

Culture, History, Biology, and Body: Native and Non-Native Acquisition of Technological Skill

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ABSTRACT *Each culture defines the appropriate ways for people to use their bodies (Mauss 1934). In this paper we examine the uses of the body in a technical skill, that of Zinacantec Maya backstrap loom weaving. We hypothesize that native learners of weaving are different from non-native learners in that they are endowed from birth on with the biology and cultural experience needed for weaving. Maya newborns have distinctive patterns of motor behavior and visual attention. These patterns, reinforced by cultural experience, are utilized when girls learn to weave, highlighting the interplay between culture and biology. Non-native learners do not begin life with the same patterns of motor behavior or cultural experience and thus begin the acquisition of the body techniques involved in the complex skill of weaving with a deficit. Conclusions are based on an empirical, historical study of two generations of girls learning to weave in Naben-chauk, a Zinacantec Maya hamlet in Chiapas, Mexico.*

In a pioneering paper presented in 1934, Marcel Mauss (1968) drew the attention of anthropologists and psychologists to cultural *techniques du corps* (techniques of the body). That is, Mauss pointed out that people know how to use their body in accord with the customs of their society. At the same time, the body is of course a basic biological fact. The body is a part of all our thoughts, feelings, and actions. Some researchers in the field of cognitive science have examined the role of the body

in cognitive processes (Bem and Keijzer 1996; Moulyn 1991) and in the role of gesture in communication (e.g., McNeill 1992). The role of the body in human action has been of long-standing interest in anthropology (see Strathern 1996 for a review).

The idea that specific uses of the body are both biologically and culturally based is an important one. Here, we consider the uses of the body in a specific cultural activity: Maya backstrap loom weaving and the ways in which these uses of the body are transmitted from one generation to the next in this culturally central skill. We also consider the historical dimensions of culture, pointing to historical changes in the transmission of weaving skill, especially the configuration of learner and teacher bodies in the teaching space.

The weaving and the studies to be discussed in this paper come from a Zinacantec Maya hamlet, Nabenchauk, located in Chiapas, Mexico (Childs and Greenfield 1980; Greenfield 1984, in press b, 1999; Greenfield et al. 1989; Greenfield and Childs 1991). We have studied two generations of Zinacantec girls as they learn to weave. The Zinacantec database consists of 72 girls videotaped in the process of weaving apprenticeship. The first generation was studied in 1970, the second in 1991 and 1993. In this paper we include data on techniques *du corps* of nine Zinacantec weaving learners selected because they represent different stages, times, and experiences of weaving acquisition. For comparative purposes, the second author was videotaped as she was taught to weave in Nabenchauk in 1970. The first author did an ethnographic study of the process by which she was taught to weave in Nabenchauk in 1995.

Ancient Maya backstrap loom weaving, which survives to the present, is a means of subsistence and an art form of the Zinacantec Maya Indians. Weaving defines womanhood in Zinacantan. Traditionally, all Zinacantec women learn how to weave; men do not. All Zinacantees wear woven clothing. Girls and women weave skirts and shawls, worn by females, and ponchos, worn by males. Skillful weaving is a major asset in finding a husband.

In this paper we consider several facets of techniques *du corps* in Zinacantec Maya weaving. We begin with a description of the techniques *du corps* important for weaving to introduce the reader to these unique ways of moving the body in a cultural skill. We then discuss our typology of the native, versus the non-native learner, highlighting the stages of development in learning to weave and the causal factors in the native acquisition of weaving skill. By analogy with language, our thesis is that there are two kinds of learners: native and non-native. The native learner is endowed, from birth, with the biology and the culture that aid in furthering the use of the various body techniques in weaving. The non-native learner is at a disadvantage in this realm and has more difficulty learning to position and use the body at each step in the process. Finally, we consider a

historical shift in the spatial organization of bodies during weaving apprenticeship. The relationship of teacher and learner has gone from two bodies working as one, to two independent bodies. This shift expresses the growth of individualism over our study period of two decades.

TECHNIQUES DU CORPS IN ZINACANTEC MAYA WEAVING

The skill of weaving requires modulation of important corporal techniques that involve the whole body. A woman's body becomes an essential part of the loom. Weaving is not possible if there is not a body serving as part of the loom frame. The warp or frame threads are stretched between a post and the weaver's body. The lower end of the loom is held in place by a strap going around the weaver's lower back (see Figures 1a and 1b).

