conservation after pouring and screening.

first posttest, but not on the second. The reasons for the greater difficulty of this task will be taken up later.

Could the rather dramatic effects of "doing it yourself" be the potentially universal result of activity *per se*, or do they occur because this training technique undermines the "magical" mode of causal thinking peculiar to unschooled bush children? Or might the superiority of "pouring" over screening stem from a procedural artifact—in other words, the children who poured had no pretest on which it was easy to err, and thus they had no "commitment" to an incorrect solution. To test these two possibilities, an additional control experiment was run with some Dakar school children attending a girls' school. Although the other groups tested had included boys, this aspect seems unimportant, since no consistent sex differences had shown up in the first conservation experiment in Dakar.

The control experiment comprised two conditions—a "pouring" condition and a "screening" condition. There was no pretest under either condition. Fifteen Wolof children from the first and third grades took part in the pouring experiments, seventeen in the screening experiment. The screening experiment was exactly like that already described, minus the pretest. The pouring experiment was like the first one, except that the six small beakers were completely eliminated.

First screening. The proportion of children showing conservation (41 percent) when the screen separated subject from beaker was between that obtained on the *pretest* of the previous experiment and that obtained while the screen was in place during the same experiment. But the posttest result was clearly inferior to that produced by the first screening experiment. This suggests again that screening itself is not effective, but rather that it permits a repetition of the conservation tasks. The control experiment, lacking a pretest, permitted less repetition and produced inferior results. We may also eliminate the issue concerning the effect of initial error on the pretest, leading to an interfering commitment that diminishes the effects of training. Initial error does not reduce the effect of screening: the screen promotes conservation no better, even when it is the child's first experience with the conservation problem.

The results of the pouring experiment do indeed suggest that the effectiveness of the "active" form of the conservation task is based on its "antimagic" capability. Pouring does not work at all among the city-school children who do not have the "magical" thinking that the procedure was designed to combat. Only one child showed conservation under this condition, a performance that is even markedly inferior

to the level of the Dakar school children operating under standard conditions in the first experiment. It may well be that pouring for the city children may have an interfering effect, but time did not permit a fuller examination of the matter.

The success of an instructional method in one group of children and its failure in another strengthens our conviction that differently enculturated children have basically different schemata for approaching conservation, schemata which go beyond mere verbal differences. Indeed, the variation from group to group in response to "screening" and "pouring" indicates the presence of greater subcultural differences in thinking than might have been concluded from the differences in the verbal reasons they gave in defense of their judgments. For example, more than half of the nonconservation reasons given by the two older unschooled bush groups in the pretest of the screening experiment were perceptual rather than action ("magical"); yet the act of pouring was followed by conservation in all of a matched group of rural subjects. In contrast, there is no reason to think that any subject in Dakar was moved from nonconservation to conservation as a result of transferring the water from beaker to beaker, though the verbal justifications of these children were also highly perceptual.

Price-Williams' (1961) study of conservation of both continuous and discontinuous quantities among unschooled Tiv children in Nigeria gives further indication of the importance of active manipulation. This investigator found that 100 percent of the Tiv children had achieved both types of conservation by age eight, in sharp contrast to our upper limit of 50 percent with much older children. However, his description of the children's behavior during the experiments indicates that the Tiv culture is quite different from the Wolof one in promoting an active manipulative approach to the physical world. Price-Williams describes the children's behavior like this:

> These children would spontaneously actually perform the operation themselves. . . . Furthermore, they would reverse the sequence of operations, by, for example, pouring back the earth from second container to the first (Price-Williams, 1961, p. 302).

Such self-initiated action was *never* observed among unschooled Wolof children, and it may well be the key to the great disparity between the two cultures in spontaneous conservation results.

