a model of the sexual division of labor

MICHAEL L. BURTON—*University of California, Irvine*
LILYAN A. BRUDNER—*University of Pittsburgh*
DOUGLAS R. WHITE—*University of Pittsburgh*

Division of labor has long occupied a prominent place in sociology and anthropology as the foundation of processes of economic specialization and exchange in human society. Division of labor by sex has gained specific recognition as a major cause of marriage and of social organization. Murdock (1949), drawing on his pioneering study of sexual division of labor (Murdock 1937), attributes the universality of marriage and the nuclear family to the sexual division of labor, which binds husband and wife into mutual dependencies; Murdock thus supports Durkheim's concept of organic solidarity. In a more recent study, Murdock refers to sexual division of labor as "the most fundamental basis of marriage and the family and hence the ultimate source of all forms of kinship organization" (Murdock and Provost 1973:203). Recent theorists (Sanday 1973) have also emphasized the importance of sexual division of labor for the status of women and place importance on some aspects of women's contributions to subsistence that had been neglected by earlier anthropologists. For example, women in hunting and gathering societies are now known to make a valuable contribution to subsistence through their gathering activities.

Attempts to explain sexual division of labor have tended to focus on physical strength and on the burdens of childbearing and child care. For example, Murdock says:

> Man, with his superior physical strength, can better undertake the more strenuous tasks, such as lumbering, mining, quarrying, land clearance, and house building. Not handicapped, as woman, by the physiological burdens of pregnancy and nursing, he can range farther afield to hunt, to fish, to herd, and to trade (Murdock 1949:7).

A more recent formulation emphasizes the constraints of child care:

> the degree to which women participate in subsistence activities depends upon the compatibility of the latter with simultaneous childcare responsibilities. Women are most likely to make a

Assumptions about economies of effort in performance of tasks in the same production sequence and assumptions about constraints on women's geographic mobility due to nursing and child care are used to derive hypotheses about the allocation of tasks in the sexual division of labor in preindustrial societies. The hypotheses constitute a locational model of the division of labor by sex that makes predictions in the form of entailments: for one sex, doing task X entails doing task Y. The predictions of the locational model are tested using a new procedure for statistical entailment analysis applied to a body of data on fifty tasks in the 185 societies of the standard cross-cultural sample. Assumptions about constraints of nursing and the effect of supplementary feeding of infants on women's participation in task activities are also tested and found to be supported from the evidence on this sample.

substantial contribution when subsistence activities have the following characteristics: the participant is not obliged to be far from home; the tasks are relatively monotonous and do not require rapt concentration; and the work is not dangerous, can be performed in spite of interruptions, and is easily resumed once interrupted (Brown 1970:1074).

We see that Murdock and Brown both emphasize that women are less able to do tasks requiring distant travel, but they differ in that Brown makes no mention of differences in physical strength. In addition, Brown makes the original suggestion that uninterruptible tasks are not consistent with the demands of child care. In our opinion, nursing is the primary interruption requiring consideration in discussions of sexual division of labor. Other interruptions by children can be obviated much more easily than the demands of infants for feeding.

Emphasis on nursing as the primary burden of child care has found a place, for example, in Zelditch's treatment of the family as a small group (Zelditch 1955). However, Zelditch overgeneralizes a functionalist assumption that every group must have instrumental and expressive specialists to reach the conclusion that women are universally the expressive specialists in the family (by their nursing activities). Reactions to such formulations have reached the opposite extreme in Aronoff and Crano's denial of the importance of sexual division of labor. Their findings supposedly "provide no support for the theoretical position of a universal principle of task segregation and sex role differentiation within the family" (Aronoff and Crano 1975:17).

Nerlove (1974) introduces a new perspective on the nursing issue by making the point that women of many societies can adopt means to reduce the constraint of nursing on women's activities. She refers not to early weaning, which rarely occurs before the age of twelve months (Barry and Paxson 1971), or to bottle feeding but to early introduction of supplementary foods in conjunction with nursing. The use of supplementary foods allows the mother to space out the periods of nursing or leave the infant with an alternate caretaker for a longer period of time and thus permits more time for subsistence tasks. As predicted, she finds through a cross-cultural test for eighty-three societies that women introduce supplementary foods at an earlier age in those societies where they make a higher contribution to subsistence.

Murdock and Provost (1973) place the study of sexual division of labor on a sound empirical footing. They code fifty different technological tasks for relative male and female contributions in each of 185 societies. Through two different modes of analysis, they find several interesting factors pertaining to the relative advantages of males and females: societal complexity, the agricultural cycle, nomadism versus sedentary residence, the properties of raw materials, processing of animal products, and sequential series.

In this paper, we formulate a model of sexual division of labor that follows the work of Murdock, Nerlove, and Brown.[1] We test it cross-culturally with data coded by Murdock and Provost (1973) and through a new procedure for the analysis of cross-cultural data, entailment analysis (D'Andrade 1976; White, Burton, Brudner, and Gunn 1975; White 1975). In the formulation of this model, we emphasize the child care constraints described by Murdock, Brown, and Nerlove in terms of a reduction of women's geographical mobility and a tendency for women not to engage in dangerous tasks. We do not rely upon assumptions concerning differences in physical strength, since constraints that derive fundamentally from childbirth and nursing are more pervasive than any constraints that derive from sexual dimorphism. In no societies are men capable of bearing children. In very few societies (depending upon the availability of baby bottles and other factors) are men more capable of nursing infants than women. However, in all societies, some women will be physically stronger than some men. The physical strength

constraint on task allocation by sex, then, is the weakest of the three constraints. Combining this argument with the fact that in many societies women regularly do heavy physical work, we find it unnecessary to invoke differences in physical strength as a factor in a general explanation for the main cross-societal patterns in the sexual division of labor.

model of sexual division of labor

We invoke two principles to account for patterns of sexual division of labor: a tendency for women not to work at great distances from home and a tendency for women to avoid doing dangerous tasks. The consideration of interruptible tasks mentioned by Brown enters into this formulation indirectly, since the frequent demands of infants for nursing will prevent mothers from going on long journeys, except when they have made an alternate arrangement for a substitute caretaker to feed the child.

We assume that human households tend to be in the center of areas that have been tamed by human effort. These centers have higher frequencies of human interaction than other locations, and are the places where children receive care. Travel that is progressively more distant from such centers takes one more and more into the natural world. We also assume that there is a strong positive correlation between such travel and the existence of various kinds of danger, mainly from animal predators and human enemies.

We assume that assignments of men and women to economic tasks are not simply a function of features of the task taken in isolation from the context in which the task is performed. Distant travel and danger lead a task to be assigned to men rather than to women. A consequence of these assumptions is that the same task, performed in two different locations, could be men's work at one location and women's work at the other location.

We assume that tasks can be arranged into production sequences. A production sequence is a set of tasks in which raw materials from some tasks are the finished products of other tasks in the set. Production activities can be arranged from the beginning to the end of a sequence. We assume that there is an economy of effort in having the same sex perform adjacent tasks in the sequence, since adjacent tasks often require similar technologies and are also often performed in similar contexts.

We also assume that raw materials for human economic activity tend to be found in the realm of nature. A consequence of this is that men will be more likely engaged in raw material production than will women, due to the factors of distance and danger.