In each part of the weaving process, there are important uses of the body. Each part requires correct position, strength, coordination, and balance, or the weaving cannot continue. Of particular interest are body "errors" and their consequences for weaving. One part of the weaving process in particular involves by far the most difficult body movements. (Figure 1a and Figure 1b).¹ Lifting the heddle stick as seen in Figure 1a, is difficult because the weaver must do three things at once. First, with her body, she must rise and lean forward to obtain just the right tension of the loom—loose, but not too loose (the forward lean is seen most clearly by comparing the body position of the weaver in Figure 3, who is leaning back, with that of the weaver in Figure 1a). Second, with one hand (left hand, Figure 1a), the weaver must lift the heddle and keep it level. The heddle is a weaving stick that is lashed to, and can therefore lift up, every other warp thread (the white threads in Figure 1a and Figure 1b.) Third, with her other hand (right hand, Figure 1a), she must grasp the beater and the bamboo spacer together (two more weaving sticks), keeping them parallel, while pinching the upper warp threads (the white threads) between them. She must rotate the sticks away from herself to shorten the upper threads and make it possible to lift the lower threads with the heddle (held in the left hand in Figure 1a). When she has lifted the heddle stick far enough, she must keep the loom balanced in that position while she carefully lifts off the beater and inserts it into the new space. This sometimes requires her to lower her head and look into the new space from the inside (Figure 1b), all the while keeping her hips absolutely still. Successful weavers are able to modulate this entire process with great body skill.

If the weaver lets the loom tilt to the left or right, the bamboo spacer stick may fall out. We see this occurring in Figure 1b. Replacing that stick can be a very time-consuming process. Thus, lack of perfect balance can have dire consequences for the weaving. Correct position, balance,



Figure 1a: Lifting the heddle. Note how the weaver, Paxku' 244,² is rising up on her knees while lifting the heddle with her left hand and grasping the beater and bamboo spacer together with her right hand. (Nabenchauk, 1991; Video by Patricia Greenfield.)

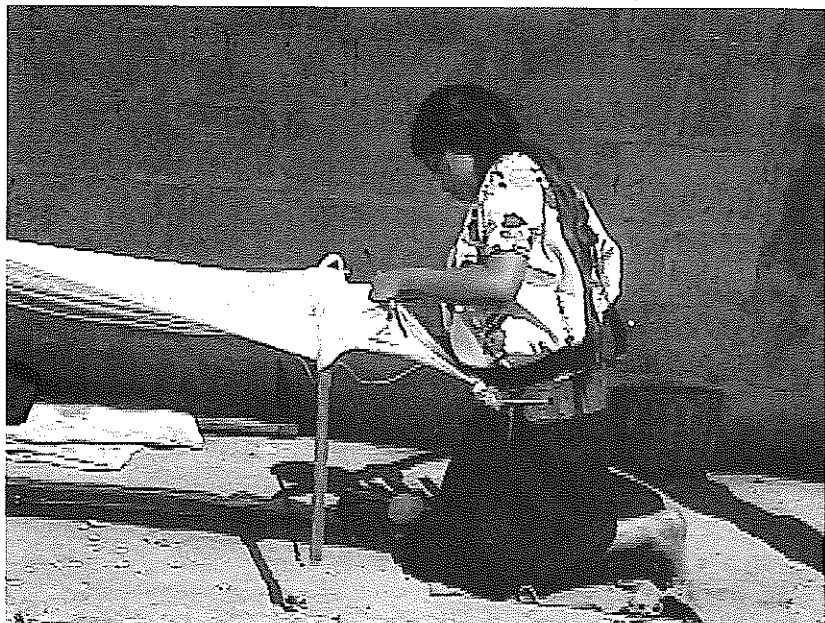


Figure 1b: Paxku' 244 has allowed the spacer stick to fall out as a result of shifting the loom out of balance. (Nabenchauk, 1991; Video by Patricia Greenfield.)

strength, and coordination, and the modulation of these techniques du corps together, are essential for Zinacantec weaving.

NATIVE VERSUS NON-NATIVE LEARNERS

The question arises as to the degree to which the important body techniques for weaving are specifically taught and the degree to which they are supported by biology and the overall cultural environment. With respect to the body techniques of weaving, we propose that there are two kinds of learners: native and non-native. The native learner is endowed from birth with the biology and the culture that aid in furthering the use of various body techniques in weaving. The non-native learner is at a disadvantage in this realm and needs more extensive instruction in learning how to position and use the body at each step in the process.

The analogy is of course to native and non-native learners of language. The native language learner learns young, does not need formal instruction, masters the subtleties of grammar, and has no "foreign accent." The non-native language learner begins later, needs formal instruction, still does not master the most subtle grammatical points, and never gets rid of his or her "accent" (Johnson and Newport 1989). Most of these same distinctions hold for native and non-native learners of weaving skills. We use this analogy as a framework for discussing how these factors are involved in the native and non-native acquisition of weaving skill, recognizing that the acquisition of language and the acquisition of weaving differ in other important ways.

The distinction between native and non-native learners of body techniques in weaving arises from observations that link the distinctive use of the body by Zinacantec newborns to later uses of the body in weaving. Zinacantec babies are born with distinctive patterns of motor movement and visual attention. In comparison with Euro-American babies born in the United States, Brazelton, Robey, and Collier (1969) found an overall lower level of motor activity and a higher level of visual attention in Zinacantec infants from birth. Resting the arms close to the upper body was especially striking in comparison with the Euro-American babies from the United States, who displayed more extensive arm movement.

