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ABSTRACT

This study examined the impact of culture, language, and familiarity with materials on the ability to solve traditional conservation problems. A total of 80 Tzeltal speaking children from two traditional Mexican Indian (Mayan) villages participated in the study: 5 boys and 5 girls drawn from each of four age group (6-7, 8-9, 10-11, 12-13). The men in both villages are agriculturalists; the women in one village are potters and in the other village they embroider blouses. Conservation of continuous quantity was examined using beans, clay, and water. Conservation of weight was studied using clay. Each child completed all tasks. Analysis of the data suggests that the ability to make conservation judgments improves with age among Mayan children as it does elsewhere in the world, but that performance lags behind U.S. norms by about 3 years. Language and culture differences which may explain this apparent performance lag are described. It was concluded that the conservation paradigm may not be a "culture free" test of cognitive competence. (ED)

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Culture and Conservation in Chiapas

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More than 20 years ago as noted by Lloyd (1971), Anastasi and Foley (1949) warned that the administration of intelligence tests to people of other cultures involves a two-fold problem. Not only are our test instruments culture specific, but so are the intellectual processes which we typically assess. A plethora of cross-cultural intelligence testing in the 30's and 40's revealed that people from other cultures performed below our cultural norms on our standardized tests. However, rather than uncovering knowledge about the intellectual processes of persons from other cultures, it revealed that our intelligence tests were "culture bound" rather than "culture free". The importance of this finding, in itself, should not be minimized. It was necessary to administer our tests in clearly diverse cultures before we could acknowledge the effects of the variations in our own culture upon performance.

In the last decade, interest in intellectual differences (indicated by intelligence test performance) has yielded to a concern with the comparative development of cognitive processes. While most psychologists appear to perceive intelligence tests as "culture bound", they seem to accept tests of cognition as "culture free". The evidence supporting this distinction is two-fold. First, many questions on intelligence tests clearly relate to culture specific information and values. For example, "Why should criminals be locked up?" and "What should you do if you find a letter with a stamp on it?" are two instances of this

problem. In contrast, cognitive problems such as those involved in conservation appear to be more abstract. Thus, by definition, they are presumably free from culture specific referents.

Secondly, 15 years of cognitive research in Western cultures has suggested that there are universal cognitive processes and stages. These stages presumably are revealed in the performance of Piagetian tasks. There appears to be an organic relationship among the various Piagetian tasks and these tasks are accomplished in an invariant developmental sequence rarely observed among items on intelligence tests. It is established that environment can influence the age at which cognitive stages or substages emerge. However, the invariant order of emergence suggests an essentially preprogrammed "unitary comprehensive sequence" (Sigel and Hooper, 1968, 5).

On the other hand, certain evidence raises questions about the universality of cognitive development as reflected in Piagetian conservation tasks. There is literature which reveals a general impact of culture upon the development of conservation. For example, social technology and specifically schooling appear to influence at least the age at which conservation is attained (Goodnow, 1969; Greenfield, 1966). Furthermore, Price-Williams, Gordon and Ramirez (1969) demonstrated that sons of Mexican potters are able to handle clay conservation problems at an earlier age than their peers. There is, in addition, research which has investigated a number of performance factors which inadvertently play a critical role in our tests of conservation. These factors include attentional strategies, language comprehension, variations in confidence, estimation skills, and sex typing of test materials.

The research presented here was designed to examine the impact of culture, language, and familiarity with materials upon the ability to solve traditional conservation problems. The specific tests which are discussed in this paper are those which involve the conservation of continuous quantity and the conservation of weight.

Price-Williams et al. (1969) had studied the development of conservation among male potters' sons in two Mexican Ladino[2] towns. They had found that on tasks involving clay, the potters' sons in both towns conserved more frequently than their controls. Meanwhile, no significant differences in performance were found on other conservation tasks.

The present study was carried out in Amatenango and Aguacatenango, two Tzeltal-speaking Mayan villages in Chiapas, Mexico. Having spent time in Amatenango studying the traditional pottery-making techniques of the village women, it became obvious that this was an ideal setting in which to extend the Price-Williams et al. (1969) research.

Aguacatenango is situated only 8km from the pottery-making village of Amatenango. The two towns are similar in every respect except that the Aguacatenango women are not potters. Tzeltal, the language spoken by both villages, was also of interest because it has two characteristics which are relevant to conservation research. First, it lacks the linguistic comparative; no evidence has been found for an equivalent for either the morpheme "more" or "er". Second, Tzeltal has numeral classifiers which are obligatory expressions that must be used when counting certain objects. In Tzeltal, these numeral classifiers tend to be monosyllabic, bi-morphemic stems which are preceded by a numeral and followed by a noun. The preceding numeral indicates the

number of items in the particular condition or state, or the number of actions performed on the item designated by the noun. The numeral classifier names the class containing all objects in that particular state or condition. Berlin (1968) has noted that the more appropriate name would be nominal classifier since it is the nouns, not the numbers which are being classified.

