

In comparing the Mexican-American with the male Anglo-American (Texan) interest patterns we note that both sets of interests are quite similar in both groups. Persuasive is high in both groups (49% and 50% for Mexican-Americans and Anglo-American males respectively). This might suggest that Mexican American males would like to have further training in clerical work to replace their traditional current jobs as farm hands. Comparing the female Mexican-Americans with female Anglo-Texans in Texas, we see that persuasive is still high in both groups, and that personal service is high in the female Anglo-Texans but not the female Mexican-Americans. The female Mexican-Americans seem to have interests in the professional and artistic occupations while the female Anglo-Texans have interests in the personal service and unskilled trades. Finally, it will be noted that both male and female anglo-Texans have "low" interest patterns which are almost the same, suggesting that similarity of interest patterns may be more a function of race, rather than sex or living in the same geographical region.

# WEAVING, COLOR TERMS, AND PATTERN REPRESENTATION: CULTURAL INFLUENCES AND COGNITIVE DEVELOPMENT AMONG THE ZINACANTECOS OF SOUTHERN MEXICO<sup>1</sup>

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*Our study examined the question of how specific cultural experiences foster the development of particular cognitive skills by examining the relation between weaving, an important craft among the Zinacantecons, and pattern representation. We found that knowing how a pattern is woven influenced the weaver's concept of that pattern, but weaving experience did not promote a generalized facility in representing patterns. School experience alone had an effect similar to weaving on representation of the woven patterns. Use of color in patterns was related to an individual's color lexicon. There was also evidence for universal processes in the development of pattern representation.*

*Este estudio examinó la relación entre ciertas experiencias culturales y el desarrollo de ciertas habilidades cognitivas a través del estudio de la relación entre la actividad de tejer (actividad artesanal muy importante entre los Zinacantecons) y la representación de patrones. Se encontró que el hecho de saber cómo se teje un patrón influyó en el concepto que el tejedor tenía de tal patrón, pero la experiencia de tejer no promovía una facilidad generalizada de representar patrones. La experiencia escolar en sí tenía un efecto similar a la actividad de tejer en cuanto a la representación de los patrones de tejido. El uso de los colores en los patrones estuvo relacionado al léxico de colores del individuo. Hubo también evidencia sobre procesos universales en el desarrollo de la representación de patrones.*

Does knowing how to weave a given pattern have an effect on the weaver's mental representation or concept of that pattern? Can a specific skill like weaving promote a general ability to represent abstract linear patterns? Our study sought answers to these questions in the hopes of shedding light on the problem of how culture-specific experiences foster the development of particular cognitive skills. Looking at this matter from the point of view of weaving itself, we hoped that the study would also provide information about the cognitive nature of learning a manual skill.

<sup>1</sup> Carla Childs received financial support from the National Science Foundation and the Mexican government, through an Abraham Lincoln Fellowship. Data from the first summer, 1969, was the basis of her honors thesis in anthropology, entitled "Developmental Study of Pattern Representation in Zinacantan".

<sup>2</sup> We are indebted to Evon Z. Vogt, Director of the Harvard Chiapas Project, for making it possible for us to work together in Zinacantan as members of the Project for three (C. C.) and two (P. M. G.) summers. We greatly benefited from the stimulation, experience, and friendship of its staff and students. We owe a special debt of gratitude to T. Berry Brazelton, M. D., Fellow at the Center for Cognitive Studies, and John S. Robey, M. D., who initiated developmental study among the Zinacantecons and who invited one of us (P. M. G.) to participate in this exciting venture.

For making our research in Navenavuk the most pleasurable aspect of the entire project, we thank Xun and Xunka Pavlu, the Pavlu children and grandchildren, and the members of all the families in Navenavuk who participated in the experiments. This paper incorporates many valuable suggestions from George Collier, Michael Cole, Sarah Harkness, Nancy Modiano, and Douglas Price-Williams, all of whom generously commented on an earlier draft.

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Our research was inspired by Price-Williams, Gordon, and Ramirez' (1967) study in Mexico which demonstrated both a specific influence of pottery-making on the concept of quantity of clay substance and a general influence on other quantitative concepts, all described by Piaget under the rubric of "conservation".

The research was conducted in Chiapas, Mexico, with Zinacanteco Indian children of different ages, both sexes, different degrees of schooling, and different amounts of weaving skill. Comparison among the various subgroups allowed us to place pattern representation in a developmental context and to relate this ability to the general demands of Zinacanteco culture, as well as to the specific demands of Zinacanteco weaving. In the course of investigating these matters, our experimental method yielded interesting findings on color choice in pattern continuation tasks, and raised a question as to whether a person's use of color in patterns is related to his or her color lexicon.

#### Zinacantan: Background for the Experiment

##### *Ethnographic Information*

In explaining the performances of the Zinacantecos on our tasks, we must first explain some of the things that make Zinacantecos different from Americans and different from each other.<sup>1</sup> The Zinacantecos are a Mayan people dwelling in the highlands of Chiapas, Mexico, near the Guatemalan border. They are ethnically distinct, putting pride in traditional behavior.

The *municipio* of Zinacantan has a population of approximately 8,000, and about one-fifth of these people live in the major hamlet of Nabencavuk, site of our experiments. Within Nabencavuk, houses are grouped in clusters reflecting patrilocally extended domestic groups (Vogt, 1969) and are interspersed with cornfields and flower plots. Beans and tortillas constitute the staple diet.

Zinacantan is a male-oriented society. Men hold most of the important religious and political roles; women are influential in these spheres only through their husbands or in their old age. To be influential, a man must be *p'ih<sup>5</sup>* or clever. Advancement along any of the available lines of power involves detailed organization of one's life, especially in its economic aspects (Cancian, 1965). After deciding upon his goals, a man must arrange his life so as to achieve them as nearly as possible. The skills and intelligence required for life as a successful Zinacanteco are not incomparable to the analytical problem-solving ability that is cultivated in Western school systems.

##### *Schooling in Nabencavuk*

Nabencavuk, the Zinacanteco hamlet in which we worked, has two schools a state school built about forty years ago, and a new federal school, built in 1966. The second school is said to be the result of a request to the authorities made by the leaders of the community. The large population of the hamlet (the 1960 census figure is 1,427) and the poor quality of the teaching in the older school prompted their action. The effectiveness of teaching in all Indian schools in Chiapas is questionable. Teachers are often sent there because they did not perform well elsewhere. Few know anything of the oral Indian languages, and their Spanish teaching methods are based on rote performance. Not all children go to school; but in recent years both interest and attendance have been increasing, and now girls are beginning to attend.

<sup>1</sup> For a more complete and detailed account of Zinacanteco culture, the reader should consult *Zinacantan* by E. Z. Vogt (1969).

<sup>5</sup> Tzotzil words are written throughout in the orthography used in the Tzotzil-English, English-Tzotzil Field Dictionary adapted from Laughlin's *Tzotzil-English Dictionary*. For reading purposes, *x* is pronounced as "sh" in English, *c* as "ch" and *z* as "ts".

#### *Weaving in Zinacantan*

One of the reasons for not sending girls to school is that they should stay home and learn to cook and weave. Weaving, the skill with which our experiment is concerned, is of great importance in Zinacantan. Women weave almost all clothing on backstrap looms. The two most visible, and, by Zinacanteco standards, most beautiful garments are the *pok' k'u ul*, a cotton poncho worn by all men, and the *pok' mocebal*, a cotton shawl worn by all women. Boys and girls wear smaller versions of the same red and white striped garments. Though some variation is allowed, certain distinctive elements of the two patterns must remain fixed. The defining features of the two patterns can be seen in Figure 1, where two possible versions of a *pok' k'u ul* and two possible versions of a *pok' mocebal* are shown.