An ethnographic example of these processes is provided by the Maasai of Loita Hills, Kenya, who were observed by one of the authors between October 1973 and June 1974. These people subsist mainly by herding cattle, sheep, and goats. Cattle are kept either at home inside a thorn fence enclosure or at a temporary camp to which they are taken when grass and water are not good near home. During the day, cattle are herded by men or boys in grasslands, which are interspersed with deep forest. Sheep and goats graze nearer to home than do cattle and are more often under the care of women. When cattle are at home, they are milked by women. However, when they are away from home at the temporary camp, they are milked by men. Animals are never slaughtered inside the boundaries of the thorn fence that encloses every homestead. Rather, they are taken into the forest to be slaughtered, where they are butchered by men. However, if a cow dies a natural death on the grassland, in an area where women commonly travel, women will participate in the butchering process. Preparation of the skins for sale or for future use is done by women inside the compound. In this example, we see distance and danger factors

at work (the forest is believed by all to be dangerous due to wild animals) to the extent that sex participation in the performance of two tasks, milking and butchering, depends upon the location where the tasks are performed.

The assumptions of our model can be combined to make predictions about the division of labor by sex within production sequences. Our assumption about similarity of adjacent tasks predicts that there will be a minimum of switching from male to female participation within a given sequence. The assumption concerning the production of raw materials in natural areas predicts that men will more likely concentrate in earlier stages of productive sequences than in later stages. From these two considerations can be derived the following generalization: if women participate in an early activity in a production sequence, then they will also participate in all later (presumably safer or less distant) activities in the same sequence. An equivalent formulation of the prediction can be stated in terms of male activities: if men participate in a late activity in a production sequence, then they will also participate in all earlier (presumably more distant and dangerous) activities in the same production sequence.

These predictions do not allow for a situation in which women perform a more distant or dangerous (and therefore earlier) activity than any activity performed by men in the same production sequence.

Given these predictions, there are five logical possibilities for the distribution of tasks across a production sequence:
 (1) all tasks in the sequence are done exclusively by men;
 (2) all tasks in the sequence are done exclusively by women;
 (3) all tasks in the sequence are shared equally by the two sexes;
 (4) the sequence is begun by men and completed by women, with an intermediate stage of equal participation by both sexes;
 (5) the sequence is begun by men and completed by women, without the intermediate stage of equal participation.

Note that two societies could correspond to types four or five for a given sequence and yet locate the boundary between male participation and female participation differently. For subsistence activities, differences in the location of that boundary will be equivalent to differences in the total amount of female contribution to subsistence. We will make two tests of the above model. The first is a test of our primary hypothesis about the ordering of male and female participation in production sequences. The second is a test of Nerlove's hypothesis about the relationship of early supplementary feeding to women's subsistence contribution in which we will use the Murdock and Provost data on sexual division of labor.

the cross-cultural sample

The data for this study consist of information concerning fifty tasks for 185 societies, as coded and reported in Murdock and Provost (1973). The societies are the members of the standard cross-cultural sample (Murdock and White 1969) less one society for which data on the division of labor were not available. The full list of fifty tasks can be seen in Table 1. In this table, the tasks are listed in descending rank order of male participation, so that tasks which are most frequently done by males are found at the top of the list. The table lists the number of societies coded within each of five categories for each task: M (exclusive male participation in the task), N (predominant male participation with some female participation), E (equal or equivalent participation between the sexes), G (predominant female participation), and F (exclusively female participation). In addition,

Murdock and Provost coded each task for its presence or absence in the society or for the presence or absence of relevant data.

Table 1. Sex allocation of 50 technological activities in 185 societies.

	Task	M	N	E	G	F
1.	Hunting large aquatic fauna	48	0	0	0	0
2.	Smelting of ores	37	0	0	0	0
3.	Metalworking	85	1	0	0	0
4.	Lumbering	135	4	0	0	0
5.	Hunting large land fauna	139	5	0	0	0
6.	Work in wood	159	3	1	1	0
7.	Fowling	132	4	3	0	0
8.	Manufacture of musical instruments	83	3	1	0	1
9.	Trapping of small land fauna	136	12	1	1	0
10.	Boatbuilding	84	3	3	0	1
11.	Stoneworking	67	0	6	0	0
12.	Work in bone, horn, and shell	71	7	2	0	2
13.	Mining and quarrying	31	1	2	0	1
14.	Bonesetting and other surgery	34	6	4	0	0
15.	Butchering	122	9	4	4	4
16.	Collection of wild honey	39	5	2	0	2
17.	Land clearance	95	34	6	3	1
18.	Fishing	83	45	8	5	2
19.	Tending large animals	54	24	14	3	3
20.	Housebuilding	105	30	14	9	20
21.	Soil preparation	66	27	14	17	10
22.	Netmaking	42	2	5	1	15
23.	Making of rope or cordage	62	7	18	5	19
24.	Generation of fire	40	6	16	4	20
25.	Bodily mutilation	36	4	48	6	12
26.	Preparation of skins	39	4	2	5	31
27.	Gathering of small land fauna	27	3	9	13	15
28.	Crop planting	27	35	33	26	20
29.	Manufacture of leather products	35	3	2	5	29
30.	Harvesting	10	37	34	34	26
31.	Crop tending	22	23	24	30	32
32.	Milking	15	2	8	2	21
33.	Basketmaking	37	9	15	18	51
34.	Burden carrying	18	12	46	34	36
35.	Matmaking	30	4	9	5	55
36.	Care of small animals	19	8	14	12	44
37.	Preservation of meat and fish	18	2	3	3	40
38.	Loom weaving	24	0	6	8	50
39.	Gathering small aquatic fauna	11	4	1	12	27
40.	Fuel gathering	25	12	12	23	94
41.	Manufacture of clothing	16	4	11	13	78
42.	Preparation of drinks	15	3	4	4	65
43.	Potterymaking	14	5	6	6	74
44.	Gathering wild vegetal foods	6	4	18	42	65
45.	Dairy production	4	0	0	0	24
46.	Spinning	7	3	4	5	72
47.	Laundering	5	0	4	8	49
48.	Water fetching	4	4	8	13	131
49.	Cooking	0	2	2	63	117
50.	Preparation of vegetal foods	3	1	4	21	145

The above table is from Murdock and Provost (1973:207).

entailments and role constraints

Predictions from the model of sexual division of labor take the logical form of entailments: if men participate in task X, they will also participate in task Y; or,

equivalently, if women participate in task Y, they will also participate in task X. This relationship is one kind of a logical *entailment*, the *inclusion relationship*: for example, societies for which men participate in task X are included in the set of societies for which men participate in task Y. Other possible entailments are mutual *exclusivity* (if men participate in task X, they will not participate in task Y), and *collective exhaustion* (in all societies, men participate either in X or in Y). We have not made predictions using the latter two entailments. Our model is concerned with inclusion entailments within production sequences.

An entailment relationship corresponds, in the cross-tabulation of dichotomous variables, to a fourfold contingency table in which one cell is equal to zero. For the inclusion entailments predicted by our model, the zero cell will be either in the upper right corner of the table or in the lower left corner of the table. Table 2a is an example for two hypothetical tasks, X and Y. Here the subscripts refer to sex participation; for example X_m means societies where males do task X. In this example, the zero cell is at the lower left. In all fifty cases where males do task X, they also do task Y. There are also twenty-five cases where males do task Y, but females do task X, and twenty-five cases where females do both tasks. An opposite example can be seen in Table 2b where we find the entailment for which, if males do task Y, they also do task X. In this example, the zero cell is at the upper right. Note that the correlations between variables X and Y are identical for the two tables, while the entailments are diametrically opposed.