This culture-specific body style provides an innate foundation for the use of the body in backstrap loom weaving. We are using the term *innate* in its literal sense of "born with." Indeed, we cannot establish the relative roles of genetic and environmental influences in native learners. We can, however, note characteristics that are stable over time (Hinde 1996). Such stability in fact depends on a match between the organism and the environment, so that the environment reinforces behavioral characteristics of the organism (Greenfield et al. 1989; Greenfield and Childs 1991).

Indeed, the low level of neonatal motor activity is likely influenced by prenatal environment. Zinacantec women in general use controlled motor movements (Haviland 1978), employing a small space for movement around the body. Pregnant mothers therefore provide developing fetuses with a calm, restrained movement environment.

Low motor activity in Zinacantec newborns is further reinforced by the culture in which the infants mature. For instance, infants' movements are restricted by the cultural practice of swaddling (Brazelton et al. 1969; Greenfield 1972). Also, infants are encouraged to nurse at the slightest sign of motor activity; this practice further lessens infant movement (Brazelton et al. 1969). Girls mature, having observed their mothers and other women exhibit restricted motor movements; women do not move their arms far from their bodies and, traditionally, they do not exhibit any loose motor movements, such as dancing (Haviland 1978). In weaving, this low level of motor activity, and especially upper-body stillness, is central to providing a solid anchor for one end of the backstrap loom. The confluence of culture-specific environment and organism creates what Arthur Kleinman (1996) calls a "local biology."

As Zinacantec infants mature and become children, they learn other motor behaviors proper for their culture. Girls grow up watching their mothers and other older females use a kneeling position, with their legs under them, during many daily activities. For example, women kneel to change their babies, to cook at a fire, and to make and press tortillas.

Girls learn to maintain this position, essential for backstrap loom weaving, through cultural practices as they themselves make tortillas, cook, or observe the activities of adults in the household.

As the paleontological record shows, kneeling at a young age shapes bone development so that the capacity to kneel is maintained into adulthood (Molleson 1996). Thus, there is a sensitive period during which experience is critical for kneeling ability to continue undiminished. There is analogous evidence in the arena of language: experience with a particular language can be critical during developmentally sensitive periods for language maintenance (Fillmore 1991).

As Fillmore (1991) points out, cultural definitions and priorities have an important influence on language experience. Bril (1996) notes that motor stages are also culturally defined. Her example is squatting. Although infants universally assume this position, Bril notes that squatting is considered a developmental stage only in cultures where this position is elaborated in adulthood. In a similar fashion, we would hypothesize that kneeling would be considered a stage for female children in Zinacantan, although it is not considered a developmental milestone in European-based cultures.

Balance is another quality important for the daily activities that Zinacantec girls and women perform; it is also an important body skill for weaving. Girls and women often must carry heavy loads of firewood hanging from their heads on tumplines. Good balance is crucial for carrying such cumbersome loads, often for long distances. Practice in carrying wood can also provide practice for the balance required by weaving.

Thus, innate capabilities, both universal (like kneeling) and culture-specific (like upper-body stillness) are strengthened by cultural values and practices. When girls are introduced to weaving, these practiced motor characteristics surface and place native learners at an advantage. As we will see in the next section on stages of development, the native learner needs less instruction in body technique and has less trouble weaving because of her ability to kneel for long periods of time, her gentle and controlled motor activity, and her balance.

Native learners of Zinacantec weaving also differ from non-native learners in the ability to use visual attention for observation as a mode of learning. Zinacantecs, from the newborn period, have long visual attention spans, relative to Euro-American babies for example (Brazelton et al. 1969). Opportunities for observation of adult activities are plentiful throughout the daily life of Zinacantec children. Learning from observation is an important component of Zinacantec weaving apprenticeship. Non-native weavers, on the other hand, may have more trouble using observation to learn. In our culture, we often consider "learning by doing" to be most effective and employ trial-and-error methods of learning (Greenfield and Lave 1982).

A dramatic example of the difficulty someone from another culture might have trying to learn by observation comes from an American college student's description of learning to weave in Zinacantan. This student, Marta Turok, had been watching weaving for two months, an activity which her teacher called "learning," and which Ms. Turok called "observation." She says,

Many times she [the teacher] would verbally call my attention to an obscure technical point, or when she would finish a certain step she would say, "You have seen me do it. Now you have learned." I wanted to shout back, "No, I haven't! Because I have not tried it myself." However, it was she who decided when I was ready to touch the loom, and my initial clumsiness brought about comments such as, "*Cabeza de pollo!* (chicken head) You have not watched me! You have not learned!" [Turok, 1972:1-2]

In line with this example, observation of models is extremely important both at the preweaving and early-weaving stages of apprenticeship in Zinacantan (Childs and Greenfield 1980; Greenfield 1984).

The relatively developed visual attention spans present in Zinacantec newborns (Brazelton et al. 1969) are manifest in weaving itself, even for first-time weavers. Among our 1991 weaving learners, for example, is Loxa 203 (see note 2), age six, weaving on an adult loom for the first time. She

has an extended visual attention span and level of concentration hard to imagine in a U.S. child of the same age. Throughout the hour of our weaving video, her attention never wavers from the task at hand. Persistence and a lengthy attention span are important qualities for weaving. A large weaving, such as a shawl, could take several weeks to complete, and individual weaving sessions often range from 15 minutes to one or two hours.