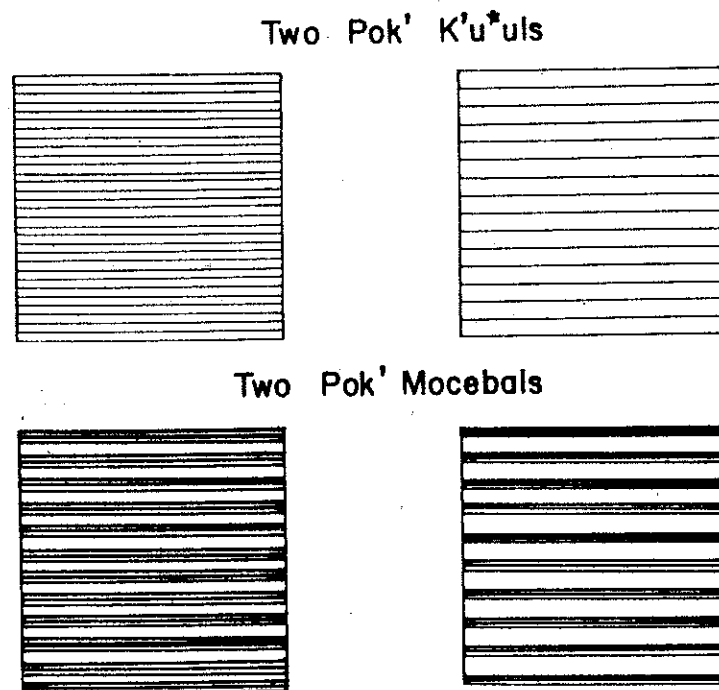


Figure 1. Zinacanteco woven patterns

The representation of these patterns constituted the focus of our study, and in fact, are the only patterns ever woven in cotton. There is only one other pattern woven by Zinacanteco women, a somewhat more complicated black and white pattern done in wool or wool and cotton.

The weaving process itself is a long complicated one. The first two steps—spinning and dyeing—are not necessary for all garments. The next step—winding the warp threads onto a frame—gives the threads their first shed and gives the final piece of cloth

whatever striped pattern it may have. Thus, the striped patterns are differentiated at the warp-winding stage. Girls start learning to weave when they are about nine-or ten-years-old. Before eight, they are simply not strong enough to operate a loom. They learn the easier steps of weaving first — boiling warp threads and dyeing wool. Weaving itself comes next, then warp-winding, and finally spinning. By age twelve or thirteen a girl can weave on her own without adult supervision. Not all Zinacanteco women become highly skilled at these tasks, but all attain some degree of proficiency.

### Method

#### Tasks and Procedure

We did not take a U.S. test and present it to the Zinacantecos, but rather developed our procedures from what we knew of Zinacanteco culture. In principle we followed the strategy suggested by Price-Williams (1967), of starting with a familiar task, performed with familiar materials in a familiar context, next varying the context, then, in addition, the materials, and, finally, the task itself. This strategy makes it theoretically possible to judge the extent to which a person is capable of generalizing the skills involved in a specific task beyond the context in which they were originally learned.

The task itself consisted mainly of placing wooden sticks of different colors and widths into a wooden frame to make different striped patterns. Our equipment consisted of a wooden frame with inside dimensions of 9 by 16 inches and a total of 218 colored sticks. All were 9 inches long and three-quarters of an inch high. In width they measured one-quarter inch, one and one-quarter inches, and two and one-quarter inches. The reason for having sticks of varying widths was to permit varying degrees of detail and abstractness in the representation of woven patterns. In weaving, one can create a broad stripe with a number of threads of the same color, analogous in our experiment to using several narrow sticks of the same color. In our experiment, it was also possible to create a broad stripe with a broad stick, a representational device that is a more abstract, if less detailed representation of woven stripes. The availability of sticks of three different widths corresponding to stripes of three different widths in the *pok' ku\*ul* and *pok' mocebal* made it possible to investigate the effects of weaving and other kinds of experience on the representational conventions used to reproduce the two woven patterns. There were eight different colors — red, white, orange, light pink, olive green, yellow, black, and sky blue. The 60 white, 60 red, 30 pink, and 30 orange sticks came in all three widths. The remaining sticks — 16 green, 16 yellow, 3 black, and 3 blue, came only in the narrowest width. (These color descriptions refer to colors designated by the English terms. The relation of the stick colors to Tzotzil color terminology will be discussed later.) The frame served to eliminate the culture-sensitive skill of orienting designs in space; there was only one way to place the sticks (Deregowski, 1968).

We presented the subjects with the frame and the sticks and demonstrated how to put them in. Participants were then given a series of nine pattern representation tasks. An overview of the tasks in terms of the dimensions of familiarity and complexity is presented in Table 1.

The first two problems of the experiment (unfamiliar context) involved using strange materials in a *familiar task*. We asked the subjects to use our colored sticks to make representations of two items of their own clothing—the *pok' k'u\*ul* (top of figure 1) and the *pok' mocebal* (bottom of Figure 1). By starting with a representation of the subjects' own clothing we hoped to keep the task from being ethnocentric or centri-cultural (Wober, 1969). These two problems constituted our greatest degree of cultural familiarity. The

Table 1  
CHARACTERISTICS OF THE PATTERNS

Familiar tasks with unfamiliar materials: Pattern representations		Unfamiliar tasks with unfamiliar materials: Pattern continuations		
Less complex		More familiar ← Color → Less familiar		
↑ Pattern ↓	Pattern 1 ( <i>pok' ku*ul</i> )	Pattern 3	Pattern 6	Less complex (more familiar)
		Pattern 4	Pattern 7	↑ Pattern
	More complex	Pattern 5	Pattern 8	↓ More complex (Less familiar)
	Pattern 2 ( <i>pok' mocebal</i> )			

two highest degrees of cultural familiarity schematized by Price-Williams were impossible to integrate into this study. Zinacantecos would have been outraged had we used the real materials of weaving in an artificial experimental context — the conditions required by the second level of familiarity. To study pattern representation in its most familiar manifestation would require observing the weaving process itself. Because variation was neither permitted nor observed in Zinacanteco patterns, the weaving process really offered nothing to study in the domain of pattern representation. The process of learning to weave did, however, become the topic of a later study, yet to be reported. Despite the absence of an opportunity to observe Zinacanteco pattern representation in its most familiar contexts, our design did utilize Price-Williams' strategy in that the remaining seven problems constituted a stepwise progression in the direction of unfamiliarity. While the two woven patterns were equally familiar, they were not equally complex. The relative complexity of the two patterns can be seen in Figure 1. We asked for the simpler pattern — the *pok' k'u\*ul* — first. Since Zinacanteco children dress exactly like adult Zinacantecos, each subject was wearing one of these garments. The other garment was also present in the experimental situation, either in the *pok' k'u\*ul* of our informant or his son or in the *pok' mocebal* that the experimenter wore. The various widths of red, white, pink and orange sticks were available for those first two tasks. The different kinds of stick gave the children the opportunity of using several strategies for representing the difference between the two patterns.

We next shifted to an *unfamiliar task* — pattern continuation. We started a pattern, with three repetitions of its repeating unit, and asked the child to finish it, doing it the same way. Our six continuations went from more to less familiar along two dimensions—pattern and color. We started a simple red and white alternation similar to the configuration of the *pok' k'u\*ul* in the first task (Figure 2<sup>6</sup>, Pattern 3), and asked the child to continue it.<sup>7</sup>

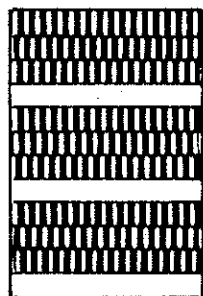
<sup>6</sup> The Figures are not made to scale in relation to the wooden frame. Only the relationship between the widths of the sticks is accurate.

<sup>7</sup> Only the narrowest red and white sticks were used, but the larger red and white sticks and orange and pink sticks of all sizes were available for the children, as in the first two tasks.

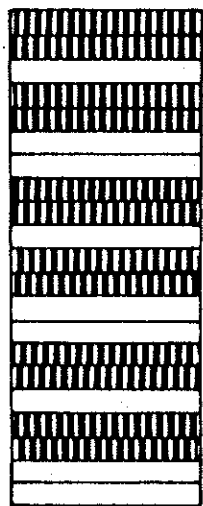
PATTERN 3



PATTERN 4



PATTERN 5



KEY:


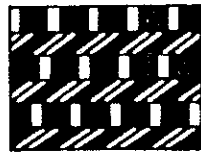
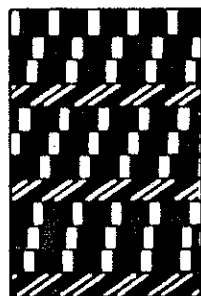
RED  YELLOW   
 GREEN  WHITE

Figure 2. Models for pattern continuation

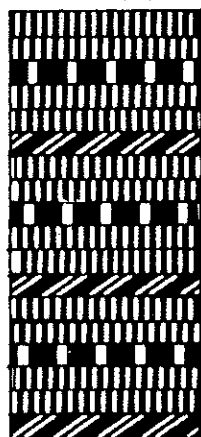
PATTERN 6



PATTERN 7



PATTERN 8

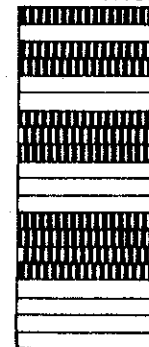


We then switched to color combinations (green + yellow; green + yellow + red) that did not appear in Zinacanteco clothing patterns (although Zinacantecos did have red and green belts and all three colors could appear in nonpatterned borders). The next three models (Figure 2) followed each other in degree of familiarity and complexity in a sequence parallel to that of the first three. The parallel structure of Patterns 5 and 8 needs explanation, as it is on a more abstract level than the others. If each kind of stripe is considered a pattern element and assigned a letter (A, B, C), then Pattern 5 and 8 are parallel in that they both consist of the sequence ABAC. They differ in so far as the third


PATTERN 9



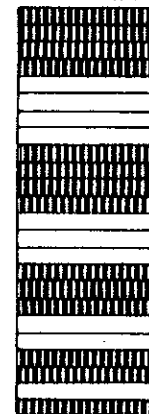
REPETITION



KEY:

RED   
 WHITE

MIRROR IMAGE



PROGRESSION



Figure 5. Model for crowing pattern and three possible continuations

element, C, is created in Pattern 5 by adding a second stick of the same color to B, in Pattern 8 by making a one-stick stripe of a third color.