The other two kinds of entailment relationships will have zero cells at the upper left (mutual exclusivity) or at the lower right (collective exhaustion).

Although our model predicts entailment relationships, it is a probabilistic model that allows some exceptions to the entailments. In actuality, we expect there to be some exceptions to our predictions due to ordinary statistical fluctuations (or due to error of observation or of coding). In testing the validity of entailment hypotheses, we will allow 3 percent of the observations to be exceptions to the predicted entailment. This results in a model of entailment relationships that is equivalent to the kind of fuzzy-set relationships described by Zadeh (1971). Table 2c is an example of an inclusion entailment with 3 percent exceptions. While the lower left cell takes on a value of three rather than zero, it can be seen that this table still expresses a very strong relationship. It could be stated as, "In almost all cases, if males do task X, they also do task Y."

Table 2a. Inclusion entailment for two tasks, X and Y.

	X_m	X_f
Y_m	50	25
Y_f	0	25

Table 2c. Inclusion entailment for X and Y with three exceptions.

	X_m	X_f
Y_m	47	25
Y_f	3	25

Table 2b. A second inclusion entailment for tasks X and Y.

	X_m	X_f
Y_m	50	0
Y_f	25	25

Table 2d. Diagonal normalization of the matrix in Table 2c.

|	X_m	X_f
Y_m	47	25
Y_f	5.64	47

The nature of entailments is such that several of them can be linked together into a structure. Our model predicts that we will find all of the inclusion entailments for a particular production sequence to be linked into a structure. The simplest such structure would be an entailment chain:

$$X_f ---- \text{(only if)} ---\to Y_f ---- \text{(only if)}----\to Z_f$$

In the above example, two entailments are linked together. This chain can be read: women do X only if women do Y and women do Y only if women do Z. An entailment chain has the same formal properties as a perfect Guttman scale. Unlike Guttman scaling, the entailment analysis allows inclusion entailments to be linked in two other ways:

a branching structure

$$X_f \overset{\nearrow \; Y_f}{\underset{\searrow \; Z_f}{}}$$
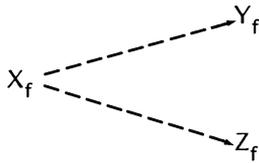
and

a convergence of entailments

$$\begin{array}{c} X_f \searrow \\ \quad Z_f \\ Y_f \nearrow \end{array}$$
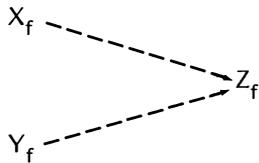
In the branching structure above, women do X only if women do Y and Z. In the convergence of entailments above, women do X or Y only if women do Z.

Our model predicts that if women produce a primary economic input then they also produce the secondary products that are made from it. A branching structure can result from a situation where several secondary products are made from a single primary input. As an example we can take the production of cow dung houses, milk, and hides from cattle. Our model will predict a branching structure as follows:

$$\text{women tend cattle} \begin{cases} \text{(only if)} -----------\to \text{women make cow dung houses} \\ \text{(only if)} ------------\to \text{women do the milking} \\ \text{(only if)} ----------\to \text{women prepare hides} \end{cases}$$
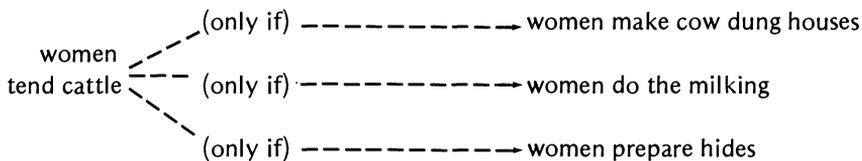
As is evident from our examples, the entailment analysis requires that the data be dichotomized as a prerequisite to the computation of fourfold contingency tables. Since the data on sexual division of labor are coded into five categories, M, N, E, G, and F (described above), we have had to make a decision as to how to dichotomize the data. The model predicts that entailment relationships will hold so long as the data are

dichotomized in terms of increasing male participation in the tasks. For example, we should be able to code all tasks so as to contrast exclusive female participation (F) with the four situations in which there is at least some male participation (G, E, N, M). Table 3 contains a cross-tabulation for two tasks that have been dichotomized in this manner: soil preparation and harvesting. Soil preparation is earlier in the productive sequence than harvesting. Therefore, our model predicts that if women participate exclusively in soil preparation, they will also participate exclusively in harvesting. It can be seen that the entailment is verified with two exceptions. Table 3 is also statistically significant (p < .02).[2]

Table 3. Cross-tabulation of soil preparation and harvesting.

| | Soil Preparation | |
Harvesting	Participation Exclusively Female (F)	Not Exclusively Female (G, E, N, M)
Participation exclusively female (F)	8	14
Not exclusively female (G, E, N, M)	2	110

p < .02, Gamma (Yule's Q) = .94, N = 134.
Entailments for Table 3: (Soil Preparation) F → (Harvesting) F. (Harvesting) G, E, N, M→(Soil Preparation) G, E, N, M.

At the opposite extreme, we could dichotomize the same data so as to contrast exclusive male participation (M) with the four situations where there is at least some female participation (N, E, G, F). In Table 4, the relationship between soil preparation and harvesting has been tabulated using that dichotomization. Now the prediction is that if women have any participation in soil preparation, they will have at least some participation in harvesting. This time the entailment is verified with no exceptions and at a higher level of statistical significance (p < .007).

Table 4. Cross-tabulation of soil preparation and harvesting.

| | Soil Preparation | |
Harvesting	Some Participation by Females (F, G, E, N)	No Participation by Females (M)
Some participation by females (F, G, E, N)	68	56
No participation by females (M)	0	10

p < .007, Gamma (Yule's Q) = 1.00, N = 134.
Entailments for Table 4: (Soil preparation) F, G, E, N→(Harvesting) F, G, E, N. (Harvesting) M→(Soil preparation) M.

Although the two extreme forms of dichotomization obtain significant results for the above example, it makes more intuitive sense to dichotomize the data so as to contrast male dominance in a task with female dominance in the same task. There are two such dichotomizations: MNE versus GF and MN versus EGF. In all data analysis for the present paper we have used both of these dichotomizations. We have also required that all results be verified for both dichotomizations with an average of less than 3 percent

exceptions for the two dichotomizations and no more than two exceptions for any one dichotomization.

Tables 5 and 6 show the cross-tabulations of soil preparation and harvesting for the two dichotomizations, MNE versus FG and MN versus EFG, respectively. In these examples, we obtain much higher levels of statistical significance because the marginals of the tables are closer to being equal.

Table 5. Cross-tabulation of soil preparation and harvesting.

| | Soil Preparation | |
Harvesting	Participation Predominantly Female (F, G)	Participation not Predominantly Female (E, N, M)
Participation pre-dominantly female (F, G)	27	28
Participation not predominantly female (E, N, M)	0	79

$p < .00000005$, Gamma (Yule's Q) = 1.00, N = 134.
Entailments for Table 5: (Soil preparation) F, G→(Harvesting) F, G. (Harvesting) E, N, M→(Soil preparation) E, N, M.