Native Learners: Stages of Development

Learning to weave typically begins with play weaving on a toy loom when girls are around three or four years old. Weaving on a "real" loom for the first time could take place when a girl is as young as five, under exceptional circumstances. More typically, girls start weaving on an adult loom when they are eight or nine years old. By mid-adolescence, Zinacantec girls are usually skilled weavers.

Zinacantec girls need very little instruction in body techniques when learning to weave. This is an indication of their status as native learners. Nonetheless, as we will see, there is a developmental progression in the teaching and learning of body technique, with younger girls needing more instruction than older girls. Our video analysis indicates that, by the age of six or seven, first-time weavers on a real loom need little, if any, instruction in body technique.

Play Weaving

A native learner's first opportunity to practice the body techniques needed for weaving is play weaving, a preweaving stage which all girls in Nabenchauk perform. In play weaving, a young girl between three and seven either has a loom set up for her or sets up a toy loom herself. In some cases, the girl will try to weave an unweavable set of threads she has incorrectly wrapped around the end-sticks, drawing on general impressions she has gained from observational learning. Figure 2 shows a play loom that a young girl has, most likely, set up for herself.

In other cases, the girl will receive careful instruction about how to weave the threads. The youngest subject in our database, three-year-old Rosy 206, was given her very first experience and instruction in play weaving on a toy loom for our camera. A young aunt set up the loom and showed her how to weave the threads. We saw this as an example of the older girl solidifying her knowledge of the set-up process (conceptually the most difficult part of weaving) through the process of teaching a younger child.

The warp on the toy loom on which Rosy 206 was learning was about an inch wide and about six inches long, a very small piece of cloth, suitable for such a young beginner lacking strength and weight. Rosy demonstrated her knowledge of body technique with many of her movements. Rosy had



Figure 2: A young girl, Rosy 211, tries to weave on her toy loom. (Nabenchauk, 1991; Photo courtesy of Lauren Greenfield.)

seen some of these movements before, observing other girls and women in her family while they were weaving. While she was not able to pass the beater through the open sheds or lift the heddle on her own, she was able to beat down the threads, often leaning back as she did, something she had seen other women do. During her weaving session, Rosy tries to pull back on the threads in order to create a space for the bobbin (as in Figure 1), an action she also must have observed many times. Virtually the only part of the weaving process that Rosy can do on her own in the first lesson is beat the threads down. However, she demonstrates her knowledge of body techniques by keeping the backstrap low and leaning back into it at the appropriate times.

There are, nonetheless, a few points in the hour-long videotape at which the teacher tells Rosy explicitly to lean back. By age six or seven, girls do not always require such instruction. Weaving learners simply lean back without being told. From a developmental perspective, it is therefore significant that Rosy is the youngest weaver in our database. A comparison with the next-youngest weaver, Octaviana 172, age five, demonstrates the developmental progression of techniques du corps.

First-Time Weavers, Real Loom

Octaviana 172, age five, is our youngest first-time weaver on a real loom. Weaving something so tiny it can hardly be called a piece of cloth,

Octaviana is given quite a bit of body instruction. Octaviana, like Rosy, is told to lean back several times (for example, at 12:10:55)³ and how to hold the beater correctly (12:10:44). She shows her awareness of body techniques, however, when, after waiting patiently in a sitting position for her sister to set up the loom around her, she moves into a kneeling position on her own initiative as soon as it is time for real weaving to begin (12:09:37), and then maintains the position for nearly an hour. It is hard for us to imagine a U.S. five-year-old acting thus, in terms of both body techniques and technical knowledge.

As girls mature, they may no longer need any instruction in body technique. Loxa 203, age six, is seen on video demonstrating her knowledge of body techniques. Figure 3 shows Loxa expertly leaning back into the backstrap as she weaves. Although she has some difficulty with the more complex part of the weaving process—the simultaneous leaning of the body, lifting of the heddle, and rotating of the beater and spacer—it is only because her hands are too small to grasp the two sticks and hold them parallel. She has no difficulty with coordinating the three activities (8:47:04, 8:49:44, 8:52:42). Her mother, who sits near her during the entire hour-long weaving session, does not tell her daughter to lean back, sit down, or rise up even once. Loxa is able to modulate all the techniques *du corps* in her very first weaving session.



Figure 3: Loxa 203, age six, leans back into the backstrap as she weaves. (Nabenchauk, 1991; Video by Patricia Greenfield.)

Another young learner in our sample, Menencia 172, age seven, though not as proficient as Loxa 203 in the movement of her body for the complex part of the weaving process, is able to lean back steadily and keep the loom taut for an hour-long weaving session. However, the need for instruction is variable among the young weaving learners. Unlike Loxa 203, Menencia requires instruction to lift the heddle. Markarita 172, the instructing sister, whispers an imperative to her (trucks are rumbling by) and then demonstrates how to lift herself up on her knees. Menencia complies. At all other times, Menencia stays down and Markarita ignores her, yanking her forward a bit with the belt when necessary and making the shed herself.