The sticks available to complete patterns 6 and 7 were the thin green, yellow; black, and blue ones. The models used only green and yellow (Figure 2). The available sticks for Pattern 8 were limited to the correct ones: thin red, green, and yellow ones.

At this point in the experiment we put in a growing pattern to give the subjects a chance to stop merely imitating our behavior and do some expanding of the original pattern (Figure 3). Three correct continuations of the pattern are possible.

The tenth task involved a shift of the materials from wood to paper. The subject saw a model pattern drawn on paper and had to match it by choosing one of three alternative patterns. We thought we were keeping the task the same—pattern continuation—but in fact, we introduced the confusing element of multiple-choice. The concept of multiple-choice never really made the transition to Zinacantecan. One problem was the difficulty of doing a clear demonstration of a multiple-choice task. These tasks elicited mass confusion: children often placed their choice on top of the original, turned their choice around, piled all four papers on top of each other, or paired their choice with the original and then paired the two remaining patterns. Data from the multiple-choice problems were therefore not analyzed; but the difficulty posed by the problem mode *per se* is both an interesting finding about cognition and a methodological lesson for cross-cultural research.

The specific instructions and procedure were developed through extensive work with our informant, Xun Pavlu, and through pretesting the procedures with Zinacanteco children.

#### Experimental Design

The Zinacanteco participants in the study were constituted into groups along the dimensions of age, sex, and schooling, as shown in Table 2.

Table 2  
ZINACANTECO SAMPLE CHARACTERISTICS

	Traditional Zinacanteco Education Only		Age 8-10		Age 13-18	
	Age 4-5 Female	Male	Female	Male	Female	Male
Extent of Participation						
Patterns 1-9	6	6	6	6	9	9
Patterns 1-3 only	0	0	3	2	9	4
	Federal or State School					
Patterns 1-9	0	0	0	10	0	9
Patterns 1-3 only	0	0	0	2	0	3

Zinacanteco girls are generally rather skilled weavers by the time they reach the age of our oldest participants, while Zinacanteco boys do not learn to weave. School girls were not included because none existed in the oldest age range and very few in the

middle age group. No school children existed in the youngest age group because these children were too young for school.

In comparing the development of pattern representation in schooled and unschooled groups of boys, it is important to consider what factors determine which boys are selected for schooling. If these factors relate to the cognitive abilities being tested in our experiment, then apparent effects of school experience may be artifacts of the original selection bias. Ignorance on the part of the parents was mentioned as a reason why a whole family of boys might not go to school. This source of bias, whether related to ignorance of modern ways or innate ability would tend to bias the school group toward greater ability than the unschooled group. On the other hand, boys without fathers living at home may tend to go to school (Trosper, 1967). This factor would not bias the sample either way. The most usual pattern, however, is for some but not all sons in a family to attend school. The only basis for within-family selection which emerged spontaneously either from our informant in Nabencavuk or from Trosper's (1967) group of informants in another Zinacanteco village relates to the family's need for help at home. The first-born son is least likely to receive a school education because he is needed at home. This selection factor would not cause sample bias in terms of cognitive ability. When asked directly whether parents ever send their smartest children to school, our informant in Nabencavuk claimed the opposite to be the case: parents send the stupid ones to school so the teacher can make them smart, while bringing up their smart children at home. Thus, the biasing factors go in both directions, one tending to produce a school group of greater ability, the other tending to produce a school group of lesser ability. In any case, the pattern of results, to be reported, eliminates the possibility that performance differences have been produced by ability differences between the schooled and unschooled groups that existed independently of the school experience. For these reasons, sample bias does not appear to be a problem in assessing the effects of schooling in the present study.

In summary, our experimental design made it possible to assess the effects of age, sex, and schooling on the children's approach to the pattern representation tasks. In terms of groups, it was not possible to separate sex from weaving skill as these are perfectly correlated in the Zinacanteco culture. Females always learn to weave; males never do. We were, therefore, dependent upon the pattern of results across tasks to detect distinct effects of these two independent variables in the group comparisons.

Supplementing the group division according to age, sex, and schooling, however, were questions which could reveal relevant differences in weaving experience even within the female groups.

Each girl was asked how much she knew about weaving in a detailed way. After determining the steps of the weaving process the girls had learned, Childs asked them specifically which garments they had woven and wound warps for, to see if their knowledge of the construction of the woven striped patterns represented in our experiment was first-hand.

## Results and discussion

### Representation of Woven Patterns

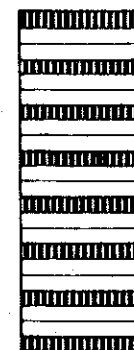
*Effect of age and weaving skill.* Table 3 shows how the children represented the *pok'* *k'u'ul* and *pok' mocebal*. Examples of the two garments are shown in detail in Figure 1. Of the youngest children, only one had reached a stage where he could represent both patterns as a simple alternation; none could differentiate the two. All seemed to

**Table 3**  
**PERCENTAGES OF CHILDREN IN DIFFERENT GROUPS**  
**REPRESENTING THE WOVEN PATTERNS**  
**(POK' K'U\*UL AND POK' MOCEBAL) IN VARIOUS WAYS**

	Unschool ed groups				Schooled groups		
	4-5 yr old Girls & Boys (N = 12)	8-10 yr old Girls & Boys (N = 7)	13-18 yr old Girls (N = 18)	Boys (N = 15)	10 yr old Boys (N = 12)	13-18 yr old Boys (N = 12)	18 yr old college Girls (N = 6)
Patterns Differentiated by <i>complete</i> analytic representations of threads	0	0	33%	15%	0	50%	0
Patterns differentiated by <i>abstract</i> analytic representation of threads	0	0	0	0	0	0	67%
Patterns differentiated by width of stripes, represented in detail.	0	6%	17%	39%	33%	8%	0
Patterns differentiated by width of stripes, represented abstractly	0	0	22%	0	0	0	33%
Patterns differentiated by color.	0	0	0	31%	17%	8%	0
Both Patterns the same or differentiated ambiguously	0	71%	28%	15%	28%	34%	0
Both patterns constructed randomly (no differentiation)	100%	23%	0	0	25%	0	0
	100%	100%	100%	100%	100%	100%	100%

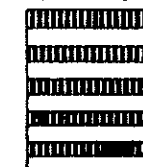
**Differentiation by Analytical Representation of Threads**

Pok' K'u\*ul      Pok' Mocebal



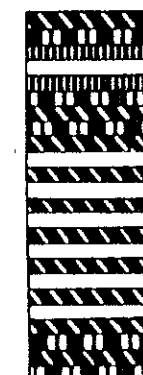
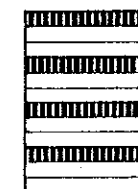
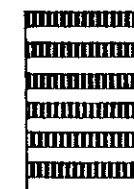
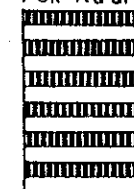
**Differentiation by Color**

Pok' K'u\*ul      Pok' Mocebal



**Differentiation by Width of Stripes**

Pok' K'u\*ul      Pok' Mocebal



**KEY:**

RED      ■■■■■■  
 PINK      ■■■■  
 ORANGE      ■■■  
 WHITE      ■

Figure 4. Zinacanteco ways of representing the woven patterns

the *pok' mocebal* pattern, containing three differentiated parts or elements, became identical with the two-part *pok' k'u\*ul* pattern. It is clear that the general failure to differentiate the two patterns stems from a failure to differentiate the elements within the more complex pattern. The tendency of this age group to simplify the more complex patterns was also manifest in the pattern continuations, to be described later.