Berlin's research (Berlin, 1968, p. 20) has revealed five main categories of classifiers, three from verb roots, one from noun roots, and one of unknown derivation. The first class can serve as an example. This class contains numeral classifiers derived from transitive verb roots which refer to: (a) actions of the transitive verbs from which they are derived, (b) sounds emitted as a result of the action, (c) certain objects resulting from the action. For example there is a classifier which refers to the action of breaking branches, limbs, etc. off at their base. There is also a classifier which relates to forming clay-like substances into particular sizes and shapes.

Relevant to conservation is the fact that some classifiers refer to inherent characteristics of objects while others refer to their transitory states. Informants' responses to Berlin's questions concerning the appropriateness of certain classifiers often depended upon whether Berlin was understood to be referring to inherent characteristics of the objects or to transitory states. In terms of conservation, this means that children's responses to the problems will vary as a function of whether the transformations are viewed as inherent characteristics of the objects or rather are seen as transitory states of the clay.

Method

Subjects

Eighty Tzeltal speaking children from two traditional Mexican Indian villages participated in this study. Subjects included five boys and five girls drawn from each of four age groups (6-7, 8-9, 10-11, 12-13) in each village. The villages are located in the highlands of Chiapas about 25 miles south of San Cristobal las Casas, the departmental capital. The central hamlet in each village has a population of about 1,500 inhabitants including approximately 300 children. A high proportion of these children attend their village school for about 3 years beginning at age 6. However, the schools are conducted in Spanish, a language which the children barely understand even upon graduation. It has been estimated (liberally) that only about 30% of the 150,000 Tzeltal and Tzoltil speakers in Chiapas speak some Spanish.

The men in both villages are agriculturalists growing beans, corn, and wheat. The women in the two villages differ in their occupations. In Amatenango the women are potters and devote the major part of their time to activities related to this work. In Aguacatenango the women spend much of their time embroidering blouses and are not involved in pottery in any way.

Experimenters

All the children were tested by a bilingual (Tzeltal-Spanish) woman from Amatenango who managed to maintain remarkable rapport with the children of both villages. She also demonstrated a clear understanding of the requirements of the task although she was not aware of the specific nature of the hypotheses tested.

One of the authors was also present during each testing session operating a tape recorder and making written notes of all actions of the subject and tester.

Tasks

The tasks included traditional tests of conservation of continuous quantity and weight. However, two modifications upon the traditional paradigm were made. First, while children were asked to give justifications for their judgments of equality or inequality, they were not asked to make predictions preceding stimulus transformations. This procedure was employed because asking the children the identical question more than once caused them to change their responses as Rose and Blank (1974) also reported. Secondly, children directed the tester to equalize the stimuli at the beginning of each task rather than doing so themselves. This procedure was adopted because many of the children had been reticent to handle the stimuli themselves.

Conservation of continuous quantity was examined using beans, clay, and water, while conservation of weight was studied using clay. Each child completed all tasks in the following order.

Conservation of bean quantity. This task employed locally grown, red beans which are consumed daily by the families of all children. With the subject watching, the experimenter filled two 8-oz. glasses approximately 2/3s with beans. The subject was asked, "Are there a lot of beans in this glass or are there a lot of beans in this other glass or are the beans the same, equal?" (literal translation). If the subject said one had a lot or a few, the beans were adjusted until a judgment of equality was made. This procedure preceded each

of two transformations: (a) All of the beans from one of the two equal glasses were poured into a short squat jar. (b) All of the beans from one of the two standard glasses were poured into three smaller (6-oz.) glasses. In the second task many children seemed to relate to each of the three glasses individually, comparing each to the large glass or comparing each to one another. When it was clear that there was confusion it was emphasized to the child that the question was whether there were a lot of beans in the three small glasses together. Following each transformation the child was asked, "Why is it that they are (are not) equal?" The experimenter also asked for clarification as to whether it was the beans or the glasses that the child was referring to.

