# Entailment Theory and Method: A Cross-Cultural Analysis of the Sexual Division of Labor<sup>1</sup>

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The purpose of this paper is to explore a more precise form for theoretical propositions in certain types of cross-cultural problems and to develop and explicate an accompanying statistical method. An inductive application of the method for entailment analysis has led us to formulate a new and powerful theory of the sexual division of labor.

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Division of labor has long occupied a prominent place in sociology and anthropology as the foundation of the processes of economic specialization and exchange in human society. In a recent study, Murdock and Provost (1973a: 203) refer to the 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." Other recent theorists (e.g. Sanday 1973) have emphasized the importance of sexual division of labor to the status of women.

In developing the present model of sexual division of labor, we have tried to veer from the shoals of extreme functionalist assumptions, which, when linked to sex differences, have led to the conclusion that men and women universally

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divide the instrumental and expressive functions between them (Zelditch 1955) and the extreme relativist position, such as Aronoff and Crano's assertion (1975) that Murdock and Provost's data "provide no support for the theoretical position of a universal principle of task segregation" between the sexes. We will argue that there are, indeed, universal principles of task differentiation, which are not absolute, but which form various kinds of probabilistic constraints on the division of labor by sex. Some of these constraints will be shown to have major theoretical implications. If we consider some of the constraints of task allocation discussed by Judith Brown (1970), we can, for females, rank childbearing, nursing, and child care along a continuum in terms of the extent to which they necessarily occupy or constrain aspects of women's activities. While there is no alternative for childbearing, the extent to which nursing exerts a constraint on women's time can be reduced, for example, through the early introduction of supplementary feeding. Nerlove (1974) has shown that in societies where women predominate in agricultural labor, early supplementary feeding is frequently introduced to infants, allowing lactating mothers to spend more time away from the nursing task. With child care, the range of alternatives increases even further. Many other people than the mother can care for the child, including elder siblings, co-wives, grandparents, schoolteachers, and the child's father. Indeed Pasternak, Ember, and Ember (1976) argue that social organizations tend to adapt to the need for alternative caretakers to the mother, so that societies in which women perform roles which are inconsistent with child care tend to develop extended families. Murdock and Provost (1973a) have argued that in addition to the constraints placed on women's activities and mobility by childbearing, nursing, and child care, the greater physical strength of men causes the assignment of certain tasks to males. While we do not deny that humans exhibit sexual dimorphism, this constraint must be considered to be highly probabilistic, since (a) there is great plasticity in the development of physical strength, allowing for large crosscultural diversity in the degree of difference between adult males and females on physical strength; and (b) many tasks require relatively little physical strength. Given these constraints, we now consider the division of labor by sex as a universal problem concerning the allocation of personnel to tasks. We hypothesize that factors of efficiency are of universal importance in the following ways:

- 1. There are economies of effort in having the same persons perform adjacent tasks in production sequences, since adjacent tasks often require similar technological skills, and are often performed in similar contexts.
- 2. There are economies in assigning tasks in clusters which are based on physical locations and temporal sequences of the tasks.
- 3. There are diseconomies in the use of human resources roughly in proportion to the extent that adult females and infants are exposed to danger—diseconomies in that females are the source of reproduction, and infants are relatively defenseless.

On the basis of these economies, we would expect that adult females would be more likely to be assigned to tasks which are consistent with nursing (to a large extent) and child care (to a lesser extent) and to tasks which involve less exposure to danger. This is the result of a process of optimization of allocation of people to tasks, based more on the social contexts and geographical locations within which the tasks are performed than on intrinsic features of the tasks taken out of context.

We thus rephrase the general problem of task allocation in terms of a locational model, in which danger and physical skill or endurance enter as secondary factors affecting human activity.

First, we assume that human households tend to be located in areas that are tamed by human effort. Whether the mode of life is settled or nomadic, these areas have higher frequencies of human interaction than other locations, and are the places where children are cared for under relatively safe conditions. Travel that is progressively more distant from

such areas may take people more and more into the natural world (in many societies), but in general there is a strong positive correlation between such travel and the existence of various kinds of danger, mainly from animal predators or human enemies, or simply from lack of familiarity with distant territory.