Maruc 228, an eight-year-old weaver working on her first piece of cloth, also gets some body instruction (12:06:18). Her body movement errors are much more a matter of degree. Her actions are perfectly coordinated, but her leaning forward is not sufficient to create a space for the beater to enter. As another example of instruction in body techniques, the mother of Loxa 204, a nine-year-old weaver working on her second piece of cloth, gently places her hand on her daughter's back twice (10:40:50, 10:43:41) when she needs to lean further forward to make a shed, but Loxa has already initiated the gracefully combined leaning of the body, lifting of the heddle, and rotating of the beater and spacer.

To summarize, even the very youngest learners demonstrated a degree of knowledge of the techniques *du corps* important for weaving. This knowledge increases with age. Because of innate characteristics of motor stillness and lengthy visual attention spans, reinforced by culturally defined experiences, and because of culturally mandated practice with kneeling and balance, Zinacantec girls were at an advantage. For all but the very youngest girls, weaving instruction focused primarily on the manual and cognitive skills of weaving, rather than on body technique. Only occasionally were Zinacantec learners above age five given instruction in basic body techniques. Skill in using the bodies as part of the weaving frame was, for the most part, a given, the foundation upon which manual and cognitive skill could be based.

Non-Native Learners

The non-native learner, on the other hand, must be explicitly instructed on what to do with her body while weaving and may have trouble with the motor requirements of weaving. Non-native learners may have trouble with body techniques required for weaving, such as balance, kneeling, coordination, and keeping movement restricted in general. We now turn to a description of two non-native learners, the first and second authors, Ashley Maynard and Patricia Greenfield. As non-native learners, Maynard and Greenfield received quite distinctive instruction when learn-

ing to weave, with much more emphasis, both verbal and nonverbal, placed on body technique than was necessary for their much younger Zinacantec counterparts.

Maynard, a 23-year-old, first-time weaver, was instructed in weaving during two months of fieldwork in Nabenchauk in 1995. She encountered problems in learning to weave because she was not able to kneel for long periods of time. Kneeling was very painful for her, and she resorted to sitting cross-legged, much to the derision of the Zinacantec teachers and other women who observed her weaving. Often, while she was weaving, a girl or woman would enter the house or courtyard and say, "Kneel! It's better, easier!" She could only reply that it hurt, causing much laughter among those present. Because of her sitting position, she had difficulty when trying to lift the heddle stick, the complex technique *du corps* shown in Figure 1a. It is much easier to lift the heddle while up on one's knees. Changing from her sitting position to rising up on her knees often caused the sticks to fall out of the loom, the same problem of balance encountered by a native learner, shown in Figure 1b. Also, even with great care and attention to maintaining the position of the sticks in the loom, it was difficult to change position from sitting to kneeling within the backstrap; it was also time-consuming. In using the sitting position, the first author departed dramatically from Zinacantec techniques *du corps*—cultural techniques that she had not mastered.

Non-native learners have more trouble leaning forward and backward with the proper tension and at the proper times during weaving; they require extensive instruction in these body processes. Unlike the native learners, Maynard had to be told many times to "Lean back!" or "Come closer!" during weaving instruction. Often the teacher, a 13-year-old girl, physically manipulated her body by pushing her forward or backward, a teaching technique only occasionally seen with native learners. When Maynard was weaving, there were several occasions when a woman or girl would enter the room and give instructions on what she should do with her body to make the weaving easier. She often required instruction and assistance in the modulation of body techniques in order to continue weaving. It is also worth noting that after extensive weaving instruction, Maynard still required assistance in lifting the heddle in long and wide pieces of cloth; she lacked the coordination required to do it by herself. She would have needed more practice to be able to weave a large piece of cloth, such as a shawl, alone.

Greenfield was a first-time weaver in 1970 at age 30. In a videotaped learning session, she also required assistance at several points in the weaving process, just as Maynard did. Many times during this session, she was told to lean back. During the most difficult part of weaving, lifting the

heddle, she, like Maynard, was also told what to do with her body to make the process easier.

Indeed, Greenfield's status as a non-native learner was demonstrated most clearly in her attempt to lift the heddle. Her body position was awkward, all bent over the loom. This is something we did not see, even in the youngest native learners. For them, the unconscious attention to the body technique of maintaining enough tension on the loom to keep it in balance would prevent them from ever leaning so far forward. Compare Greenfield's body position in Figure 4 with that of a Zinacantec weaver, also lifting the heddle, in Figure 1a. Greenfield's body accent is quite foreign, although she does not make an actual weaving error. For example, she must lean over very far to her right to see inside the space she has just created for the beater.