Among the oldest children there are several different ways of representing the patterns. More girls than boys showed detailed analysis of the threads (Figure 4): the crucial feature in this type of representation is maintaining the configuration of stripes in the two patterns, including the thin white stripes in the *pok' mocebal*. Although this type of representation was more than twice as frequent among girls than boys, specific weaving experience did not seem to make any difference.

Zinacanteco boys are clothes-conscious too, but their representations of the two woven patterns show that they consider a different aspect of the patterns significant. When the *pok' k'u\*ul* and *pok' mocebal* is seen from a distance, its thin stripes tend to disappear and the pattern looks like a solid pink or light red color. Therefore the *pok' k'u\*ul* gives the impression of being "more red" and the latter of being "less red," even though the threads in the two garments are exactly the same color. This aspect of general appearance was chosen by four out of 13 of the oldest boys as the essential difference between the patterns. Figure 4 gives examples of differentiation by color: the boys used pink and orange sticks to express the visual effect of greater and lesser "redness". One of the boys who chose color as the feature differentiation on the two woven patterns used pink sticks in the *pok' mocebal*, white in the *pok' k'u\*ul*, seemingly reversing the concept of the *pok' k'u\*ul* as the "redder". None of the girls used color to differentiate the two woven patterns. There was further evidence that the girls treated color as a less important feature in representing the *pok' k'u\*ul* and *pok' mocebal* the overwhelming majority of the oldest group freely substituted pink for white and orange for red in their representations, whereas most of the oldest boys did not. This difference between the two groups is significant at the .02 level according to a  $\chi^2$  test (two-tailed).

The girls' attention to the structural detail of the patterns contrasts with the boys' representation of a difference in superficial appearance, a difference nonetheless important in making the distinction between male and female Zinacanteco clothing. The role requirements of a Zinacanteco woman in relation to clothing are different. Girls need to know and use the detailed aspects of the patterns more than boys and so are more apt to choose those aspects when representing them.

A third feature, used equally by both girls and boys to differentiate the woven patterns, is width of stripes. But boys and girls had different ways of representing this differentiating feature. Examples of the method used more frequently by boys are shown in Figure 4. The *pok' mocebal* is represented as having broader white stripes and, sometimes, broader red stripes by the addition of more narrow stick. The distinct red and white parts composing the red stripe of the *pok' mocebal* are not preserved; the red stripe is constructed as an undifferentiated element. When the girls use stripe width to differentiate the patterns, they usually use the wider blocks to represent wider stripes, in contrast to the boys. Thus, a wide red stick could be used to form an abstract representation of the three thin red stripes separated by a few white threads in the *pok' mocebal*. Not all the differentiations were related to the patterns in an obvious way, however. For instance, one girl used alternation of red and white to represent both patterns, but used wider red and wider white sticks for the *pok' k'u\*ul*.

These sex differences in the representation of the woven patterns, significant at the .01 level (Fisher's Test, one-tailed), must relate specifically to weaving skill rather than to other aspects of Zinacanteco sex differentiation, for the pattern of sex differences is reversed in the novel pattern continuations, as we will see.

### Effect of Schooling.

School experience seems to have had a strong influence on the representation of the woven patterns (Table 3). At the middle age level the schooled boys show a much greater ability than the unschooled boys to differentiate the two patterns; this difference is significant at the .05 level (Fisher Test, two-tailed).

By adolescence, the boys with school experience represent the woven patterns more like the female weavers than like the male nonweavers! Like the unschooled boys, the schooled boys did not know how to weave. Yet their frequency of thread-by-thread representations, is significantly higher ( $p < .01$ , two tailed Fisher Test).

An interest in the effect of formal education led to the inclusion of a group of six U.S. students at Radcliffe College. These female students, lacking all experience with the woven patterns, were shown a *pok' k'u\*ul* and a *pok' mocebal* and asked to represent them using the same sticks and frame as the Zinacanteco subjects. This student sample had the highest proportion of all groups of analytic representations (Table 3); but they were of a different sort (Figure 5). While maintaining the configuration of stripes in the two patterns, they simplified their representation of the broader stripes, using a single broad stick instead of a group of narrow ones. The

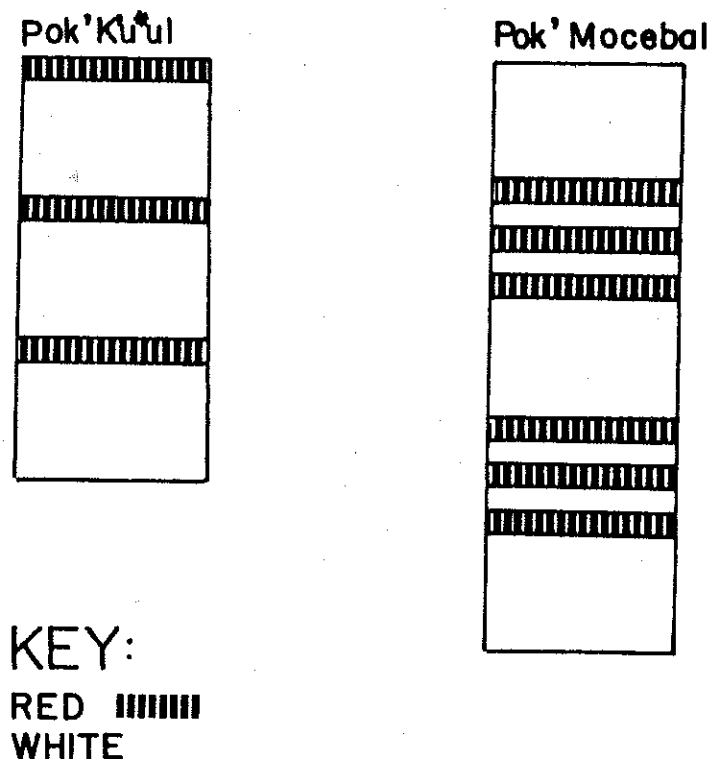


Figure 5. American college students' representations of the woven patterns

American college group differed significantly from both unschooled Zinacanteco weavers and schooled nonweavers in omitting the detailed depiction of individual threads from their analytic representations ( $p < .01$ , Fisher Test, two-tailed). In sum, this was the only group to use simplified or generalized pattern elements within the context of analytic representations which accurately preserved the configuration of stripes of the original material. A clue to the potential influence of specific training was provided by the remark of one student whose strategy differed somewhat from the majority of her group. A potential specialist in visual studies, she chose to differentiate the two patterns by width of stripes alone, saying that her art teacher was always telling her to simplify things and leave out unnecessary details. This student, like the other one using width of stripe to differentiate the two patterns, employed broad sticks to represent broad stripes. Note that Zinacanteco weavers were the only other group in which this representational strategy manifest itself.

#### *Development of the Ability to Continue Patterns: Age, Sex and Schooling*

Analysis of the children's performance on the seven pattern continuation tasks provides a general developmental context for their representation of the culture-specific woven patterns.

Age brings an increasing ability to continue patterns correctly, as Table 4 shows. In scoring performances on pattern continuations, we tried to give each child credit for what he was trying to do, rather than mark him totally incorrect for what might have been careless errors. We allowed up to three mistakes (only one mistake on Patterns 6 and 7 — the small number of sticks available made these patterns shorter) before scoring a continuation as incorrect. Among the unschooled children, the youngest fail to continue any patterns correctly; children at the middle age level complete an average of 4 out of 7 patterns correctly; and members of the oldest age group complete an average of 5 patterns correctly. These age differences are statistically significant at the .001 level according to the Mann-Whitney U Test.

The notion that knowing how to weave would, in itself, promote a general skill in pattern representation on the part of the girls is disconfirmed by the data. There are no statistically significant sex differences in the two younger age groups, but at adolescence the boys show a decided superiority in accurate pattern continuation (Table 4). This difference, significant at the .02 level according to the Mann-Whitney U Test (two-tailed), indicates that some factor is more important than weaving skill in promoting the general ability to represent linear patterns.

While we have seen that schooling exerts a strong influence on the representation of the familiar woven patterns, it has no effect on performance with novel patterns in the pattern continuation tasks. The schooled adolescent boys are no different from the unschooled adolescent boys in number of correct continuations: both groups complete about six patterns correctly, on the average (Table 4). Similarly, schooling has no effect on overall pattern continuation scores at the middle age level: both groups of boys complete an average of four out of seven patterns correctly.