Secondly, we assume that raw materials for human economic activity tend to be found in the realm of nature, generally distant from base camps or home communities.

Thirdly, we assume that women's geographical mobility will be limited by the demands of childbearing, nursing, and child care; but that the degree of said limitation will vary cross-culturally with the mode of transportation employed and with the degree to which women employ alternative means of infant feeding and child care.

As a consequence of these assumptions and of the efficiencies listed above, tasks which are more distant and dangerous are increasingly likely to be assigned to men rather than to women. Further, men are more likely to be engaged in raw material production to the extent that it involves distant travel or danger.

If it is distant travel and danger that lead a task to be assigned to men rather than women, then the same task, performed in two different locations, could be men's work at one location and women's work at the other location. This possibility is illustrated by an ethnographic example of division of labor provided by the Maasai of Loita Hills, Kenya, who were observed by one of the authors between October 1973 and June 1974. The Murdock and Provost study (1973a) codes the Maasai as having exclusive male participation in butchering and exclusive female participation in milking. However, when cows are taken to temporary camps, far from the homestead, they are milked by the men who take them there. Furthermore, if cattle die an accidental death close to the homestead, they may be butchered by women. The present code does not allow for the preservation of information about situational variations in the sexual division of labor with respect to location or other social context. However, we

take the position that these situational variations will follow the same patterns as are followed by the more general patterns that can he perceived within the present code.

## The Coded Data on Fifty Tasks

The full list of fifty tasks coded by Murdock and Provost (1973a) is given in Table 1, in descending rank order of male participation. The number of societies for which the particular activity is coded is given under the columns marked M (exclusive male participation), N (predominant male participation), E (equal or equivalent participation), C (predominant female participation), and F (exclusive female participation). We will refer to the tasks either by name or by their numbers in this table.

# Entailment Analysis: The Procedure

Entailment analysis has been suggested previously in anthropology by Greenberg (1963), who used it to examine language universals, and by D'Andrade (1976), who constructed an entailment structure of beliefs about disease. Although a perfect Guttman scale is an entailment structure, entailment analysis is a much more general procedure than Guttman scaling, in that (a) it allows for types of logical relations other than simple if-then relations, and (b) it allows for partial orderings as well as complete orderings. The six steps in our