Table 6. Cross-tabulation of soil preparation and harvesting.

| | Soil Preparation | |
Harvesting	Participation by Females at Least Equal to That of Males (F, G, E)	Participation by Females Less Than Equal (M, N)
Participation by females at least equal to that of males (F, G, E)	40	48
Participation by females less than equal (M, N)	1	45

$p < .00005$, Gamma (Yule's Q) = .95, N = 134.
Entailments for Table 6: (Soil preparation) F, G, E→(Harvesting) F, G, E. (Harvesting) M, N→(Soil preparation) M, N.

The predictions from our model can also be tested using data that have not been dichotomized, through a slight reformulation of the predictions: to the extent that females participate in task X, they will also participate to an equal or greater extent in task Y, where task X is more distant than, more dangerous than, or earlier in the production sequence than task Y.

We have made a single test of the model in this formulation, again for the relationship of soil preparation to harvesting. This test can be seen in Table 7, which contains the 5x5 contingency table for these two variables. The significance level for this table is extremely high. Out of 134 societies, there are only three cases where the extent of female participation in soil preparation exceeds the extent of female participation in harvesting.

Table 7. Cross-tabulation of soil preparation and harvesting,
without dichotomizing the data.

Harvesting	Soil Preparation				
	F	G	E	N	M
F	8	4	3	0	7
G	2	13	1	5	12
E	0	0	9	13	11
N	0	0	1	9	26
M	0	0	0	0	10

Pearson's r = .561, Gamma = .84.
Asymmetric distribution significant at p = .000000005.

measurement models for statistical entailments

Conventional correlation coefficients are not appropriate to the measurement model of predicted entailments. This is illustrated in Table 7, where the relationship between participation in soil preparation and harvesting is clearly not linear.[3] Pearson's r correlation (.561 for Table 7), which assumes linearity, loses information about the J-distribution typical of entailments. The associated variance measure (r^2) is also inapplicable. The entailment predictions for Table 7 are 98 percent accurate, although r^2 is only .31. The significance test associated with Pearson's r fails as well.

The Gamma coefficient, which is sensitive to zero cells in fourfold tables (going to +1 or −1 as the distribution approaches the J types), also loses information about entailment distributions in larger (NxM) tables. This is illustrated by a comparison of the dichotomized Tables 3 through 6 with the full 5x5 distribution in Table 7. The average Gamma for the four possible dichotomizations of soil preparation and harvesting is +.97, yet the Gamma for the 5x5 table for the same variables shows a Gamma of only +.84. Further, the Gamma coefficient cannot communicate the direction of an entailment, as noted above.

An appropriate measure for strength of an entailment prediction is the confirmation index (Goodman and Kruskal 1974). A simple confirmation index is the proportion of the total population of cases falling in predicted zero cells, or proportion of exceptions. This simple index is defective, however, when the marginal totals of the table are badly skewed. Goodman and Kruskal suggest normalizing the marginal totals of the element to be predicted. This is not satisfactory for our purposes since every prediction of the form "If X then Y" is also a prediction "If not Y then not X." Neither is normalization of both rows and columns (Romney 1971) appropriate since this forces a J-type distribution into a symmetrical mold. Our solution is to normalize the table based on the entries in the diagonal: multiply either the rows or columns, depending upon which are more skewed, by a constant of proportionality that leaves all of the diagonal entries equal. For Table 2c, where the rows are skewed, the diagonally normalized matrix would be as shown in Table 2d. The index of confirmation for this table is .045.

The use of diagonal normalization, then, will enable us to compute indices of confirmation that are not biased by skewed marginals. These will serve as a replacement

for the conventional correlation coefficients, which are not applicable to this form of hypothesis testing. The statistical significance of zero cell or near-zero cell tables, however, can be evaluated in a standard way by use of the binomial test, without normalizing the tables.

data analysis and results

The data analysis of this paper consists of two parts. The first of these is an analysis of entailment relationships in the Murdock and Provost data on sexual division of labor. The second part consists of an examination of relationships between Nerlove's data on supplementary feeding of infants and the data on sexual division of labor.

entailment analysis of the Murdock and Provost data   For each dichotomization of data (MNE versus FG and MN versus EFG) we computed fourfold contingency tables for all pairs of tasks. In all, there are 1,225 such contingency tables. Of these tables, we were interested in tables that expressed inclusion entailments with fewer than 3 percent exceptions.

Several of the tasks have little or no variability with respect to sexual division of labor. Such tasks cannot possibly enter into statistically significant entailment with other tasks. Hunting of large aquatic fauna, for example, is done exclusively by males in all forty-eight societies for which it occurs. We have computed entailments for all tasks that have marginals greater than two for both dichotomizations. The requirement that all marginals be greater than two would result in the deletion of sixteen tasks, fifteen of which are rarely done by women and one of which (cooking) is rarely done by men. However, we included cooking in the analysis because it has the least missing data. Of the thirty-five tasks included there are 513 contingency tables with sufficient data for analysis.

Our analysis would produce some tables with zero cells even if the data were random. We have used the binomial test to compute the number of zero cells that would be expected by chance for one of the two dichotomizations (MNE versus FG). We find that we expect eighty-five zero cell tables by chance for this dichotomization, of which forty-four would be inclusion entailments, twenty-five would be mutual exclusion entailments, and sixteen would be collective exhaustion entailments. Table 8 shows the number of entailments expected by chance and the number found by our analysis. It focuses on the contrast between inclusion entailments, which we have predicted to occur for our data, and the other two kinds of entailments (mutual exclusion and collective

Table 8. Comparison of entailments expected by chance with those found in analysis for dichotomization (MNE versus FG).

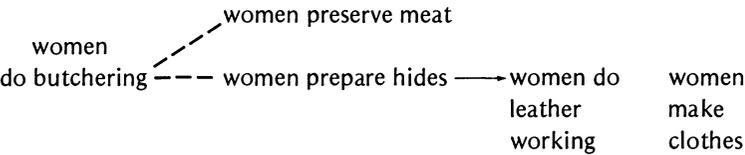|	Number Expected by Chance	Number Found by Entailment Analysis
Inclusion entailments	44	66
Mutual exclusion and collective exhaustion entailments	41	25

$x^2 = 17.24, p < .0005.$

exhaustion), which we have not predicted for our data. We can see from Table 8 that there are many more inclusion entailments than would be expected by chance and that there are many fewer mutual exclusion and collective exhaustion entailments than would be expected by chance (p < .0005). The analysis using the other dichotomization of the data (MN versus EFG) produces similar results. We can conclude that data on sexual division of labor primarily contain a structure of inclusion entailments, with very few mutual exclusion or collective exhaustion entailments.