How shall we know directly that the unschooled child's act of pouring infirms his "magical thinking? If such were the case, a child's reasons for his judgments should reflect it. They should differ according to whether the experimenter or the child pours. We have, after all,

drawn conclusions about the ineffectiveness of screening on the grounds that the children's reasons were the same before and after the procedure. And indeed, we find that when the child pours, his reasons are dramatically different from those he gives when an adult does. Magical-action reasons, which constituted a quarter of all reasons when an adult pours, are nonexistent when the unschooled older children themselves pour. Responses like, "The water is not the same because you poured it," disappear. In the younger group, action reasons drop from 42 percent with an adult pouring to 8 percent when the children pour. What emerges in place of action justifications are identity reasons. The child who pours on his own now uses his initial equalizing operation as the basis for his justification of conservation. "I made them the same." In the oldest group we find that identity reasons account for 64 percent of all justification when the child does the pouring. When the experimenter pours, only 20 percent of all reasons are based exclusively on a return to the initial situation of equality ("logical identity"). In the younger group comparable figures are 50 percent and 4 percent. There is an interesting difference between the reasoning of older and of younger children. Among the younger ones, the proportion of perceptual reasons stays the same, no matter who pours. Identity reasons replace magical-action reasons when the child pours. In the older group, perceptual reasons as well as action reasons decline when the child takes over the pouring.

How, finally, shall we explain the fact that among the Wolof children who have not been to school, those who pour the water from beaker to beaker have conservation, while those who only watch the experimenter pour do not. Why is this the case? Two possibly related reasons suggest themselves. One stresses motoric experience and its resultant sensory feedback, the other the removal from the task of a powerful authority figure. If the effect were due to feedback from the action of pouring, one would hardly expect action reasons (which refer to this new experience of transferring the water) to decrease. In fact, they do decrease, and drastically. Our view, rather, is that the intervention of an authority figure in the standard experiment attracts attention; whatever that person does is important, even if irrelevant to the solution of the problem. The attention of the child is drawn away from his own action and from the intrinsic nature of the task itself. The child, in a way, is trying to solve the experimenter rather than the problem. Only when the authority figure withdraws does the child turn fully to the logically essential parts of the action, beginning with equalizing the water and carrying through to a recognition that the initial act establishes an identity throughout.

Once again identity—a return to the beginning—turns out to be not only the logical but also the psychological heart of conservation. It seems as though identity may be the "invariant" in conservation itself. At least, identity appears to be as necessary to the attainment of conservation for these unschooled Wolof children as it was for American children (Chapter 9). But if the psychological "essence" of conservation begins to take on an aspect of universality, the techniques by which it can be implanted are not, as these experiments show. Indeed, the variation in successful instructional methods from group to group is nothing more than a sharply focused reflection of the diversity of preconservation schemata that we have been describing.

Lest it appear that action alone plays a part in the preconservation schema that is corrected by "pouring," we might consider a very revealing observation. It was often the case that a child, when asked to match the amount of water that the experimenter had poured into one standard beaker, would pour *all* the water from the pitcher into the second standard beaker, although the pitcher contained too much. The reason for his mistake seemed to be that he had initially watched the experimenter pour *all* the water from her pitcher into the first standard beaker and that he was doing likewise. Yet he was perfectly capable of realizing afterwards that he had poured too much and of correcting his mistake. The child was not merely matching the perceptual end state, as he was asked to do, nor was he matching only the action of pouring. What he was doing was making an erroneous causal connection between the two, just as in the experiment proper. He was assuming that, if he performed exactly the same action as the experimenter, the end result would also be the same.

Piaget would say something like this: "Actions are still not dissociated from the objects upon which they bear. He does not yet apprehend interrelations among objects *per se;* what are grouped are the action-object amalgams" (Flavell, 1963, pp. 137–138). Although this description fits, Piaget uses it to refer to the development of the sensori-motor state that takes place before age two and limits it to the child's representation of his own actions. Thus Piaget's child, in this instance, is said to organize his world in terms of practical space, a space that cannot be represented by symbolic means. But our Wolof children can, and certainly do, represent their world symbolically and in a very complicated language indeed! It makes much more sense to think in terms of an interaction between levels of representation, as these have been discussed throughout these pages. In the present case, we have a symbolic means of coding (language); but in terms

of content, i.e., what is coded, the representation does not go much beyond the capacities of the enactive mode—sensori-motor phenomena (actions) are represented by symbolic means. These sensori-motor phenomena differ from concrete operations, for they are not reversible. What this group of Wolof children is coding in language is a sequence of acts in the order they occur; the transformational possibilities of language are not utilized, and we are left with the symbolic analogue of an action sequence.