#### *Strategies of Pattern Representation*

Underlying the development of the ability to complete patterns correctly is a sequence of distinct strategies of pattern representation. A strategy is an internally consistent approach to patterns that deviates in a systematic fashion from the model being represented. The strategies will be described in the developmental order revealed by our comparison of age groups. This order turned out to represent a scale of increasing complexity and similarity to the models, such that older children's representations tend to preserve more aspects or features of the various patterns. Table 4

Table 4  
DEVELOPMENT OF PATTERN REPRESENTATION:  
AVERAGE FREQUENCY OF VARIOUS STRATEGIES USED BY CHILDREN  
IN DIFFERENT GROUPS TO CONTINUE PATTERNS

Strategies of Pattern Representation	4-5 yr old Girls & Boys (N = 12)	Unschooled groups 8-10 yr old Girls & Boys (N = 12)	13-18 yr old		Schooled groups 8-10 yr old Boys (N = 10)		13-18 yr old Boys (N = 9)	
			Girls (N = 9)	Boys (N = 9)				
Random (applicable to all 7 patterns)	4.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Consistent use of one color (applicable to all 7 patterns)	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Representation of pattern color (applicable to patterns 3, 4, 5, 6, 7)	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No two identical sticks adjacent (applicable to all 7 patterns)	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Consistent representation of one pattern element which inconsistent representation of other pattern element (8) (applicable to patterns 4, 5, 7, 8, 9)	0.5	0.4	0.3	0.0	0.3	0.3	0.0	0.0
Homogenization of pattern elements (applicable to patterns 4, 5, 7, 8, 9)	0.7	1.8	1.2	0.8	1.5	1.5	1.0	1.0
Quantitative reduction or expansion of pattern element (applicable to patterns 4, 5, 7, 8)	0.0	0.2	0.0	0.1	0.1	0.1	0.0	0.0
Free variation of similar colors (applicable to patterns 3, 4, 5, 6, 7)	0.3	0.7	0.7	0.0	1.0	1.0	0.0	0.0
Correct representation (applicable to all 7 patterns)	0.0	3.8	4.6	6.1*	4.1	4.1	6.0*	6.0*

\* Two of the 13 to 18 year-old boys were probably colorblind. Their responses were scored as correct since they made sense when green and red sticks were considered identical.



shows how frequently each of the various strategies was used for participants with and without school experience in each age group. At the oldest age level, strategies are presented separately for girls and boys.

*Random.* Random order of sticks was the dominant strategy of the youngest age group, just as in their representations of the woven patterns. Not only did almost all of them use it, but many did so with great persistency.

*Consistent use of one color.* Two of the youngest boys totally ignored the patterns started by the experimenter and put in all the sticks of one color that they could find. These continuations were the high points of their otherwise generally random performances.

*Representation of pattern color.* Two of the youngest girls used colors correctly, putting in only the colors used in the models, but did not create any discernible patterns with them. Each girl did this only twice. All of their other continuations were random.

*No two identical sticks adjacent.* This strategy, most prevalent with the youngest children, involves using sticks of all the different colors that were available — neither randomly nor with organized substitutions of colors, but by placing no two identical sticks next to each other. This strategy preserves the feature of stripedness without representing the color or pattern of the stripes.

*Consistent representation of one pattern element with inconsistent representation of other element(s).* This strategy was as frequent in the middle as in the youngest group. It consists of continuing a striped pattern by representing one aspect of the pattern accurately throughout but allowing other aspects to vary. Figure 6 shows two of these responses. In the first, a response to Pattern 4 (rrrw<sup>2</sup>), the subject retains only the numerically smaller element (w) of the pattern and treats the larger one (rrr) inconsistently. In the second example, a response to Pattern 8 (rrgrry), the subject represents the stable element (rr) accurately but is not able to cope with the alternating ones (g, y).

*Homogenization of pattern elements.* This strategy expresses an emphasis on qualities of the whole. By reducing the number of differentiated parts, the child represents only the more dominant aspects of the pattern. Figure 6 shows two different homogenizations of Pattern 5 (rrwrww). The two children have both retained the most stable, and therefore the most striking, element of the pattern — the double red stripe — but have chosen different ways to cope with the alternating width of the white stripe in the repeating unit. Table 3 shows that this strategy rises sharply in frequency from the youngest to the middle age level and then declines somewhat among the oldest group. Homogenization is not replaced by another "error" strategy among the thirteen through eighteen year-olds, but rather by accurate continuations: indeed, six adolescents are able to continue all seven patterns correctly.

*Quantitative reduction or expansion of a pattern element.* A strategy involving quantitative change in an element of a pattern, but preserving all of its variable features, was used only four times — in four different patterns, and by four different boys (Figure 6). Such a small number indicates that the ability to represent a given element accurately is basic to the ability to represent differentiated elements of a pattern. Only in these four cases did the latter ability exist without the former.

*Free variation of similar colors.* For continuations of Patterns 3, 4, and 5, pink and orange sticks were available as well as red and white ones. An example of a pattern yielded by this strategy is shown in Figure 4. The last two patterns in the figure show

<sup>2</sup> Patterns are symbolized in the text by the following scheme of abbreviation: r = red, w = white, g = green, y = yellow.

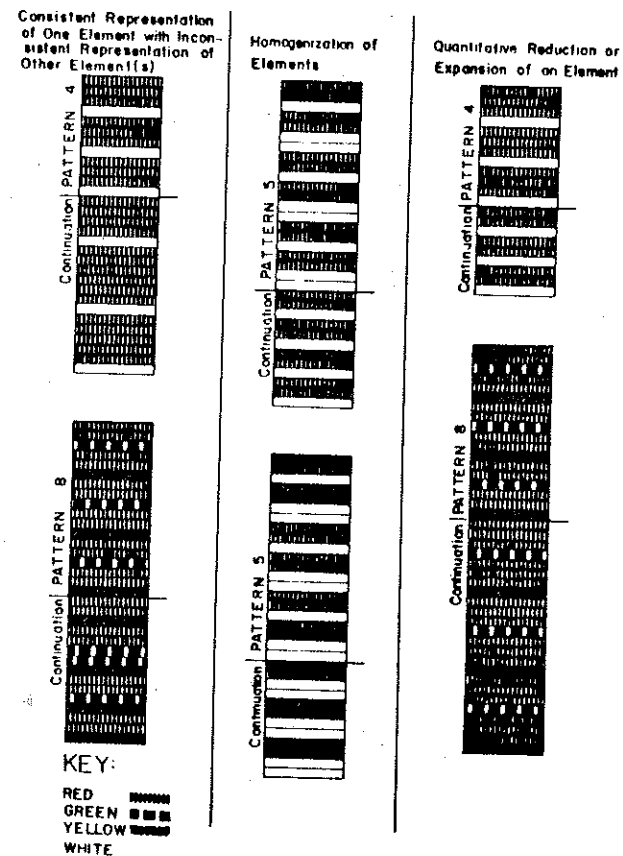


Figure 6. Strategies of pattern representation

substitution of pink for white and orange for red sticks in constructing a red and white alternating pattern. Table 4 shows that color substitution was equally frequent at all age levels, at least among the girls. Since Tzotzil speakers often use a single color term to encode this pink and white and another single term to encode this orange and red, the possibility of a relationship between color terminology and color use was suggested. Evidence relevant to testing this hypothesis will be presented later. Although blue and green are also denoted by the same term in Tzotzil, the use of blue sticks in the green and yellow patterns (5 and 6) only occurred once, perhaps because the shades were actually quite distinct. The fact that only three blue sticks were available may also have contributed to the small number of color substitutions for these patterns.

#### *Number of Sticks Placed at a Time: A Measure of Cognitive "Chunks"*

The manner in which children placed sticks in the frame — one at a time or in groups — seems to reveal something about the cognitive organization of their patterns. By putting sticks in as a group, a child indicates that he is able to predict parts of the

pattern; when his groupings relate to the pattern's structure, he shows that he has an organized mental concept of the pattern.

The frequency of the different types of stick groupings is displayed in Table 5. The youngest children, in addition to doing most of their patterns randomly, put in almost all of the sticks one-by-one. With age there is an increasing tendency for a child to place sticks in groups which correspond to stripes in his pattern. This developmental trend, significant .002 level by the Mann-Whitney U Test (two-tailed), parallels the greater ability of older children to be consistent and correct in their pattern completions. The schooled boys are not significantly different from the unschooled boys in terms of placement units. Thus, with age, the organization of the children's motor behavior comes to reflect the very structure of the pattern, specifically the differentiated elements of which it is constituted.