Of the sixty-six inclusion entailments for the dichotomization (MNE versus FG), we have accepted those that are replicated for the other dichotomization and that are statistically significant at a probability level of p ≤ .35 for both dichotomizations. In addition, we have allowed inclusion entailments with up to 3 percent exceptions, also with the requirement of statistical significance at p ≤ .35 for both dichotomizations.

a specification of the exact predictions of the model[4]   In the earlier part of the paper, the model of sexual division of labor is formulated so as to allow general predictions. In order to be able to test the model it is necessary to make specific predictions concerning entailments among the thirty-five remaining tasks in the Murdock and Provost sample. We find twenty-one of these thirty-five tasks to be arranged into six production sequences for which we can make predictions concerning entailments. These are listed below.

meat and hide processing   This sequence includes five tasks: butchering, preservation of meat and fish, preparation of hides or furs, leather working, and manufacture of clothing. Butchering is the primary activity that produces meat and hides, and the hides are used as input to leather working and manufacture of clothing. Thus, the predicted entailment structure is:

```
                         women preserve meat
      women          ⟋
do butchering ⎯ ⎯ ⎯ women prepare hides ⎯⎯→women do      women
                                           leather     make
                                           working     clothes
```

tending domesticated animals   This sequence includes four tasks: tending large domesticated animals, tending small domesticated animals, milking, and dairying. Milk is derived from large animals and is used as an input to dairy products. Small animals tend to be herded closer to home than large animals. Therefore, on distance criteria, we predict that if women tend large animals, they will also tend small animals. These considerations lead to the following predicted structure:

```
                    women tend
               ⟋⟋  small animals
women tend ⟨
large animals   ⟍
                  ⟍
                    women do milking ⎯⎯⎯→ women manufacture
                                          dairy products
```
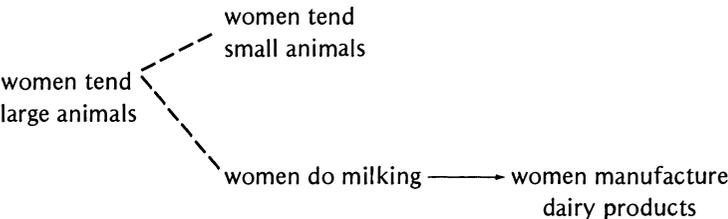
textiles   There are only two tasks, spinning and loom weaving, in this sequence. Spinning produces the primary input to weaving. Our model predicts that if women do spinning, they will also do loom weaving.

fishing   Two tasks, fishing and shell fishing, are not arranged in a production sequence. However, many societies have both activities, and shell fishing is done closer to home and in conditions that are usually less dangerous than those for fishing. Therefore, using the criteria of danger and mobility, we predict that if women do fishing they also do shell fishing.

agriculture   in this sequence, five activities make up the agricultural cycle: clearing land, preparing the soil, planting, tending crops, and harvesting.

A straightforward application of the model concerning production sequences would predict the following chain from earliest activity to latest activity:

women clear land — — — —→ women prepare soil ———→ women plant ———————→

women tend — — — —→women harvest crops

Some readers may have qualms about this particular interpretation of the model. The prediction concerning production sequences was derived from distance notions by assuming that primary products are obtained in locations distant from home. Clearly, all stages of the agricultural cycle may be enacted in the same location. However, if we return to our earlier considerations about the contrast between natural regions and areas that are under human control, it is evident that a plot of land becomes more and more tamed by human effort as it is cleared and prepared for planting. These considerations would lead to the following prediction:

women clear land — — — —→ women prepare soil ⇄ → women tend crops

with branches to: women plant, women harvest

vegetal foods   Here there are three tasks, gathering of wild vegetals, preparation of vegetal foods for cooking, and cooking. Our prediction is that if women gather wild vegetals they also prepare vegetal foods for cooking, and if women prepare vegetal foods for cooking they do cooking.

results of the entailment analysis   Table 9 lists the inclusion entailments that satisfy the criteria listed above and that fall within the six production sequences. As an aid to reading the table, we can take the first line as an example. We find that if women participate in butchering, they also participate in preparation of hides. The entailment was tested on a sample of seventy-one societies for which both tasks were present and information was available concerning the sexual division of labor. For the dichotomization of MNE versus GF, there were two exceptions to the entailment, the level of statistical significance was .24, Yule's Q^5 was .57, and the index of confirmation was .13. For the dichotomization of MN versus EGF, there were also two exceptions to the entailment, the level of statistical significance was .13, Yule's Q was .66, and the normalized index of confirmation was .09. On the next line we see the entailment that states that if women do butchering, they also do leather working. Results of the entailment analysis for production sequences are discussed below, one sequence at a time.

Table 9. Production sequence entailments.

Entailments — If women participate in A	they will also participate in B	Sample Size N =	MNE/GF p =	MNE/GF Exc.	MNE/GF Q	MNE/GF C	MN/EGF p =	MN/EGF Exc.	MN/EGF Q	MN/EGF C
Butchering	→ Preparation of hides	71	.24	2	.57	.13	.13	2	.66	.09
	→ Leather working	65	.09	1	.80	.06	.14	2	.65	.09
	→ Preservation of meat	56	.46*	1	.41	.06	.52*	1	.33	.06
	→ Manufacturing of clothing	95	.39*	1	.45	.04	.52*	1	.29	.02
Preparation of hides	→ Leather working	70	.001	2	.996	.02	.001	1	.998	.02
	→ Preservation of meat	41	.06	1	.85	.05	.07	1	.85	.06
	→ Manufacturing of clothing	67	.001	2	.91	.05	.004	1	.996	.03
Leather working	→ Preparation of hides	70	.001	1	.996	.03	.001	1	.998	.02
	→ Preservation of meat	38	.03	1	.91	.05	.05	1	.89	.05
	→ Manufacturing of clothing	65	.001	1	.96	.02	.003	1	.93	.03
Tending large animals	→ Tending small animals	48	.21	1	.69	.06	.18	2	.55	.05
	→ Milking	48	.20	0	1.00	.00	.09	1	.77	.03
	→ Dairying	28	nd[†]	0	nd[†]	nd[†]	.36*	0	1.00	.00
Milking	→ Dairying	28	.09	0	1.00	.00	.04	0	1.00	.00
Cordage	→ Loom weaving	45	.02	0	1.00	.00	.18	2	.58	.04
	→ Spinning	50	.11	0	1.00	.00	.14	0	1.00	.00
	→ Manufacturing of clothing	70	.005	0	1.00	.00	.05	2	.71	.05
Net making	→ Manufacturing of clothing	38	.20	1	.67	.03	.04	0	1.00	.00
Loom weaving	→ Spinning	72	.002	0	1.00	.00	.06	1	.90	.08
Fishing	→ Manufacturing of rope/cordage	88	.08	1	.91	.10	.10	2	.74	.12

Table 9 (cont'd.).

Entailments		Sample Size		Replications* (p < .35)						
If women participate in *A*	they will also participate in *B*			MNE/GF				MN/EGF		
		N =	p =	Exc.	Q	C	p =	Exc.	Q	C
	→ Shell fishing	53	.24	0	1.00	.00	.13	0	1.00	.00
Clearing land	→ Preparation of soil	132	.04	0	1.00	.00	.01	1	.92	.05
Preparation of soil	→ Planting	134	.001	2	.96	.03	· .001	2	.94	.02
	→ Tending crops	126	.001	2	.93	.03	.001	1	.95	.01
	→ Harvesting	134	.001	0	1.00	.00	.001	1	.95	.01
Planting	→ Preparation of vegetals for cooking	136	.27	1	.56	.03	.34	1	.61	.09
Tending Crops	→ Fetching water	110	.08	1	.77	.04	.08	0	1.00	.00
Preparation of vegetals for cooking	→ Cooking	174	.28	1	nd[†]	nd[†]	.22	2	nd[†]	nd[†]

*Transitive chains need not meet significance levels of p < .35, but must have fewer than 3 exceptions.