Entailment Theory and Method

Table 1. Sex Allocation of Fifty Technological Activities in 185 Societies

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6. Work in wood 7. Fowling 8. Manufacture of musical instruments 8. Manufacture of musical instruments 9. Trapping of small land fauna 10. Boatbuilding 11. Stoneworking 67 0 6 0 0 12. Work in bone, horn, and shell 71 7 2 0 2 13. Mining and quarrying 14. Bonesetting and other surgery 15. Butchering 16. Collection of wild honey 17. Land clearance 18. Fishing 19. Tranding large animals 19. Tranding large animals 19. Tranding large animals 19. Tranding large of the state o	5.	Hunting large land fauna	139	5	11000		0
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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       22         21. Soil preparation       66       27       14       17       16         22. Netmaking       42       2       5       1       15         23. Making of rope or cordage       62       7       18       5       18         24. Generation of fire       40       6       16       4       20         24. Generation of skins       39       4       2       5       31         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       26         29. Manufacture of leather products       35       3       2       5       23	16.	Collection of wild honey	39	5	2	()	2
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33. Basketmaking       37       9       15       18       53         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       44         38. Loom weaving       24       0       6       8       56         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       6         43. Potterymaking       14       5       6       6       7         44. Gathering wild vegetal foods       6       4       18       42       66         45. Dairy production       4       0       0       0       2         46. Spinning       7       3       4       5       73			15	2	8	2	21
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       44         38. Loom weaving       24       0       6       8       56         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       76         42. Preparation of drinks       15       3       4       4       4         43. Potterymaking       14       5       6       6       7         44. Gathering wild vegetal foods       6       4       18       42       66         45. Dairy production       4       0       0       0       2         46. Spinning       7       3       4       5       73         47. Laundering       5       0       4       8       43         <			37	9	15	18	51
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       44         38. Loom weaving       24       0       6       8       56         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       76         42. Preparation of drinks       15       3       4       4       4         43. Potterymaking       14       5       6       6       7         44. Gathering wild vegetal foods       6       4       18       42       66         45. Dairy production       4       0       0       0       2         46. Spinning       7       3       4       5       73         47. Laundering       5       0       4       8       43         48. Water fetching       4       4       8       13       13         4			18	12	46	34	36
36. Care of small animals       19       8       14       12       44         37. Preservation of meat and fish       18       2       3       3       44         38. Loom weaving       24       0       6       8       56         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       76         42. Preparation of drinks       15       3       4       4       4         43. Potterymaking       14       5       6       6       7         44. Gathering wild vegetal foods       6       4       18       42       66         45. Dairy production       4       0       0       0       2         46. Spinning       7       3       4       5       73         47. Laundering       5       0       4       8       43         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117			30	4	9	5	55
37. Preservation of meat and fish       18       2       3       3       44         38. Loom weaving       24       0       6       8       50         39. Gathering small aquatic fauna       11       4       1       12       23         40. Fuel gathering       25       12       12       23       94         41. Manufacture of clothing       16       4       11       13       76         42. Preparation of drinks       15       3       4       4       6         43. Potterymaking       14       5       6       6       7         44. Gathering wild vegetal foods       6       4       18       42       66         45. Dairy production       4       0       0       0       2         46. Spinning       7       3       4       5       73         47. Laundering       5       0       4       8       43         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117			19	8	14	12	44
38. Loom weaving       24       0       6       8       50         39. Gathering small aquatic fauna       11       4       1       12       23         40. Fuel gathering       25       12       12       23       94         41. Manufacture of clothing       16       4       11       13       76         42. Preparation of drinks       15       3       4       4       66         43. Potterymaking       14       5       6       6       7         44. Gathering wild vegetal foods       6       4       18       42       66         45. Dairy production       4       0       0       0       2         46. Spinning       7       3       4       5       73         47. Laundering       5       0       4       8       43         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117			18	2	3	3	40
39. Gathering small aquatic fauna       11       4       1       12       25         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       66         43. Potterymaking       14       5       6       6       74         44. Gathering wild vegetal foods       6       4       18       42       66         45. Dairy production       4       0       0       0       2         46. Spinning       7       3       4       5       75         47. Laundering       5       0       4       8       44         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117			24	0	6	8	50
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       68         43. Potterymaking       14       5       6       6       74         44. Gathering wild vegetal foods       6       4       18       42       68         45. Dairy production       4       0       0       0       24         46. Spinning       7       3       4       5       75         47. Laundering       5       0       4       8       44         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117		-	11	4	1	12	27
41. Manufacture of clothing       16       4       11       13       78         42. Preparation of drinks       15       3       4       4       68         43. Potterymaking       14       5       6       6       74         44. Gathering wild vegetal foods       6       4       18       42       68         45. Dairy production       4       0       0       0       24         46. Spinning       7       3       4       5       75         47. Laundering       5       0       4       8       44         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117			25	12	12	23	94
42. Preparation of drinks       15       3       4       4       68         43. Potterymaking       14       5       6       6       74         44. Gathering wild vegetal foods       6       4       18       42       68         45. Dairy production       4       0       0       0       24         46. Spinning       7       3       4       5       75         47. Laundering       5       0       4       8       44         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117			16	4	11	13	78
43. Potterymaking       14       5       6       6       7         44. Gathering wild vegetal foods       6       4       18       42       65         45. Dairy production       4       0       0       0       24         46. Spinning       7       3       4       5       75         47. Laundering       5       0       4       8       44         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117	42.	Preparation of drinks	15	3	4	4	65
44. Gathering wild vegetal foods       6       4       18       42       68         45. Dairy production       4       0       0       0       24         46. Spinning       7       3       4       5       75         47. Laundering       5       0       4       8       48         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117	1.000		14	5	6	6	74
45. Dairy production       4       0       0       0       24         46. Spinning       7       3       4       5       73         47. Laundering       5       0       4       8       48         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       117			6	4	18	42	65
46. Spinning       7       3       4       5       73         47. Laundering       5       0       4       8       44         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       11				0	0	0	24
47. Laundering       5       0       4       8       44         48. Water fetching       4       4       8       13       13         49. Cooking       0       2       2       63       11			7	3	4	5	72
48. Water fetching 4 4 8 13 13. 49. Cooking 0 2 2 63 11.			5	0	4	8	49
49. Cooking 0 2 2 63 117					8	13	131
			0	2	2	63	117
50. Preparation of vegetal foods 3 1 4 21 145					1.		145