*Comparison among the Patterns: The Role of Familiarity and Complexity*

The effect of a shift from a familiar design in familiar colors (simple alteration of red and white — Pattern 3) to the same design in a new color context (green and yellow — Pattern 6) is masked by another effect. The similarity of the colors available for the red and white pattern (and perhaps also the large number of orange and pink sticks) seems to have made it more difficult. Children often made substitutions of pink for white and orange for red. If, however, one controls for this factor by disregarding these substitutions of pink for white and orange for red, then the new color context causes great difficulty for the youngest children and much less in the two older groups. This effect is displayed in Table 6. In the youngest group, three boys succeeded with an alternating dark and light pattern with a red and white model; none could produce such a pattern with a green and yellow model. The negative effect of a new color context, while not occurring for all children, is a reliable one according to the sign test ( $p = .016$ , one-tailed test).








The patterns can also be considered in terms of complexity (Table 1). The first shifts toward greater complexity occur in the transitions from Pattern 3 (rw) to Pattern 4 (rrrw) and from Pattern 6 (gy) to Pattern 7 (gggy). Complexity stems from adding a second feature, number, to the first feature, color, which differentiates the two elements of Pattern 3 (rw) and Pattern 6 (gy). This shift in complexity is confounded with a shift away from cultural familiarity — in fact, Pattern 4 (rrrw) constitutes a color reversal of the *pok' k'u\*ul* configuration. Some children who could deal with Pattern 3 (rw) cannot deal with Pattern 4 (rrrw) (Table 5). Some of the younger children fail to represent the greater degree of differentiation of elements within this pattern. This effect, manifest in the simplification strategies discussed earlier, is also a reliable one according to a sign test ( $p = .008$ , onetailed). The effect, however, does not manifest itself in the green and yellow patterns. (Pattern 6 vs Pattern 7). A possible explanation is that the complexity added by making number a variable in the pattern is less important than the confusion caused by reversing the figure-ground relationship of the familiar red and white striped pattern. Problems involving transformation of the familiar may cause more difficulty in a traditional society than a totally foreign problem of equal complexity.

The second shift — to a repeating unit consisting of three differentiated elements (Pattern 5, rrrrrw; Pattern 8, rrrrry) — had a larger effect. On both Pattern 5 (rrrrrw) and Pattern 8 (rrrrry) the eight-to ten-year-olds show a definite drop in competence from each of the preceding patterns (Table 5). These drops are reliable according to a sign test ( $p < .02$ , one-tailed). (The drop in accurate reproduction from Pattern 7 to Pattern 8 occurs, despite the fact that only sticks of the correct colors were available for Pattern 8 whereas sticks of colors not appearing in the model were available for Pattern 7.)

Table 5  
AVERAGE PERCENTAGE OF STICKS USED IN PLACEMENT  
UNITS OF DIFFERENT TYPES BY CHILDREN OF  
DIFFERENT AGES AND EDUCATIONAL EXPERIENCE

	Unschooled boys and girls		Schooled boys	
	Age 4 to 5 N = 12	Age 8 to 10 N = 12	Age 8 to 10 N = 10	Age 13 to 18 N = 9
Average percentage of sticks put in singly	94%	86%	84%	56%
Average percentage of sticks put in two or more at a time as parts of stripes	2%	5%	3%	4%
Average percentage of sticks put in two or more at a time as whole stripes	2%	9%	13%	30%
Average percentage of sticks put in two or more at a time as contrasting stripes	2%	0%	0%	9%
	100%	100%	100%	100%

**Table 6**  
**PERCENTAGE OF CHILDREN IN DIFFERENT GROUPS**  
**CORRECTLY CONTINUING VARIOUS STRIPED PATTERNS**  
**WITH AND WITHOUT EXACT COLORS**

Pattern <sup>a</sup>	Unschooling groups				Schooled groups	
	4-5 yr old Girls & boys (N = 12)	8-10 yr old Girls & boys (N = 12)	13-18 yr old Girls (N = 9)	Boys (N = 9)	8-10 yr old Boys (N = 10)	13-18 yr old Boys (N = 9)
	25%	100%	100%	100%	100%	100%
	8%	75%	100%	100%	80%	100%
	0%	25%	56%	89%	50%	56%
	0%	92%	78%	100%	100%	100%
	0%	100%	78%	100%	90%	100%
	0%	42%	89%	100%	70%	100%
	0%	8%	22%	22%	20%	44%

<sup>a</sup> Patterns are illustrated in Figures 2 and 3.

<sup>b</sup> Arrows join patterns that are identical (3 and 6, 4 and 7) or similar (5 and 8) in structure but vary in color.

The frequency of the homogenization strategy in response to Patterns 5 and 8 shows that children try to reduce them to two-element patterns.

In the oldest group, there is a significant drop in correct completions with Pattern 5 ( $p = .03$ , one-tailed sign test) but not with Pattern 8. For the whole sample, in fact, Pattern 8 is easier than Pattern 5; the probability of the observed difference between the two patterns occurring by chance is .004 (two-tailed sign test). In the context of this experiment there is no way of deciding whether the lesser difficulty of Pattern 8 relative to Pattern 5 stems from the nature of the two patterns (color alternation in Pattern 8 vs number alternation in Pattern 5) or from the nature of the available sticks. (Only the correct sticks were available for Pattern 8, unlike Pattern 5).

Pattern complexity, measured in terms of the number of differentiated pattern elements, causes more representational difficulty than pattern unfamiliarity. A comparison of the results for Patterns 3, 4, and 5 demonstrates this point. If pattern familiarity were the more critical factor, the shift from Pattern 3 (rw) to Pattern 4 (rrrw) would cause a greater decrement in performance than the shift from 4 (rrrw) to 5 (rrrrrrw). It is clear from Table 6 that the opposite is true; and this difference in the decrements is significant at the .004 level (two-tailed sign test).

Pattern 9, the growing pattern shown in Figure 3, was definitely the most difficult one for all of the groups (Table 6). This pattern involves four values along the dimension of number and eight different parts in all; attempts to reduce the pattern to fewer elements were frequent. There was a tendency for the older schooled boys to do better on this pattern, but it did not attain statistical significance. Interestingly enough, however, the only participants in Navencavuk who responded to the pattern with a progressive solution (Figure 3), that is, by continuing its growth, were boys with school experience, one at the oldest age level, one at the middle-age level. Thus, schooling may encourage

the formulation of an abstract principle that goes beyond the information given, generating a solution which transcends the concrete characteristics of the model.

Both the oldest girls who successfully completed the growing pattern used a mirror image solution (Figure 3). The choice of this solution may be related to the nature of Zinacanteco woven patterns, in which thin striped borders are placed symmetrically at both edges of a piece of cloth. Again, weaving seems to produce a *specific effect* rather than a *general pattern skill*.

#### *Color Terminology and Use of Color in Patterns*

We sought an explanation for the commonly occurring substitutions of pink for white and orange for red in the pattern continuations. Pink and white, orange and red, were often in free variation in the children's representations of the woven patterns, as well. Tzotzil has five basic color terms; a single color term is usually used to describe our pink and white sticks, another single term to describe our orange and red sticks. Nevertheless, it is possible to label the color of each stick distinctively by adding diminutive suffixes or using Spanish loan-words. We wondered if there might be a correlation between the ability of a child to encode similar colors distinctively and his differentiation of these colors in pattern continuations. At the end of the experiment each child was asked to name the color of each type of stick; Table 7 shows the obtained relationship between verbal encoding of related colors and the use of these colors in the pattern continuations. (The use of English color terms in this section, as elsewhere, describes the sticks as an English-speaking person would, nothing more. This non-technical way of referring to the colors of the sticks suffices for purposes of this experiment.) While the use of color in the youngest children's patterns seems independent of color terminology, the performances of the older children appear more clearly related to the distinctiveness of their encodings.

Eighty percent of the eight-to-ten-year-olds who fail to describe the pink and white sticks in a distinctive fashion use pink and white sticks interchangeably in forming stripes; only 50% of the eight-to-ten-year-olds who give distinctive descriptions of the pink and white sticks make these substitutions. Similarly, substitutions of orange for red sticks are made by 100% of the eight-to-ten-year-olds who give non-distinctive descriptions of the orange and red sticks, and by only 33% of those who give distinctive descriptions.