[†]Insufficient data but no exceptions (transitive relation).

processing animal products   By examining Table 9 and the associated graph from Figure 1, we can see that the predictions from the model are very closely matched for this sequence. The structure begins with butchering, which is the primary activity. If women do butchering they also do all of the other four activities, with a maximum of two exceptions. Leather working and preparation of hides are secondary activities, and are very close to being equivalent. If women do leather working they also do hide preparation, with one exception, and vice versa, with a maximum of two exceptions. This differs slightly from our model, which placed leather working and hide preparation at adjacent stages in the production sequence. Another difference is that there is an entailment from leather working and hide preparation to preservation of meat and fish. If women do either of the former activities, then they do the latter activity. In our model, meat preservation was on a separate path from the other activities. The data show it to be a tertiary stage of the same path. Finally, manufacture of clothing is also a tertiary activity. If women do leather working or hide preparation they also manufacture clothing.

tending domesticated animals   Entailments for this sequence are exactly as predicted by the model and are represented graphically in Figure 2. As predicted, if women tend large animals they also tend small animals. Furthermore, if women tend large animals they also do the milking, and if they do the milking they also do the dairying.
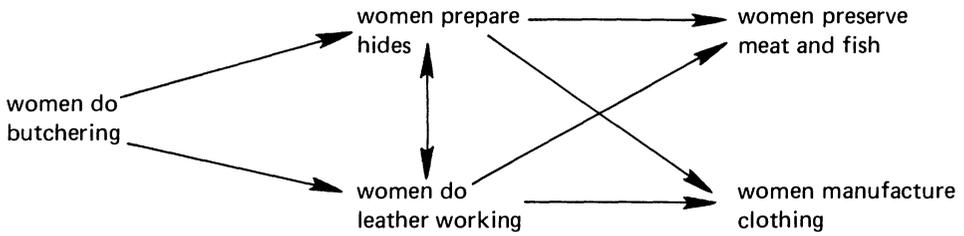
Figure 1. Entailogram for the animal products sequence.
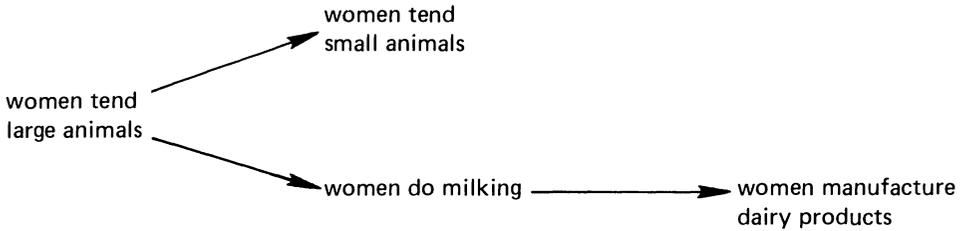

Figure 2. Entailogram for animal tending sequence.

textiles   Here we find many more entailments than were predicted, and we also find that our single prediction concerning spinning and loom weaving has been reversed (Figure 3). If women do loom weaving they also do spinning. Spinning, then, is the activity that is most frequently done by women. It seems clear that spinning is also more of a household task than loom weaving, at least in more complex societies where weaving may become an occupational specialty that is done in a workshop rather than in the home. Thus, the entailment from loom weaving to spinning does not contradict our model. Rather, it causes a reformulation of the interpretation we had made of part of the model.

Figure 3. Textiles and fiber processing sequence.

In addition, we find that if women manufacture rope and cordage they also do loom weaving and clothing manufacture, and that if women do net making they also manufacture clothing.

fishing   As can be seen in Figure 4 the single prediction for fishing and shell fishing is verified. There is also an entailment from fishing to rope and cordage. The fishing structure could be attached to the textile structure to form a single entailogram.

vegetal food processing and agriculture   In Figure 5 we find that the last two sequences have been merged into one. Our predictions are verified concerning land clearing, soil
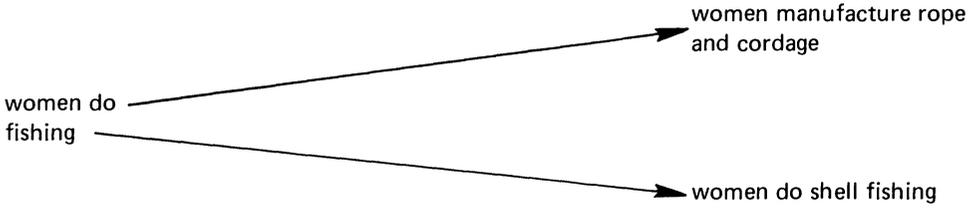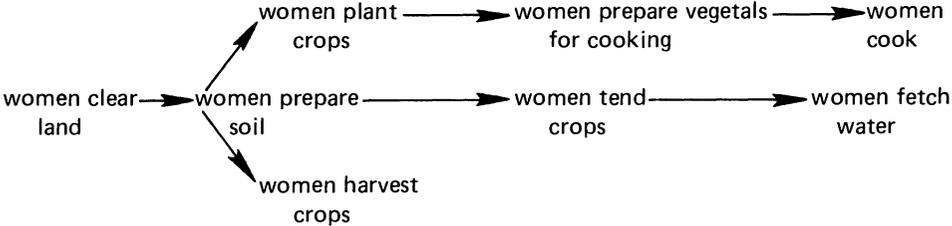
Figure 4. Fishing entailogram.

Figure 5. Vegetal food processing and agriculture entailogram.

preparation, planting, crop tending, and harvesting. As we have noted before, the levels of statistical significance for some of these entailments are unusually high. The predicted entailment from gathering wild vegetals to preparation for cooking does not appear. Instead, there is an entailment from planting crops to preparation of vegetals for cooking. This single structure links all stages of food production and consumption, from clearing the land to cooking food.

evaluation of the predictions of the model As might be expected, our method of analysis found some inclusion entailments that did not fall within production sequences. There are thirty-eight entailments (Table 9) that are accounted for on the basis of our predictions. In Table 10 we see that there are an additional sixteen entailments (all of the inclusion type) that were not predicted. Our model thus accounts for roughly 70 percent of the inclusion entailments in the data. Examination of the remaining 30 percent of the entailments (Table 10) suggests that they are not the result of random processes. For example, over half of these entailments are accounted for by items in the processing-of-animal-products sequence (butchering, preparation of hides, leather working) that have entailments with sex participation in various crafts (matting, basketry, pottery). These are obviously not within the same production sequences but involve domestic production sequences with overlapping technology. None of the entailment findings suggests any major contradictions to the model.

a scalogram analysis of the vegetal food processing chain As we have stated above, an entailment chain corresponds to a scalogram. We have such a chain for five activities, which can be used to illustrate the similarities and differences between entailment analysis and scalogram analysis. This chain (Figure 5) begins with clearing land and goes sequentially to soil preparation, crop planting, preparation of vegetal foods for cooking, and cooking. In the scalogram analysis we include only these five items and exclude the other tasks that appear in the entailogram but that branch off from the chain. The major