Source: Murdock and Provost (1973a)

procedure for entailment analysis are described below.

The first step of entailment analysis is to dichotomize all of the variables. We have dichotomized exclusively or predominantly female (F or G) versus equal or greater participation by males (E, N, or M).

The second step is to analyze the contingency tables for all pairs of variables. For soil preparation and harvesting, for example (variables 21 and 30), we find twenty-seven cases where females predominate in both activities, twenty-eight cases where females predominate only in harvesting, seventy-nine cases where females predominate in neither activity, and no cases where females predominate only in soil preparation. (This asymmetry is statistically significant at p <5/100 million!) All such tables with zero, cells, or one or two exceptions to a zero cell, are classed as conditional relationships. In the above case, female participation in soil preparation is conditional upon participation in harvesting. For a conditional relationship to be statistically valid, it is also necessary that (1) none of the marginals in the table be less than the number of exceptions allowed (0, 1, or2); and (2) the chance of obtaining a near zero cell (0, 1, or 2 exceptions) be less than some specified level. We used, initially, a significance level of p < .15, computed by the binomial test as a criterion of statistical validity.

Entailments for two activities hold only when both activities are present in a society. Entailments of the form: "If females do task A, they also do task B" should be read to mean: "Theyalso do task B if it is present in the society."

The third step is to assemble the conditional relationships into entailment chains, which are checked for transitivity. Finding, for example, that female participation in task X entails female participation in task Y, and also that female participation in Y entails female participation in Z (with two or less exceptions in each case), the entailment chain  $X \to Y \to Z$  is valid under the rule of transitivity only if there are two exceptions or less for the conditional relationship  $X \to Z$ , regardless of the level of statistical significance of the latter relationship.

The fourth step is to eliminate the weakest conditional relationships, so as to make the entire entailment structure transitive. This is done by using an algorithm which removes the fewest and least significant relationships from the structure, until there are no more intransitives. In the remaining structure, we know that if X entails Y, and Y entails Z, then X entails Z with two or less exceptions.

The fifth step is to assess the overall significance of the structure by comparing the actual number of entailments with the number expected by chance. With perfect zero cells, ten inclusion entailments ("If females do X, then females do Y") are expected by chance to be significant at p < .15, as compared with the seventeen such entailments that actually occur. The probability that this number of inclusion entailments could occur by chance can be computed, using the normal approximation to the binomial test. Inclusion entailments occur more frequently than expected by chance (p < .02). Mutual exclusion entailments (If females do X, then they do not do Y), however, occur less frequently than expected by chance (p < .02). Collective exhaustive entailments (If females do not do X, then they do Y) also occur less frequently than expected by chance (p < .09). Thus, only the inclusion entailments are described by the final analysis.

The sixth step is to construct a digraph to represent the entailment relationships. The resulting digraph can easily be read by examining chains of arrows: Female participation in tasks at the beginning of the chain entails female participation in all of the later tasks in the chain. This digraph will henceforth be referred to as an entailogram.