Conservation of clay quantity. This task employed locally found, grey clay which is used in Amatenango's pottery production. The clay was familiar to all of the children. With the child watching, the experimenter divided a fist-size ball of clay into two approximately equal balls. She then asked the child, "Is this ball a lot or is this other a lot or are the two the same, equal?" Again, the experimenter adjusted the balls until a judgment of equality was made. This procedure preceded each of two transformations: (a) One of the balls was rolled into a sausage. (b) One ball was divided into three small balls. Following the child's response to each transformation, the experimenter asked, "Why is it that the two are (are not) equal?"

Conservation of water quantity. This task was identical to the bean task with the exception that water was used instead of beans and the glasses were shaped somewhat differently.

Conservation of weight: Clay. This task followed the same procedure as the task involving conservation of clay quantity. However,

the word "weight" was used in the questioning.

Scoring

The scoring procedure utilized the combined information of the transcript of each taped session and the observer's record of all actions of the tester and of the subject. Three aspects of the child's response were considered in scoring conservation of continuous quantity and conservation of weight. (a) Pass/fail: on each transformation the child was scored pass or fail on the basis of the first response she/he gave after appearing to have understood the question. It should be noted that this procedure differs from that of Greenfield (1966) whose analysis included the child's final response instead. In the present study, asking the child for an explanation of his/her response seemed to instill doubt followed by a number of changes in the child's judgment of equality. Consequently, an analysis of the child's first response was judged to reflect his/her opinion more accurately. (b) Change of judgment: it was noted whether or not the child changed his/her judgment of equality during the response. Again, each transformation was scored separately and replies given before the child appeared to understand the question were not included. (c) Level of justification: the child's explanation for him/her response was categorized as either perceptual, direct action, or transformational according to the descriptions presented by Greenfield (1966) and Lloyd (1971).

In addition to the separate scoring of pass/fail, change in judgment, and level of justification, a weighted score was derived for each task based on a combination of the three factors. Scores ranged from one to nine. Children who passed and did not change their minds, the conservers, scored in the highest range (7-9), those who failed

and did not change their minds, the nonconservers, scored in the lowest range (1-3), and those who either passed or failed but subsequently changed their minds at least once, appearing to be transitional, scored in the middle range (4-6). Within the conservers, the nonconservers, and transitional groups, scores increased from perceptual to direct action to transformational explanations. Thus, for example, a conserver who gave a direct action explanation received an 8 while a conserver who gave a transformational explanation received a 9.

Results

Conservation of Continuous Quantity

The weighted scores for conservation of continuous quantity were examined with a 2x2x3x4 analysis of variance (Sex x Village x Material x Age). It will be recalled that two transformations of each material had been presented to each child. However, many children appeared to have difficulty comprehending the task in which they were to compare three smaller balls or glasses with a single larger one. Children often compared the smaller objects with one another rather than with the standard. Preliminary analyses suggested that those children who did understand both tasks performed quite similarly on each. However due to the substantial number of children across all ages who did not appear to fully understand the second transformation problem, the data analysis only included scores from the first transformation task. Table 1 presents the cell means for weighted scores of conservation of continuous quantity.

Insert Table 1 about here

A significant main effect for Age ($F_{3,64}=12.26$, $p < .001$) reflected the fact that each successive age group showed improvement in performance over the preceding group. The greatest change occurred between the 8-9 and 10-11 year olds with each of the two oldest group scoring significantly higher than each of the two youngest groups (Newman Keuls, $p < .05$). A significant main effect for Material was also revealed ($F_{2,128}=17,66$, $p < .001$). A Newman Keuls comparison indicated that there was greater success on the water task than on either the bean ($p < .05$) or the clay ($p < .01$) task. The transformation employing beans was also easier for children than that which used clay ($p < .01$). Finally, a Sex x Village interaction ($F_{1.64}=7.89$, $p < .001$) reflected the fact that girls in Amatenango (the pottery village) were superior to boys of the same village whereas boys in Aguacatenango were superior to the girls of their village (and, in fact, to all other groups).

It will be recalled that the weighted scores were derived by considering three factors: (a) whether the child passed or failed, (b) whether the child changed his/her judgment during the response, and (c) the level of justification the child offered for his/her response. In order to examine the role of each of these factors in more detail, a separate 2x2x3x4 analysis of variance (Sex x Village x Material x Age) was performed on each of the three dependent measures. The pass/fail and justification analyses closely paralleled the analysis of weighted scores. The analysis of whether or not the subject had changed his/her judgment was interesting only in so far as material was concerned. Children changed their minds only 12% of the time when judging water (which they were most successful in doing) whereas they did so twice

as often when judging either beans or clay.