In the thirteen- to eighteen-year-old group of unschooled boys and girls 73% of the children with non-distinctive encodings for the pink and white sticks make corresponding substitutions in their patterns, as compared to 30% of those with distinctive encodings. All the thirteen- to eighteen-year-olds who fail to describe the orange and red sticks distinctively substitute orange sticks for red sticks in their patterns; only one-third of those with distinctive descriptions do so. All but one of the thirteen- to eighteen-year-old schooled boys distinctively encode both the pink and white and the orange and red sticks; and there are almost no color substitutions in this group. But the relation between terminology and color use is weakest among the eight- to ten-year-old schooled boys (Table 7). Perhaps this group is learning Spanish terminology in school, but has not yet mastered its referential properties. Nevertheless, looking at the association between distinctive color terms and distinctive color use for the two older groups of unschooled children combined, we find that there is a reliable correlation between non-distinctive (or incorrect) encoding of pink and white and the substitution of pink for white in pattern continuations ( $\chi^2 = 5.1$ ,  $p < .025$ , one-tailed). Similarly, we find a reliable correlation between non-distinctive encoding of orange for red in pattern continuations ( $p < .05$ , one-tailed Fischer Test). The language of the distinctive terms

**Table 7**  
**PERCENTAGE OF CHILDREN IN DIFFERENT AGE GROUPS**  
**WITH AND WITHOUT DISTINCTIVE COLOR ENCODINGS WHO MAKE**  
**CORRESPONDING SUBSTITUTIONS IN CONTINUATIONS OF RED AND WHITE**  
**PATTERNS**

	Unschool'd girls & boys			Shooled boys	
	Age 4-5	Age 8-10	Age 13-18	Age 8-10	Age 13-18
Distinctive color encoding of pink and white sticks N	Pink-white substitutions in pattern continuations				
	100%	50%	30%	67%	0%
	2	8	20	3	11
Nondistinctive (or incorrect) color encoding of pink and white sticks N	100%	80%	73%	71%	0%
	2	5	11	7	1
Distinctive color encodings of orange and red sticks N	Orange-red substitutions in pattern continuations				
	100%	100%	100%	67%	9%
	3	5	2	6	11
Nondistinctive (or incorrect) color encoding of orange and red sticks N	—	33%	33%	50%	0%
	0	9	27	4	1

does not matter: Tzotzil diminutives and Spanish loan-words are equally effective; distinctive and specific encoding is the crucial factor.

At this point we wondered whether color substitutions in the patterns were a matter of representational preference or discrimination failure. We therefore did another experiment in which children who had made pink-white or orange-red substitutions in their pattern continuations were asked to sort sixteen sticks by color, matching four standards set up in different locales—a basket, small pail, large pail, and tortilla table. The four colors were pink, white, orange, and red. Twelve children participated in this experiment, five eight—to ten-year-olds and five thirteen—to eighteen-year-olds without school experience and two eight—to ten-year-olds with school experience. Eleven out of the twelve children sorted without error. Thus, free substitution of pink for white and orange for red in pattern continuation and representations is not based upon an inability to discriminate these colors.

#### Summary and conclusions

##### *The Role of Weaving Skill*

Knowledge of weaving has a large degree of influence on the representation of Zinacanteco clothing patterns. Pattern analysis, more frequent among the weavers,

appears to reflect the perceptual requirements of the task in which the patterns are embedded.

Since analytic representations were constructed by two girls who had never created the two patterns by winding warps for them in the actual weaving process, it is impossible to conclude anything about the relation of pattern representation to the weaving skill itself. A later, unpublished, study of how Zinacanteco girls actually learn to weave does, however, support the idea that girls have already learned how to carry out a great deal of the process before they sit down to weave their first piece of cloth.

The weavers also tended to use wide sticks to represent a stripe composed of a number of threads, whereas the nonweavers more frequently used several sticks placed next to each other. Thus, knowing how a woven pattern is constructed apparently can lead to a more generalized concept of the pattern, as well as foster a more analytic representation. While these two characteristics of the weavers seem somewhat contradictory, pattern analysis and generalization can be integrated, as the performance of the American college students shows, for they used generalized stripes while accurately representing the configuration of stripes in both woven patterns. Originally it was thought that weavers might use a group of narrow sticks of the same color to represent a single stripe, just as a woven stripe is composed of a number of individual threads of a single color. But this was not the case, for the nonweaving Zinacanteco boys used narrow sticks to represent broad stripes more frequently than the weaving girls. Consequently it seems as though the effect of weaving knowledge on the conceptualization of woven pattern lies more in the analysis of pattern configurations than in the detailed representation of threads per se.

The high frequency of analytic representations among the weavers confirms the notion that a craft develops the component cognitive abilities necessary to its performance. This effect of weaving knowledge on the representation of woven patterns directly parallel the effects of pottery making knowledge on conservation of clay substance in Price-Williams et al's (1967) study. Generalized representation of individual stripes through the use of broad sticks, on the other hand, would seem to constitute a cognitive effect rather than a component part of the weaving process itself.

Knowledge of weaving did not, however, foster a general proficiency in the representation of linear patterns, as manifest in the continuation tasks. One possible explanation is that the girls did not weave enough for their skills with patterns to become generalized. This interpretation is suggested by the Mexican study of Price-Williams, Gordon, and Ramirez (1967). They found that where young boys were very actively involved in pottery making, such as occurs when the skill is commercialized, the conservation of clay substance generalized to other types of conservation concepts such as weight and volume. In contrast, where boys were less actively engaged in pottery making, clay substance was the only conservation concept to reflect the influence of the potting skill.

But the fact that the weavers (unschool'd female adolescents) in our study actually performed more poorly on pattern continuations than the comparable nonweavers (unschool'd male adolescents) belies any interpretation based simply on amount of weaving experience. Perhaps the crucial factor is that Zinacanteco culture develops general problem solving skills more in Zinacanteco males than females, particularly the skills useful in carrying out economic transactions. Even in the study of Price-Williams and his colleagues, degree of pottery making experience seemed to be confounded with the amount of commercial activity in which it was involved.

Perhaps, then, practical experience develops specific component cognitive skills—as in Mexican weavers (our study) and potters (Price-Williams et al., 1967)—whereas other more general cultural influences, economic activity for instance, develops generalized cognitive performance—the representation of novel patterns by adolescent

boys in our study, the conservation of liquid quantity and other conservation concepts in the Price-Williams et al. (1967) study. Other studies are needed to unravel the precise nature of the environmental forces which lead to the generalization of cognitive skills.

### *Developmental Stages of Pattern Representation*

Our results demonstrate with striking clarity that pattern representation is subject to seemingly universal stages of organization and that the effects of culture-specific experiences are shaped and delimited by these general developmental processes. Werner has applied his general theory of comparative mental development to the sphere of perceptual representation. In his view this development proceeds from diffuse organization characterized by "qualities-of-the-whole" to an organization in which the essential feature is a "decisiveness of parts standing in clear relation" (1948; page 112).

We have seen that, whereas older Zinacanteco children may copy a given pattern accurately, younger children will represent only its dominant features. The Zinacanteco child solves the problem of complexity by reducing different parts, either by ignoring them or by making them identical to other parts.

### *The Role of Formal Schooling*

Schooling did not have any definite effect on the growth of representational skill as manifest in performance on the pattern continuation problems. This result is quite different from Greenfield's earlier findings among the wolof in Senegal, where schooling produced a striking effect on cognitive development (Greenfield, 1966, Greenfield, Reich, and Olver, 1966.) The position of formal education there was similar to its place in Zinacantan, for schooling introduced a written language into an otherwise oral culture.

A possible explanation of the difference in schooling's effect in the two cultures is that an emphasis on general problem solving skills is encouraged in the indigenous Zinacanteco, but not Wolof, culture and that these skills are therefore not augmented by low quality formal schooling in Zinacantan. This interpretation was suggested by Greenfield's informal comparison of the two cultures and is supported by the informal observations of Miyamoto,<sup>8</sup> the only other investigator familiar with both the Zinacantecos and the Wolof.

Only in the response to the growing pattern was there a suggestion that school experience might make a difference to the representation of novel patterns. Two schooled boys were the only participants who made this pattern "grow" beyond the concrete details of the model. Zinacanteco culture places great stress on doing things the "true" (*baç'i*) way. Very likely most children treated our model of the growing pattern as something to be emulated rather than extended. But School, with its emphasis on learning principles transferable to any context, could be erosive of the notion of the *baç'i* way. Two of the schooled boys did, in fact, formulate the principle behind our pattern and used this principle to develop the pattern beyond our model, rather than merely copying it.