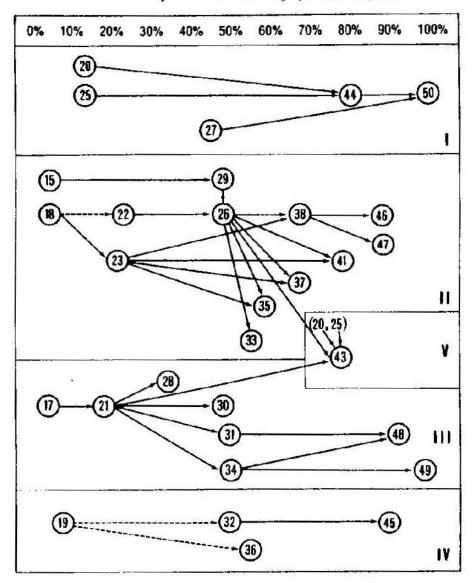
# Entailogram for the Sexual Division of Labor

Results of the entailment analysis of the fifty sexual division of labor variables are given in Table 2. Numbers contained in the boxes of the entailogram correspond to ID numbers in Table 1, the list of tasks. The column of percentages across the top of the entailogram shows the approximate percentages of societies with female predominance for

each of the tasks. Housebuilding (#20), for example, is primarily a male activity, with about 16 percent female predominance out of the 178 societies coded in the sample. The arrow from housebuilding (#20 to #44) reads: "If females predominate in housebuilding, they also predominate in gathering wild vegetal foods." Following out this chain (from #44 to #50), we also see that: "If females predominate in gathering wild vegetal foods, they predominate in cooking." As we move from housebuilding to gathering wild vegetals to cooking, we see an increase in the percentage of female participation in the tasks, which is a concomitant of an entailment structure. Some of the items at the head of entailment chains have a great many entailments. Female predominance in fishing (#18), for example, while relatively rare, entails female predominance in tasks #22, 23, 26, 33, 35, 37, 38, 41, 46, and 47: netmaking, making rope or cordage, preparation of skins, basketmaking, matmaking, preservation of meat and fish, loom weaving, manufacture of clothing, spinning, and laundering. It is easy to see that the direct entailments (adjacent tasks in chains) are often more closely connected in terms of technological sequences than the indirect entailments. It should be noted, however, that the entailments of variable #18 above (female predominance in fishing) form not a single chain, but a branching structure.

Two levels of statistical significance for direct entailment are indicated by the arrows in Table 2. Solid arrows indicate that the contingency table is significant at p < .15: of these relationships, six are significant at p < .001; five more at p < .01; five more at p < .01; five more at p < .05; fifteen more at p < .10; and thirteen more at p < .15. The average direct entailment, then, is significant at about the .05 level. An additional seven relationships are indicated in Table 2 by dotted arrows. These are significant at p < .20. It was decided to include these because some were consistent with the structure of the stronger relationships, but several of these are not drawn on the entailogram because they are not consistent with the main structure, and tend to cross-cut the main clusters of entailments.

Table 2. Complete Entailment Digraph (Entailogram)



Not shown: 25-37; 25-41; 36--47; 15--30; 43--50

Key: Solid arrows → significant at p ≤ .15 (strong)
 Dotted arrows → significant at p ≤ .20 (weak)
 Variable numbers in boxes are those in Table 1.
 Percentages across the top indicate the proportion of societies for which females predominate in performance of the task.

Five main clusters of entailments are sectioned off in Table 2 and labeled with Roman numerals I through V. The clusters themselves are highly meaningful. Cluster I (tasks 20, 44, 50, and 27) pertains generally to food collection activities, plus housebuilding. It is doubtful whether task #25 (bodily mutilation) should be included in this cluster, since it also has entailments with other clusters (to 37, 41, 43). Bodily mutilation (e.g. tattooing, circumcision) is dropped from further consideration, since it is not part of any production sequence, but rather part of the ornamental and projective system, for which other codes are lacking.

Cluster II pertains to fishing, animal products, and related crafts, including textiles, with an additional entailment to potterymaking. Cluster III pertains to agricultural activities. Cluster IV contains only animal husbandry activities. Thus, it is clear not only that the entailment relationships are highly structured but also that the main clusters pertain to different production sequences.