Clay quantity vs. clay weight. To examine the general assumption that that conservation of quantity developmentally precedes conservation of weight (e.g., Flavell, 1963), conservation of clay quantity and clay weight were compared using a 2x2x2x4 analysis of variance (Sex x Village x Task x Age). The most interesting finding was a significant main effect for Task such that, contrary to expectation, conservation of weight was superior to that of quantity ($F_{1,64} = 5.27$, $p < .01$). It must be noted that the present experimental design did not control for the possibility of a practice effect since the training literature suggests doubt that conservation of weight could readily be acquired in this way, especially when conservation of quantity has not been fully achieved. On the other hand, Lloyd (1971) has demonstrated that practice effects can arise in such research and children in the present study were always presented with the weight task at the end of the testing session. Post hoc, it seems that certain linguistic factors to be discussed later might have contributed to the children's greater difficulties with quantity as compared to weight conservation.

A significant main effect for Age ($F_{3,64} = 13.30$, $p < .001$) reflected the gradual improvement on both tasks with age, from a mean weighted score of 3.4 (out of 9) at 6-7 years to 6.8 at 12-13 years. Significant improvement occurred both from 8-9 to 10-11 years and from 10-11 to 12-13 years (Newman Keuls, $p < .05$). Once again, a significant Sex x Village interaction was found ($F_{1,64} = 7.92$, $p < .01$) such that females in Amatenango performed somewhat better than the males while the males in Aguacatenango performed far better than the females (and,

in fact, better than both groups from Amatenango).

Discussion

Analysis of the data suggests that the ability to make conservation judgments improves with age among Mayan children as it does elsewhere in the world but that performance lags behind U.S. norms by about three years. This is what would have been predicted on the basis of previous cross-cultural research by Greenfield (1966), Laurendeau and Pinard (Piaget, 1973), and others. However, any meaningful discussion must consider both the particular circumstances of this research which might have produced these results and also the question of what it is that we really learn from cross-cultural studies.

Clearly, a conclusion which might be drawn from the work of Bruner and his colleagues (1966) is that the minimal schooling in these two villages has not been sufficient to provide the children with the problem solving skills and abstract abilities necessary for successful conservation. Linguistic determinists, on the other hand, would infer that children who speak a language lacking the comparative would be incapable of thinking comparatively.

Neither of these conclusions coincides with our observations in Chiapas. Our research has led us to the conviction that the Tzeltal language and culture influenced the childrens' conceptions of the demands of the testing situation and their assumptions of the strategies appropriate to solving conservation problems.

Tzeltal culture is unusually nonjudgmental as is reflected in the lack of the linguistic comparative. The Indians would never say that one person is more of something than another. Moreover, they would be

unlikely to make comparative judgements about objects since objects always belong to people. One anthropologist told us that if you really insisted on a judgment, an Indian might say, "Well I don't know myself, but it is said that he is a very strong man." This characteristic is also reflected in the hundreds of categories denoted by the numeral classifiers. Things are not good or bad or more or less; they are different. Moreover, actions performed on objects causes these objects to be classified differently. Any verb root whose meaning involves specifying position, shape, or state of an object can be made into a numeral classifier. A piece of clay is reclassified when it is changed from a ball into a sausage.

A second characteristic of Tzeltal people is that they take you seriously when you ask a question. The children (as has been noted by Miyamoto, 1969 working with Tzotzil children in the nearby village of Zinacantan) assume that when you ask a question you are seeking useful information. This presents a major problem in a task requiring a culturally anomalous judgment such as the question of whether a ball and a sausage are the same. (See Glucksberg, 1975 for a related discussion.) Seriousness was also reflected in a need for precision which led some children to have the tester equalize the standards over and over again.

Lenneberg (1963) noted that a basic tenet of linguistics is that anything can be expressed in any language. If this is so, the Tzeltal Indians must have a way of handling the fact that Tzeltal has no morphemes which coincide with "more" or "er". Adults, but not children, often deal with the problem by using <u>más</u>, the Spanish word for "more".

Additionally, the numeral classifiers seem to obviate the need for comparison within class by means of reclassification. One does not need to say that this is a long stick and that a short one if beyond a certain length the former becomes a "pole". It is our contention that one cannot couch conservation problems in Western terms and expect them to be understood in those same terms by Chiapans. One can no more literally translate a concept thana a sentence and expect it to have direct correspondence to our meaning. It appears that subjects were not perceiving our questions in the same terms in which we were asking them.