Just as a skilled user of a language relies on many cues besides phonemes for complete understanding of meaning and nuance, a skilled weaver can rely on many different cues to tell her if the space has been correctly made. Greenfield can rely only on direct visual observation; thus she leans out to the side, risking the tension and balance of the loom. A skilled Zinacantec weaver's understanding of the weaving process would prevent her from moving in such a way. Even the beginning Zinacantec



Figure 4: Greenfield lifting the heddle. Note the nearly horizontal body position, very different from that of Zinacantec weavers. (Nabenchauk, 1970; Video by Carla Childs.)

weavers never find themselves in that awkward position; their body techniques keep them close to a vertical position.

Causal Factors in Native Learning of Techniques du Corps

To what extent does the native use of body technique depend on starting to weave at a young age? To what extent does it depend on the innate foundation and general cultural reinforcement described earlier? To examine this question, we analyzed the videotapes of our three oldest first-time Zinacantec weavers. Most girls in Nabenchauk start learning to weave by age eight or nine. There were, however, three girls who did not learn to weave until they were teenagers, when they had their first weaving session in front of our camera. The oldest late learner, Paxku' 221, was 15 years old in 1991. Unlike her mother, whom we had videotaped learning to weave in 1970, this girl had not learned to weave as a young girl because she was a wage worker, a new phenomenon in Nabenchauk. She wound thread for wages. She had to do this to help support the family because her mother was a widow. The other two older, first-time Zinacantec weavers are Loxa 222 and Katal 230, both 13 years old at the time of their first independent weaving project. Loxa 222 had not woven because she was working in a thread business, winding and selling. She indicated that she would learn to weave when she quit working for wages. Katal 230 had not woven before because she had a learning disability. Instead, she had wound thread on spools for the family shop.

These weavers—Paxku' 221, Loxa 222, and Katal 230—were therefore a natural (albeit, an imperfect) experiment on the role of age in native learning of techniques du corps. Would their techniques du corps look more like the non-native learners' Maynard and Greenfield, because they had learned later than the other girls in Nabenchauk? Or would their body techniques in weaving look more like those of the young Zinacantec girls in the database who learned to weave earlier in their development?

An examination and analysis of the three weaving sessions provide some interesting data to answer that question. In many respects, all three girls are indistinguishable from the young native learners. They have restrained movement and native body positions. They are all good at processes reinforced in other culturally valued skills, such as kneeling, leaning forward, and balancing, all of which are necessary for both weaving and other tasks, such as making tortillas (kneeling and leaning forward) and carrying wood (using the body to balance objects).

Two of these later learners show good examples of skill at balancing the loom. Loxa 222 holds the loom taut and level with one hand (4:09:35), while re-tying her backstrap with the other. When she needs to reach across her loom to pick up a new stick (4:12:03), she manages to do so

without leaning forward and losing tension on the loom. Paxku' 221 also needs to reach across her loom to receive a new beater that a boy is bringing to her (12:45:28). She reaches only as far as she can while maintaining the balance of the loom, and then holds her hand gracefully poised over her head, demanding that the boy bring the stick closer.

We can learn from this comparison that being born to and growing up in the Zinacantec culture has provided certain basic body skills fundamental to weaving on a backstrap loom: restrained movement, kneeling, and leaning forward. We attribute these skills to early and ongoing experience with kneeling and carrying wood; Maynard and Greenfield, however, lacked these experiences and these skills. Earlier experience with play weaving and opportunities to observe skilled weavers may also have enhanced the weaving-specific body skills of these first-time learners. These earlier experiences, especially play weaving, may have occurred within a sensitive period. During the sensitive period, such experience could stimulate the relevant neural development required for the later acquisition of weaving skill—at whatever age this later acquisition might occur (cf. Fairbanks in press; Greenfield in press a).

Alternatively, there could be a decrement in body skills correlated with later weaving apprenticeship, despite play weaving and other priming experiences. A comparison of a Zinacantec learner the same age as Maynard (or Greenfield) both with early Zinacantec learners and with Maynard (or Greenfield) would indicate the presence or absence of such an age-related decrement.

THE GROWTH OF INDIVIDUALISM: CULTURAL HISTORY AND SOCIAL CHANGE

We now move from considering bodies in isolation to bodies in relationship. Specifically we consider the relation between the body of the learner and the body of the teacher. We will discuss changes in these relations in a much broader context, as a function of cultural history and social change. Here we compare our video data from 1970 with our data from 1991 and 1993. In 1991 we returned to Nabenchauk to study the descendants, both direct and collateral, of our 1970 weaving learners.

In the decades from 1970 to the 1990s, there have been significant economic changes in the culture of Nabenchauk (Cancian 1992). Zinacantecs have taken important steps in a movement that began much earlier. They have changed from an agrarian, subsistence culture to a commercial society, and from family- and community-held land to individually owned trucks and vans. Even woven textiles are sold—both to outsiders and to other Zinacantecs. This type of entrepreneurship is part of a pattern of increasing innovation and individualism. Innovation is seen in the change

from a small, closed stock of traditional woven patterns to a constant process of pattern innovation (Greenfield 1999); each woven artifact now has many more unique features, an indication of individual expression. Commerce promotes individualism because nuclear family members are traveling in different directions independently of each other. For instance, a child might go to a nearby market to sell fruit with a neighbor or a father might drive 18 hours one way to pick up a commodity to sell. Members of a family operate more and more independently of each other, as their involvement with commerce increases.