Table 10. Entailments not accounted for by the predictions.

| Entailments | | Sample Size | Replications* (p < .35) | | | | | | | |
| | | | MNE/GF | | | | MN/EGF | | | |
		N =	p =	Exc.	Q	C	p =	Exc.	Q	C
Butchering	→ Mat making	78	.17	0	1.00	.00	.28	1	.57	.04
	→ Pottery making	87	.52*	0	1.00	.00	.77*	1	nd	nd
	→ Basket making	99	.43*	1	.48	.10	.70*	3	nd	nd
Preparation of hides	→ Mat making	42	.14	1	.73	.03	.03	0	1.00	.00
	Pottery making	48	.09	1	.77	.03	.16	1	.70	.04
	Basket making	53	.002	0	1.00	.00	.005	0	1.00	.00
	→ Laundering	25	.27	0	1.00	.00	.27	0	1.00	.00
Leather working	→ Mat making	38	.08	1	.81	.03	.04	0	1.00	.00
	→ Pottery making	46	.09	1	.77	.03	.13	1	.73	.03
	→ Basket making	47	.001	0	1.00	.00	.007	0	1.00	.00
Manufacturing of rope/cordage	Gathering of wild → vegetals	90	.21	2	.48	.03	.29	1	.58	.06
Clearing land	Manufacturing of → rope/cordage	85	.15	1	.90	.13	.05	2	.82	.11
	Fuel → collection	125	.29	0	1.00	.00	.32	1	.49	.02
House building	Gathering of wild → vegetals	132	.03	1	.78	.008	.07	0	1.00	.00
	Pottery → making	101	.14	0	1.00	.00	.17	1	.63	.01
	Preparation → of drinks	88	.34	1	.49	.03	.22	1	.59	.01

*These relationships are not statistically significant, but pottery making and basket making are entailed by preparation of hides and by leather working, which in turn are entailed by butchering.

difference between an entailogram and a scalogram is that a scalogram does not allow branchings or convergences.

Figures 6 and 7 show scalograms for the five tasks in the vegetal food chain. Figure 6, using the dichotomy FG/ENM, shows the cumulative order in which females predominate

in the five tasks. Clearing the land is the least common activity for females and cooking is the most common activity for females. This scalogram has a total of five scale errors and a coefficient of reproducibility of .993.

In both Figures 6 and 7 the right hand column lists the proportions of societies from among the 144 agricultural societies in our sample that correspond to the different scale types. Type 5 in Figure 6, where females do all five of the tasks, is found in 3 percent of the societies, whereas Type 0 for Figure 7, where males do all five of the tasks is found in only 1 percent of the societies. Thus a single sex rarely performs all five tasks exclusively. For both scales, the most frequent type is 2 where women prepare vegetals and do the cooking and leave the agricultural tasks to men (Type 2).

Figure 8 is a scalogram for the five tasks based on a distinction between male predominance (M, N), equal participation (E) and female predominance (F, G). This scalogram has twenty-one scale types that are listed in order of decreasing female participation in the tasks. This figure lists for each scale type: (a) the number of instances of the scale type with full data, (b) the number of instances of the scale type with some missing data, and (c) the number of exceptions to the scale type. Out of 704 specific predictions which are made by this scalogram, there are only nine exceptions (99 percent

			Scale Items			Proportions of Agricultural Societies	
Scale Type:	Clearing of Land	Preparing of Soil	Planting of Crops	Preparation of Vegetables for Cooking	Cooking	No.	%[†]
5	F	F	F	F	F	4	3
4	—	F	F	F	F	20	14
3	—	—	F	F	F	18	13
2	—	—	—	F	F	86	61
1	—	—	—	—	F	8	6
0	—	—	—	—	—	3	3
							100

Error Types:

2*	—	F	—	F	F	2	
1*	—	—	F	—	F	1	
0*	—	—	—	F	—	2	
						144	Total

Key: F = females predominate in the task activity;   — = females do not predominate.

$$\text{Reproducibility} = \frac{\text{Correct Predictions}}{\text{Total Cells} - \text{Missing Data}} = \frac{699}{704} = .993$$

*lowest consistent pattern of F's

[†]percentages include error types

Figure 6. Scalogram for the dichotomy FG/ENM (females predominate versus all other).

	Scale Items					Proportions of Agricultural Societies	
Scale Type:	Clearing of Land	Preparing of Soil	Planting of Crops	Preparation of Vegetables for Cooking	Cooking	No.	%[†]
5	–	–	–	–	–	8	6
4	M	–	–	–	–	33	25
3	M	M	–	–	–	36	25
2	M	M	M	–	–	59	42
1	M	M	M	M	–	2	1
0	M	M	M	M	M	1	1
							100

Error Types:

5*	–	M	–	–	–	1	
4*	M	–	M	–	–	2	
3*	M	–	–	M	–	1	
2*	M	M	M	–	M	1	
						144	Total

Key: M = males predominate in the task activity; – = males do not predominate.

Reproducibility = $\dfrac{699}{704}$ = .993

*lowest consistent pattern of M's

[†]percentages include error types

Figure 7. Scalogram for the dichotomy MN/EGF (males predominant versus all other).

accuracy). Six of these exceptions consist either of an E where the model would predict an M or an F or of an M or F where the model would predict an E. Thus, all three forms of scalogram analysis correspond very closely to the data for the vegetal food processing chain.

Two generalizations can be made from the results in Figure 8. First, for the vegetal food processing sequence, equal participation of the two sexes in any task is rare. Scale types for which more than one of the tasks are shared equally account for only thirteen out of 144 societies. Secondly, the most frequent scale types are those (Scale Types 12 and 13) that divide the sequence approximately in half. Furthermore, 76 percent of the agricultural societies fall within four of the twenty-one types:

(1) MFFFF (Type 3)
(2) MMFFF (Type 7)
(3) MMEFF (Type 12)
(4) MMMFF (Type 13)

Thus, for the vegetal food sequence, the data show strong division of labor for individual tasks with sharing of responsibility between the sexes for the entire sequence.

Scale Types	Clearing Land	Soil Preparation	Crop Planting	Preparing of Vegetals for Cooking	Cooking	Full Data	Partial Data	Scale Exceptions	Totals (including Exceptions)
1	F	F	F	F	F	4			4
2	E	F	F	F	F	1			1
3	M	F	F	F	F	18	1	2 Jivaro Amahuaca	21
4	E	E	F	F	F				
5	E	E	E	F	F	2			2
6	M	E	F	F	F	3		1 Ifugao	4
7	M	M	F	F	F	13		1 Tiv	14
8	M	E	E	F	F	5	1		6
9	E	E	E	E	F		1		1
10	E	E	E	E	E				
11	M	E	E	E	E		1	1 Kwoma	2
12	M	M	E	F	F	20	2	2 Marquesans Basques	24
13	M	M	M	F	F	47	5		52
14	M	M	E	E	F				
15	M	E	E	E	E				
16	M	M	E	E	E	1			1
17	M	M	M	E	F	2			3
18	M	M	M	M	F	2			2
19	M	M	M	E	E		1		1
20	M	M	M	M	E				
21	M	M	M	M	M	1		1 Samoans	2
									144

Societies where soil preparation is not done prior to planting:

Scale Types	Clearing Land	Soil Preparation	Crop Planting	Preparing of Vegetals for Cooking	Cooking	Full Data	Partial Data	Scale Exceptions
12*	M		E	F	F	1		
12*	M		F	F	F	1		
13	M		M	F	F	2		
17	M		M	E	F			1 Orokaiva

Societies which have exceptional task patterns:

3	M	F	E*	F	F	Jivaro, Amahuaca
7	E*	M	F	F	F	Tiv
6	M	E	F	M*	F	Ifugao
11	M	E	M*	E	F	Kwoma
13	M	M	M	F	E*	Marquesans
13	M	E*	M	F	F	Basques
17	E*		M	E	F	Orokaiva
21	M	M	M	F*	M	Samoans

Key: M = M or N (males predominate); E = E (equal sex participation);
F = G or F (females predominate).