There is one specific characteristic of Tzeltal which may account for the unexpected superior performance on weight conservation as compared to quantity conservation. The word for "equal" in Tzeltal is pajal which has some implication of "even" as well as "equal". (This problem was encountered by Greenfield, 1966, with the word yum in Wolof.) When pajal stands alone it may be difficult to distinguish between form and content. Thus, it can be confusing when you transform a ball into a sausage and ask whether the two are pajal, especially because the material has then been reclassified. The word for "equal weight" is pajalal, al meaning "weight". It is possible that the addition of the word al may clarify the form-weight distinction necessary for understanding the conservation task. Thus the children were significantly more successful with conservation of clay weight than with conservation of clay quantity.

Water and beans problems may have been easier to solve than clay quantity for similar reasons. Changing the shape of the glass has no effect on classification of the contents while changing the shape of

the clay does. In addition, solution of the water tasks may have been facilitated by the fact that the colorless, local liquor traga is forever being measured out in small glasses.

We were surprised that the children in the pottery-making village did not perform better than their peers, contrary to predictions bases upon the work of Price-Williams and his colleagues. There are two possible explanations for this finding. First, perhaps the culturally specific responses to the test situation (described earlier) overshadowed other results. Second, perhaps Price-Williams' subjects had very different kinds of experience with clay than our subjects had. Price-Williams' children came from towns where pottery is made, to a great extent, in molds.

> In preparing the clay for baking, the children have standardized balls that are put into a mold. The child can, therefore, observe the clay being altered in length and width but remaining the same amount. Occasionally, they have to remove the clay from a mold if it is not properly fitted....the procedure of removing the clay and re-forming it into a ball resembles the classic operation of inversion. (1969, p. 3).

The children in Amatenango have no such experience. The pots are built out of coils of clay which are simply added, one after the other. The size of each coil and the number of coils per pot vary greatly from one to the next. It may also be important that the Chiapan children's experience has been such that many changes in the clay which they have observed have not, in fact, left either amount or weight invariant. When a ceramic pot dries or is fired it becomes both smaller in size and lighter in weight (from loss of moisture).

In conclusion, it appears that differences in performance on conservation tasks between Chiapan and U. S. children can best be explained on the basis of the disparities between their conceptions of the problems.

The Chiapan child's frame of reference and his strategies for solving conservation problems differ substantially from those used in our culture. If schooling facilitates the performance of older children, it is probably because it affects changes in set, rather than because it is necessary for abstract thought.

It appears that if one wishes to obtain a true understanding of cognitive development, processes and functioning in Chiapas, one might follow the lead of Berlin, Breedlove, and Raven (1974). They have recently published a taxonomy of Tzeltal plants which differs greatly from previous ethnobotanical works. Rather than alphabetically listing the Latin taxonomic terms with Tzeltal translations off to the side, they have attempted to write within the context of Tzeltal classification with the Latin terms off to the side. Cole, Gay, Glick and Sharp (1971) have taken a similar approach in their study of thinking among the Kpelle in Liberia. The investigators modified their cognitive tasks to fit organically into a Kpelle context.

Perhaps we might learn a lesson from Tzeltal: reclassification can obviate the need to make comparative judgments about different cultures and can simultaneously provide the opportunity for clearly seeing the differences. It is an error to assume that a given cognitive behavior always reflects the same underlying processes or that different behaviors always reflect different underlying processes. When we study children in other cultures or subcultures we must make greater efforts to understand them in their own terms, not ours. The conservation paradigm does not seem to be a "culture free" test of cognitive competence and we should be wary of its use as such even within our own culture.

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Footnotes

1. The authors would like to express their gratitude to Julian Lopez Shunton and Janet Marren for their invaluable assistance in data collection and translation.
2. The word "Ladino" has range of uses (Nash, 1970 XVII). In Chiapas and among anthropologists it refers (without derogatory connotation) to any non-Indian.

TABLE 1

Cell Means of Weighted Scores for Conservation of Continuous Quantity

Village / Sex		Amantenango		Aguacatenango	
		Female	Male	Female	Male
Material	Age				
Clay	6&7	2.2	2.2	1.8	4.6
	8&9	3.8	2.8	3.0	4.4
	10&11	5.4	3.4	4.0	5.0
	12&13	5.0	5.8	6.0	8.0
Beans	6&7	4.0	2.8	5.4	3.4
	8&9	6.4	2.6	2.6	6.2
	10&11	8.2	6.6	4.2	6.2
	12&13	8.2	6.4	8.2	8.0
Water	6&7	3.8	2.4	3.8	6.8
	8&9	5.8	5.2	5.2	5.6
	10&11	9.0	8.6	6.0	7.8
	12&13	8.2	6.4	8.4	9.2