Consider now whether the unschooled children's lack of response to the screen bears out this view of the achievement of conservation. To do so, we must first look at the school children. The school children, recall, differed from the unschooled young Wolofs and, as we noted, were much closer in their conservation responses to American children than to their own countrymen. Yet they did not learn conservation from the screening procedure, as American children had. We have delayed a closer look at the failure of screening until now. At this point, however, it becomes especially appropriate.

When the screen is put in place before the American children, 82 percent of them agree that the hidden beakers contain equal water. In Senegal 62 percent of the unschooled rural children respond in this way, 67 percent of the rural school children, but only 42 percent of the city children. Why is this the case, if the school children are most like American children in their approach? In fact, it turns out that in certain respects they are even more perceptual than American children, particularly the Dakar children, and far more so than the unschooled bush children. With the beakers hidden behind the screen, they persist in wondering about where the water level is. American children almost always give their judgments when the screen is in place with not an apparent thought for the water levels. Not so the Dakar children, of whom several had to be eliminated because they peeked behind the screen—behavior never encountered in America. The Dakar children often predicted the water level by the compensation principle and then gave the judgment of inequality on that basis.

What happens when the screen is removed? The results are exactly what would be predicted from the preceding analysis of the reasoning in different groups (Table 3; Figure 4). Unschooled children, using action cues more than the school groups, are not affected by the new perceptible cues revealed when the screen is taken away. Conservation responses are more frequent without the screen than they were with it, in sharp contrast to the response of the three school groups (bush, Dakar, and American), in which removing the screen results in a sharp decline of conservation answers. Note that unscreening involves no new "pouring" cues which might lead the rural children astray. It is just such cues that make the second part of the standard conservation situation—where the water is divided among the six small beakers—more difficult for this group of children than the first part, as has been mentioned before. When the water is poured into the six small beakers, it is particularly easy to explain the perceptual discrepancy by action inequality. The child is presented with an action contrast of six pouring motions to one. For children sensitive to action, this inequality situation must be much more compelling than the one in which water is poured once into the standard beaker and once into a beaker of a different shape.

TABLE 3
Percent of Children with No Conservation on Pretest Who Give Conservation Responses During and After Screening

	Cambridge	Bush No School	Bush School	Dakar School
Screen present	82%	62%	67%	42%
Unscreening	61%	69%	33%	16%
Posttest	54%	38%	33%	19%
Number of children	28	29	15	31

As for the posttest, the school children who survived unscreening also survive the posttest, the unschooled children less well. It may well be that the unschooled children, given their tendency to action-magic, more easily fall prey in the posttest to all the pouring done by the experimenter, whereas perceptible cues, the nemesis of the school children, are no more misleading than on the previous unscreening condition.

SOME CONCLUSIONS

We have covered much ground and examined in fine detail the responses and reasons of our Senegalese children. Several points stand out consistently.

The first is that there is a wider gap between unschooled and schooled Wolof children from the same rural village than between rural and urban school children. By the eleventh or twelfth year virtually all the school children have achieved conservation. Only about half of those not in school have done so.

The school children, moreover, show the typical early reliance on perceptible cues in justifying their judgments and a later decline in such judgments. In contrast, unschooled children in the bush show a gradual rise in perceptual reasons over the same age span.

Screening the children from perceptible cues has a relatively minor effect on children who have not yet started to fluctuate. It has its effect principally by virtue of giving the fluctuaters a chance to practice. In general, screening has a minor pedagogical effect in contrast to its effect in hastening conservation in American children.

A principal difficulty with the unschooled Wolof children was their tendency to "explain" the changed (to them) amount of water in terms of action-magic—it was different because the experimenter had poured it. The specific cure for this was having the children pour for themselves. But it is noteworthy that such a do-it-yourself expedient helped the unschooled children and not the school children, who were much less given to such reasoning.

In fact, the most characteristic thing about the unschooled children is the extent to which action is crucial to their representation of the world and the degree to which symbolic representation is, for them, a sequential account of a train of actions. What is striking about the African child who is exposed to Western education is the degree to which he rapidly becomes perceptualized, almost overperceptualized. This is so much the case that the interposition of a screen between him and the "misleading" beakers of liquid, rather than freeing him to carry on a symbolic equation of the liquid, only tempts him to look behind the screen to see how it looks.