Figure 8. Scalogram of the five vegetal food processing tasks (MN versus E versus GF)

Although part of the entailment in Figure 5 corresponds to an almost perfect Guttman scale, it would have been a mistake to attempt to perform scalogram analysis on the entire body of data on sexual division of labor. A scalogram analysis of the tasks that appear in Figure 5 would achieve a high coefficient of reproducibility. At the same time, it could mislead the investigator into ignoring the structural details that are brought out by the entailment analysis.

The two kinds of analysis are both suitable for models such as the present one, which predicts asymmetrical relationships between variables. The major difference between them is that the scalogram analysis is more restricted with respect to the kinds of structures of relationships that it can consider. Both kinds of analysis contrast with correlational analysis in that they allow for asymmetrical relationships.

Although our model has used the same concept of sequential series that was described by Murdock, we have reformulated it so as to predict asymmetrical entailments among tasks. Murdock's formulation, "a general tendency for the sex which uses a product to be the same as the sex which produces it" (Murdock and Provost 1973:212), is stated in a symmetrical form. We find it to be equivalent to our assumption that adjacent tasks in a production sequence will tend to be done by the same sex. Our reformulation of Murdock's thesis consists of the addition of the asymmetrical entailment predictions that have been tested above.

production sequences may override "nurturance" tasks   Contrary to Zelditch (1955), some of the basic "nurturance" activities of women may be overridden by production sequence tasks. Nerlove's study of supplementary feeding (Nerlove 1974) shows that high feminine contributions to subsistence are associated with early supplementary feeding of infants. As a further test of this hypothesis, we have computed correlations between the sexual division of labor variables and the Barry and Paxton (1971) codes for supplementary feeding. These correlations are listed in Table 11 for five types of tasks: agricultural food production, domestic animal tending, intermediate processing of raw materials, crafts, and domestic activities. A positive correlation indicates a relationship between increased feminine participation in the task and early supplementary feeding.

We find that the predicted correlations hold for most subsistence tasks, particularly milking and the three agricultural tasks, soil preparation, planting, and crop tending. Opposite correlations hold between the age of supplementary feeding and most domestic

Table 11. Correlations of early supplementary feeding of infants
with women's participation in selected activities.

	Pearson's r =	Significance p =	Sample N =
Agricultural Food Production			
Clearing land	+.004	.49	69
Soil preparation	+.15	.13	65
Planting	+.14	.12	70
Tending crops	+.35	.002	64
Harvesting	+.006	.48	70
Domestic Animal Food Production			
Tending small animals	+.02	.44	50
Tending large animals	−.02	.46	40
Milking	+.31	.11	17
Intermediate Processing of Raw Materials			
Hide working	−.21	.11	35
Spinning	−.09	.28	42
Loom weaving	+.13	.22	36
Crafts			
Mat making	−.14	.15	58
Net making	−.44	.002	39
Basket making	−.19	.05	71
Manufacture of rope and cordage	−.23	.04	55
Leather working	−.26	.08	33
Manufacture of stone artifacts	−.19	.14	36
Domestic Activities			
Fire making	−.19	.14	36
Laundering	−.30	.05	44
House building	−.13	.11	87

crafts, such as net making, basket making, and leather working. Intensive participation by women in agricultural tasks is associated with early supplementary feeding of infants, whereas participation by women in domestic crafts activities is associated with later supplementary feeding. Thus, the requirements of main production sequences may reduce the allocation of time by women for nursing and child care.

summary and conclusion

Studies of sexual division of labor using an entailment analysis of Murdock and Provost's codings for fifty tasks show a very strong correspondence between theory and data, with at most two exceptions on each of more than thirty contingency tables. These predictions are reached using a model that considers only the factors of distance of the task from home and danger. Specifically, we emphasize the context in which the task is performed rather than any possible context-free definition of the task in terms of physical difficulty, technical expertise, or qualities of the materials being processed. In addition, we find further evidence to support Nerlove's hypothesis that increased female participation in subsistence tasks, particularly in agriculture, is facilitated by early supplementary feeding of infants. These results taken together support the notion that

childbirth and nursing of infants are the main constraints on the sexual division of labor. They generate a strong universal tendency for men to be allocated tasks within production sequences beginning with the more distant and dangerous (often primary in the sequence) and for women to be allocated tasks in production sequences beginning with low risk tasks closer to home. This does not rule out, however, the possibilities of either sex dominating an entire production sequence or of both sexes dividing tasks equally across an entire production sequence or any intermediate portion thereof.

notes

[1] We would like to thank G. P. Murdock, A. K. Romney, and R. N. Adams for their detailed comments on an earlier paper on this topic. Also thanks to R. Kozelka, J. M. Roberts, D. B. Kronenfeld, M. Orans, J. Kirk, and M. Butler. Our colleague Joel Gunn has put a considerable amount of effort into aspects of the data analysis reported in the earlier paper. Willett Kempton helped in improving the final version of the entailment analysis computer program developed by D. White at the University of Texas, Austin.

[2] Significance levels for contingency tables were computed using a one-tailed binominal test, which computes the probability of obtaining by chance a table with as many or fewer exceptions to the entailment relation as were observed, assuming fixed marginals.

[3] There is another means of testing for nonlinearity between ordinal measures (Goodman and Kruskal 1974), referred to as a test of quasi independence. When rows and columns containing predicted zero cells are removed, for example, from Table 7 (columns F and G for soil preparation and rows M and N for harvesting), the positive correlation between the two variables essentially disappears (Gamma = −.40) the remaining 3x3 table does not differ from the null hypothesis of statistical independence ($X^2 = 8$, $p > .5$).

[4] Parts of our model were formulated before the data analysis was begun, and parts were formulated as a result of our attempts to systematize our thinking about the results of the entailment analysis. Our aim has been to formulate a model that was consistent with our findings and with the findings of other researchers, that was logically tight, and that had a minimum of unnecessary assumptions. The predictions are logical consequences of the model as it has evolved through interaction with the data analysis. As the reader may suspect, the predictions in their present form were derived after the data analysis had been completed. Their purpose is to show the ways in which the model is or is not compatible with the data.

[5] Yule's Q ranges from −1 to +1. It will always take a value of +1 if there is a perfect inclusion relationship in either direction. It will take a value of −1 if there is a perfect (zero cell) entailment of mutual exclusion or collective exhaustion. The index of confirmation ranges from zero to +1. It is zero if there are no exceptions to the entailment, and +1 if all cases are exceptions to the entailment.

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