There are several other factors in the innovation in woven patterns. Two of these are the availability of colors and the Zinacantees' increasing wealth. In the 1970s, thread was available in cotton and wool, dyed cotton thread was more expensive than white, and wool came only in natural sheep shades. Today synthetic yarns, in acrylic and metallic threads, are available in a rainbow of colors. All colors of acrylic thread are sold at the same low price. Thread is also available locally, whereas it used to be necessary to travel to San Cristobal to buy it. These facts, added to the increased wealth of the community, have enabled the proliferation of designs in both weaving and embroidery.

Although all woven garments now have some features that distinguish them from others, such as unique flower embroidery, still some basic background patterns have been maintained across the decades. Both the maintenance of tradition and innovation are found in one of the two women's shawl patterns, the *pirik mochebal*. The design rules for this shawl have stayed the same, with the mirrored stripes at the left and right edges, the same basketweave pattern in the middle part of the cloth, a variation on that pattern at the lower edge, and embroidery around the points where the tassles are tied together.

However, in comparing two particular shawls (as shown on-line—see note 1), one woven in 1969, and one woven in 1991, we found obvious differences. In the 1991 shawl, the mirrored side stripes are wider, and the color combinations are quite different. The color of the weaving in the middle part of the 1991 garment is light green, whereas before all *pirik mochebals* were predominantly grey or black with a white basket-weave pattern. The weaving at the lower edge of the newer garment is much bigger than that of the older garment. Lastly, the embroidery around the shawl-ties has become much bigger and more elaborate. The individuation of the garment is present in the varied colors and, especially, in the embroidered designs, each of which is different. The space for design individuation has grown from the small embroidered flowers and tiny striped borders of the older shawl, to the large embroidery, much broader striped borders, and a shadow design along the bottom edges.

Another illustration of increasing individuation of designs in the context of a traditional Zinacantec garment is the men's poncho, the *pok' k'u'ul*. The basic striped pattern of the *pok' k'u'ul* has also been maintained, but innovations are now made in the woven brocade patterns at the bottom of the garment and the embroidery that is added after weaving. A poncho woven in 1970 has the same basic red and white background stripe as one woven in 1991, although the ratio of red to white has increased.

There is a relative lack of individuation in the design of the 1970 version, compared to that of the 1991 version, which has distinctive embroidery and brocade bands at the bottom. (Photographs of old and new ponchos can be found on-line [see note 1].) The recent garment has unique features, while still adhering to the traditional garment shape and the striped background pattern. Thus, textile production reflects both the maintenance of tradition, in the basic stripe and basket-weave patterns, and innovation in the colors, embroidery, and brocade.

But this situation is not a stable one. Since 1991, the design rules for making woven and embroidered items have been falling by the wayside, one at a time. In 1997, even the rule that a man's poncho should have a particular striped background was broken, and, for the first time, we saw background material for a poncho woven in solid red. As traditional rules for each garment are relaxed, the potential for unique designs and individuation increases. What has stayed the same up to now is the shape of the garments, the basket-weave pattern in the *pirik mochebal*, and the important use of red in the man's poncho (*pok' k'u'ul*) and in a cotton woman's shawl (*pok' mochebal*), as well as stripes in the latter garment.

Increased innovation in Zinacantec weaving has been concomitant with increased involvement in commerce and wealth in the community. However, we do not wish to lead the reader to think that there was no innovation in the community in the 1970s. Indeed, Frank Cancian (1972) discussed innovation in Zinacantec corn farming during the late 1960s. He found that innovative practices were related to economic status. In our studies, increased community wealth is also related to innovation in textile production. Now that threads are so widely available and inexpensive, virtually everyone in the community can afford a wide array of colors. The increased innovation in weaving and embroidery has become a part of being fashionable. For each major fiesta in the community, women and teenage girls weave and embroider impressive new garments for themselves and their relatives, and the fiesta becomes a fashion show for the latest styles. Thus, though increased wealth and availability of materials have affected textile patterns, weaving has continued to reflect adherence to tradition, along with design innovation.

From Social Guidance to Independent Learning

With these changes in society in general and woven artifacts in particular, the apprenticeship of weaving in the family has shifted from a highly assisted and socially guided method of teaching to more independent, trial-and-error learning (Greenfield 1999; Greenfield et al. 1999). In 1970, weaving teachers and learners were always in close proximity to one another. At the first stage of learning, the teacher provided an observational model for the learner. At the next stage, she provided developmentally appropriate help and guidance. The learning sessions in our video database demonstrate a pattern in which the teacher, generally a member of the older generation, would enter to help the learner on the teacher's own initiative without being summoned (Greenfield 1999; Greenfield et al. 1999, in press).

In the 1990s, weaving teachers are less available and attentive to learners and are more often members of the younger generation. There is now much more independent trial-and-error learning as more innovations enter the woven patterns. Changes in the material culture of woven artifacts to a more innovative mode seem related to changes in the method by which weaving is taught and learned—that is, a movement toward more independent discovery learning. A discovery-oriented process is better adapted to innovation than is social guidance by the older generation (Greenfield and Lave 1982).