Although school performance had minimal effect on pattern representation in general, it had a large effect on representations of the two Zinacanteco woven patterns. This outcome was quite unforeseen. At the middle age level boys with school experience more frequently differentiated the two patterns; at the oldest age level, they represented the thread-by-thread configuration as often as the female weavers. Perhaps schooling

induces operations which make it possible to translate a principle from one medium — the woven material — to a different one, wooden sticks in a frame. In our experiment, only the woven patterns demanded this translation, and these patterns were the only ones to elicit substantial differences between schooled and unschooled groups. In fact, an intrinsic characteristic of reading and writing is translation between two media, the oral and the visual. Because this translation aspect of schooling would be present wherever reading and writing were taught, even when schools were of low quality, it seems a reasonable account of the means by which formal schooling influences representation of the woven patterns.

### *Color Lexicon and the Use of Color in Patterns*

A whole range of studies have focused on the relationship between color lexicon and monolingual behavior relating to color, in attempts to test out the Whorfian hypothesis that language determines thought. The relationships observed in these experiments between language variables and cognitive variables have been, in general, small or nonexistent; this body of research is summarized and discussed by Greenfield and Bruner (1969). On an overall cultural level, the Zinacantecos' use of the color in patterns and its correspondence to Tzotzil terminology seems to constitute the most striking correlation between color terminology and nonlinguistic behavior ever noted. Zinacantecos at all ages frequently substituted pink for white and orange for red. Light pink and white are both covered by the basic color term *sak* in Tzotzil, orange and red by the term *zoh*. The U.S. college students, speakers of a language in which each pair of colors is denoted by a pair of basic color terms, rarely used pink and white sticks or orange and red sticks in free variation in their patterns. The reason for this seemingly large correlation between lexicon and cognitive behavior might be that our task was a representational one, therefore offering a choice of appropriate responses without becoming a culturally ambiguous task. To our best knowledge no other study has ever used an esthetic problem to study the relationship between language differences and nonverbal thought. Supporting evidence that to some degree participants "choose" to ignore fine color discriminations for the purpose of the representational task comes from the control experiment in which these fine discriminations were clearly required. There the very same children who had substituted pink for white or orange for red in constructing their patterns discriminated all four colors perfectly. Although Tzotzil lacks basic color term to distinguish pink from white and orange from red, it is possible for a Zinacanteco to encode each color linguistically, either by modifying the basic color terms or by using Spanish loan-words. On the level of individuals there was a very imperfect but statistically significant relation between color substitutions in pattern construction and non-distinctive encoding of the relevant colors.

In our study two strong qualitative relationships between culture and cognition have appeared — between experience with clothing and its representation and between the language of color and its use in patterns. Perhaps the realm of esthetic representation, where choice is real rather than illusory, is the ideal domain for demonstrating the cognitive implications of different world views.

### References

- Berlin, B., & Kay, P. *Basic color terms: their universality and evolution*. Berkeley: University of California Press, 1969.

<sup>8</sup> Personal communication, 1971.

- Brazelton, T. B., Robey, J. S., & Collier, G. A. Infant development in the Zinacanteco Indians of Southern Mexico. *Pediatrics*, 1966, 44, 274-293.
- Bruner, J. S. *Processes of cognitive growth: infancy*. Worcester: Clark University Press, 1968.
- Cancian, F. *Economics and prestige in a Maya community: the religious cargo system in Zinacantan*. Stanford: Stanford University Press, 1965.
- Deregowski, J. B. On perception of depicted orientation. *International Journal of Psychology*, 1968, 3, 149-156.
- Goodnow, J. J. A test of milieu effects with some of Piaget's tasks. *Psychological Monographs: General and Applied*, 1962, 76 (36, Whole N° 555).
- Goodnow, J. J. Cultural variations in cognitive skills. *Cognitive Studies*, 1968, 1.
- Greenfield, P. M. On culture and conservation. In J. S. Bruner, R. R. Olver, P. M. Greenfield et al. *Studies in cognitive growth*. New York: Wiley, 1966.
- Greenfield, P. M., & Bruner, J. S. Culture and cognitive growth. In D. A. Goslin (Ed.), *Handbook of socialization theory and research*. Chicago: Rand McNally, 1969, pp. 633-657.
- Greenfield, P. M., Reich, L., & Olver, R. R. On culture and equivalence: II. In J. S. Bruner, R. R. Olver, P. M. Greenfield, et al. *Studies in cognitive growth*. New York: Wiley, 1966, pp. 271-318.
- Harkness, S. The learning of color codes in two cultures. Unpublished manuscript, Harvard University, 1971.
- Harvard Chiapas Project, Tzotzil-English, English-Tzotzil Field Dictionary. Unpublished manuscript, Harvard University, 1968.
- Heider, E. Universals in color naming and memory. *Journal of Experimental Psychology*, 1972, 13, 10-20.
- Miyamoto, J. Cognitive equivalence in Zinacantan: a developmental study. Unpublished honors thesis, Harvard University, 1969.
- Mundy-Castle, A. C. Gestalt continuation and design copying in Ghannain children. *Ghana Journal of Child Development*, 1968, 1, 40-63.
- Price-Williams, D., Gordon, W., & Ramirez, M. Manipulation and conservation: a study of children from pottery-making families in Mexico. *Memorias del XI Congreso Interamericano de Psicología*. Mexico City, 1967, pp. 106-126.
- Price-Williams, D. Towards a systematics of cross-cultural psychology. *Memorias del XI Congreso Interamericano de Psicología*. Mexico City, 1967.
- Trosper, R. L. Schools and schooling in Zinacantan. Unpublished paper, Harvard University, 1967.
- Vogt, E. Z. *Zinacantan: a Maya community in the highlands of Chiapas*. Cambridge: Belknap, 1969.
- Werner, H. *Comparative psychology of mental development*. New York: Science Editions, 1948.
- Wober, M. Distinguishing centri-cultural from cross-cultural tests and research. *Perceptual and Motor Skills*, 1969, 28, 488.

## RELAÇÃO ENTRE SEXO E CLASSE SOCIAL DA CRIANÇA E O SEU DESEMPENHO E ATRAÇÃO POR UM BRINQUEDO CONSIDERADO ADEQUADO, NEUTRO, OU INADEQUADO A SEU SEXO

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Neste estudo, investigou-se o desempenho e atração por um brinquedo apresentado às crianças como adequado, neutro ou inadequado a seu sexo em uma amostra de crianças de ambos os sexos de classe média e classe baixa. O brinquedo utilizado foi imaginado pelos autores do presente trabalho, devido à necessidade de um brinquedo desconhecido para a amostra. Análises de variância com três fatores — classe social, instruções e sexo — foram utilizadas para avaliar tanto a atração quanto o desempenho. Variáveis culturais foram introduzidas para explicar os resultados obtidos, os quais diferem marcadamente de resultados de estudos nesta mesma área realizados nos Estados Unidos.

In this study, the performance and attraction in a game presented to the child as adequate, neutral or inadequate to his sex were investigated in a sample of boys and girls, half from the middle class and half from the lower class. The game was created by the authors of the present study, due to the need of a game completely unknown to the sample. Analyses of variance with three factors — social class, instructions and sex were used to evaluate both the attraction and the performance. Cultural variables were introduced to explain the results obtained, which differ significantly from results in this same area obtained in the United States.

Diferenças comportamentais podem ser observadas desde muito cedo entre crianças do sexo masculino e feminino. Existe uma expectativa geral para que a criança exiba comportamentos diferentes e assuma diferentes papéis dependendo de seu sexo. Pesquisas correntes (Hetherington, 1970) indicam que os pais ensinam a seus filhos a se comportar como meninos ou meninas, reforçando comportamentos apropriados a seu sexo e punindo comportamentos característicos do sexo oposto. Isto ocorre particularmente com crianças do sexo masculino. Embora o mesmo processo ocorra no caso de crianças do sexo feminino, parece que estas sofrem menos pressões para se enquadrar em um modelo de comportamento feminino. Talvez devido ao status superior masculino adicionado à maior pressão inicial para os meninos adotarem padrões de masculinidade, as pesquisas têm mostrado que os meninos desenvolvem mais cedo uma preferência pelo papel masculino do que as meninas pelo papel feminino (Brown, 1957). Pesquisadores americanos observaram também diferenças nas preferências por papéis masculinos e femininos entre diferentes classes sociais. Rabban (1950) observou, por exemplo, que meninos de classe baixa apresentavam uma preferência mais acentuada por brinquedos considerados como próprios para o seu sexo por volta de 4-5 anos, meninas de classe baixa e meninos de classe média por volta de 7 anos e meninas de classe média por volta de 9 anos.