Conservation, it would seem, depends for its development on the presence of a sense of identity, the idea of a potential return to an initial state, in this case, the state of equality. It is identity which must be used to integrate the other cues provided by the situation. The American child often does so through an "appearance-reality" schema which allows him to deal *simultaneously* with the "appearance" of level and the "reality" of identical substance. When the definition of equal quantity shifts from the former to the latter, conservation is achieved.

The Senegalese child, however, cannot use the idea of identity to integrate conflicting cues through cross-classification of the situation according to both "appearance" and "reality." To him this distinction does not exist, and one has more than a little difficulty even communicating the contrast in the Wolof language. When American children use identity as a justification for an equality judgment, they often say, "It's the same water," or "It *looks* like more but really is the same." They make identity a *present* phenomenon. But the Wolof child says, "This one and this one [the two standard beakers] are [or were] equal." Note that one of these is now empty. Therefore he expresses identity through describing a past state rather than a present one; this is identity by recapitulation. The conflict for the Wolof child is between the initial and the later appearances of the water. It is resolved by the recognition of the identity of something observed a moment ago and something observed now. It is perhaps for this reason that the reference to two beakers is the most effective single type of perceptual reason with respect to conservation, for it is the standard beaker that provides a tie with the "past" equality of the initial situation. Similarly, the "action" experiment perhaps integrates conflicting cues by providing continuity of action between the past and the present.

It follows that a training technique for the "perceptually seduced" school children of Senegal would also be one that stresses a continuity of past and present, promoting an easier integration of the two, and one that draws particular attention to the past and its crucial equality cues.

If these experiments indicate one thing of special importance, it is the way in which different modes of thought can lead to the same results. It has too often been assumed that different intellectual means must of necessity lead to different cognitive ends. This might occur in the case of problems which have no objectively definable "right" answer. But where there are action constraints and consequences for behavior (as with the phenomena of conservation), a disparity in results is not necessarily the case. We have shown how an identity schema is as crucial to conservation in Senegal as in the United States but that it can develop by different means. Senegalese children do not utilize the language of identity ("same") or the classification of the present situation according to both appearance and reality to express identity. Both these modes of expression when employed by American children make the equality of the past simultaneous with the present inequality of appearance. The Wolof children, by contrast, achieve conservation by establishing identity between the *successive* states of past and present. Their link might be either the continuity of action from one part of the experiment to another, or the constant appearance of the standard beakers.

It is obvious that in order to survive all peoples must somehow come to terms with a few basic laws of the physical world, despite profound differences in "world view." Certainly, the conservation of a continuous quantity across transformations of appearance is one of

these basic facts. Nevertheless, certain ways of thinking may be more powerful than others as a means to the discovery of *new* laws, laws which may be "optional" to survival under certain conditions. Thus Newtonian thinking is fine for some purposes, but Einstein can do the same thing and more. Consequently, it is well to bear in mind that intellectually too there is more than one way to skin a cat—regardless of whether all ways are equally effective for skinning twenty cats, or for that matter, dogs.

CHAPTER 12

On Culture and Equivalence: I

Michael Maccoby and Nancy Modian

The study reported in this chapt undertaken to examine how general is the account of the equivalence transformation found in the work of Olver an reported in Chapter 3. Beyond that objective there is y Surely the manner in which a child goes about abstracting should reflect the nature of his society. In most instances lences imposed on one's environment have much wider limi than, say, such things as physical judgments do; for e two containers hold the same amount to drink? Whether considered as food, for example, does not depend on their value alone, but also on custom and dietary taboo. To th beef and pork are two meats, different in taste but equival tion and formal classification. But Orthodox Jews and Mos not group the two as food, nor would they meet the Hind lence requirements. In these instances, cultural training fective brake on functional and formal equivalence.

Nor should the matter be restricted to determination *content*—whether in a semantic sense two things are co grouped or not. One might expect that certain cultural t extend to the kinds of attributes preferred for equivalenc or, indeed, the kind of grouping rules employed. It is su able to expect, for example, that a "rational" or technical

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