From a Single Body to Multiple Bodies in Weaving Apprenticeship

Changes in the organization of bodies in the weaving space have accompanied the changes in weaving and weaving instruction. The relationship of teacher and learner has gone from two bodies working as one single body to two independent bodies. In the past, teachers would remain quite close to their pupils, often with their arms around the learner's back, resulting in four hands on the loom, two people essentially weaving the cloth as one body. Figure 5 shows a mother helping her daughter to weave.

In the 1990s, with teachers often away from their pupils, there are more and more instances of the learner creating something on her own, as an independent body, rather than working with her teacher as one joined body. This behavior, depicted in Figure 6, exemplifies the shift from a more interdependent teaching and learning process to a more independent learning process. The weaver in Figure 6, filmed in 1991, is the daughter of the learner in Figure 5; she is the same age as her mother was when she was studied in 1970.



Figure 5: A mother (Xunka' 5) helps her daughter (Katal 1) to weave in Nabenchauk in 1970. The two are working as one body at the loom. (Video by Patricia Greenfield.)

CONCLUSIONS

Native and Non-Native Learning

The human body has a large potential to perform a wide variety of the tasks required by any culture. This potential may include certain innate characteristics that are later socially reinforced and employed in culturally important activities, as we have seen in this example of the use of the body in Zinacantec Maya weaving.

Successful weaving involves correct body position, strength, coordination, and balance, as well as the cognitive and manual skills required. Zinacantec girls are at an advantage in learning to weave because of their inherent motor stillness and their intense visual attention. As native learners, Zinacantec girls have the biology upon which culture capitalizes even before they begin to weave. Zinacantec culture capitalizes on biology by making kneeling a customary position, and through cultural norms favoring restrained movement patterns and skillful balance. While native learners do require instruction in the cognitive and manual skills of weaving, even the youngest learners need less instruction in body technique than non-native learners need. As we have seen, many everyday practices in the culture socialize the native learner for the uses of the body in weaving.



Figure 6: This teacher (Xunka' 201) the sister of the learner (Loxa 201), stands away from the learner and must be called over when help is needed. (Nabenchauk, 1991; Video by Patricia Greenfield.)

Non-native learners do not have this advantage and must be repeatedly told how to position their bodies and how to modulate the various techniques *du corps* involved in weaving. Even then, the foreign accent remains, as we have seen (Figure 4). Just as non-native learners of language need and benefit from formal instruction in the basics of a language, so do non-native learners of weaving, as their native teachers realize. Zinacantec weaving teachers appear to be extremely adept at gearing their instruction to the needs of their learners.

Finally, the study of older first-time weavers in Zinacantan does not indicate any decrement in body technique by the age of 15, leading to the conclusion that if there were a sensitive chronological period during which a native style of learning is optimized, it would extend until that age. Alternatively, the use of the body in other Zinacantec activities and play weaving at a very young age might already have stimulated the neural and physical development required for weaving within a sensitive period or developmental window. Because of the predetermined nature of the experience of growing up as a female in Zinacantec society, it would be extremely difficult to conduct a study that separates age from other factors that might influence the learning process, such as kneeling experience,

observation, and experience with a toy loom. Conversely, it would be impossible to assess how the *absence* of the various innate and experiential factors would separately affect the learning process in non-native learners.

Moving Away from Collectivism

The findings of our larger study indicate that not only do cultures change over historical time, but the very processes of cultural learning and cultural transmission also change. More specifically, the findings indicate that collective processes—the creation of relatively uniform artifacts and learning through social guidance—are emphasized when cultures are in a more stable, tradition-maintaining state. This state is associated with an agricultural economy. In contrast, individualistic processes (the creation of unique artifacts and learning through independent experimentation) are emphasized when cultures are in a more dynamic, innovation-oriented state. This state is compatible with the rise of commerce, with its emphasis on innovative entrepreneurship. As the Zinacantecs accelerated their movement from one economy to the other in the space of two decades, the emphasis in their modes of cultural learning and creation of cultural artifacts changed accordingly.

Changes in the organization of bodies in the weaving space were a logical result of this movement from the collective to the individual. As we have seen, there was a shift toward many individual bodies working in separate spaces, rather than one body, the teacher and the learner joined, working in the same space.

In conclusion, we see, through the analysis of Zinacantec weaving, that techniques *du corps* are part of a total cultural system. This system includes a biological population and everyday practices, as well as the dynamics of historical change.

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1. We acknowledge that the video frame images literally do not provide the whole picture of the body techniques and gaze direction we refer to in this paper. Additional photos and clips of the weaving videos can be found on-line at the *Ethos* website (www.cwru.edu/affil/spa/ethos.htm).

2. Numerals here and in the rest of the paper refer to family and generation identification numbers in our database.

3. Numerals in this format represent times in the individual, hour-long videotaped weaving sessions.

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