Cluster V, however, cross-cuts three of the other structures, in that a number of entailments lead to potterymaking. If we invert this item, we see that there are multiple and branching entailments of the form "if males do potterymaking, then they will do ... ." Thus, this cluster has the same sort of branching entailments for male predominance in tasks as are shown by the other clusters for female predominance in task activities.

### Discussion of Results

Results of the analysis confirm the existence of specific clusters of related activities, within which entailment relationships hold between related tasks. The five major clusters, plus the set of tasks that do not enter into entailment relationships, are as follows:

## Cluster I. Food Collection and Related Tasks

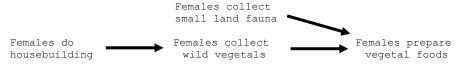
Entailments are found for the sexual division of labor among four tasks (ignoring body mutilation) related to food

12

collection or to a food-collection-based economy. The four variables, in increasing order of performance by females, are:

Task	% Female	Assignment
20. Housebuilding		16%
27. Collecting small land fauna		42%
44. Collecting wild vegetal produc	cts	79%
50. Preparing vegetal foods (befor	e cooking)	95%

The entailment structure in Cluster I is:



In this structure, housebuilding (#20) is a head item, which is predominantly done by males. However, if the society is nomadic, females tend to do the housebuilding (Murdock and Provost 1973a). In addition, if females make houses, they also collect wild vegetables (#44) and prepare them for cooking (#50). If women collect small fauna (#27) — e.g. lizards, eggs, or insects, — they also prepare vegetal foods. One item in this cluster is also connected to Cluster V; If women do housebuilding (#20), they also make pottery (#43). As is stated above, this applies mainly to nomadic societies.

Cluster II. Fishing. Animal Products, and Textile Production Sequences

This is the largest cluster, including butchering, fishing, and related craft activities, such as textiles. These variables are listed below in order of performance by females.

	Task	양	Female Assignment
15. 23. 22. 26. 29.	Fishing Butchering Rope and cordage Netmaking Preparing hides Leatherworking Basketmaking		5% 6% 22% 25% 44% 46% 53%

Task

% Female Assignment

		_
35.	Matmaking	58%
37.	Preserving meat and fish	65%
38.	Loom weaving	66%
41.	Making clothing	75%
46.	Spinning	85%
47.	Laundering	86%

Butchering, leatherworking, preparing hides, preservation of meat and fish, and making clothing form a sequence of activities concerned with production and utilization of animal products. Butchering is one of two head items. If women do butchering (#15), they also do all the activities that follow it in the sequence (#29, 26, 33, 35, 37. 38, 41. 46, 47).

Fishing is the second head item, with entailments to netmaking and rope and cordage making. From rope and cordage making (#23), there are several further entailments (to #35, 37, 38, 41, 46, 47), including one to preservation of meat and fish. Two activities in this cluster have a high number of direct entailments to other activities. These are making rope and cordage (#23) and preparing hides (#26). Both of these activities have direct entailments to loom weaving, making clothing, preserving meat and fish, and matmaking. These six activities are bound into a tightly connected structure. In addition, preparing hides has direct entailments to pottery making (#43) and to basketmaking (#33). In Table 3, we have tabulated the division of labor in preparing hides against Murdock and Provost's (1973b) index of societal complexity.

Table 3. Relationship between Hide Preparation and Social Complexity

		Hide Prepara	ation (#26)
			Equal or Mainly
Complexity	Mainly	Female	Male
0-10		21	9
11-30		15	24
31-40		0	11
	$\chi 2 = 17.75$	p < .001	

We find that women do not prepare hides in the most complex societies, and that men tend not to prepare hides in the least complex societies.

A more specific relationship can be found between hide preparation and the presence of domesticated animals. In Table 4, a tabulation is done between the division of labor in preparing hides and the presence or absence of large domesticated animals (cattle, camels, water buffalo, sheep, goats, yaks) coded by Murdock and Morrow (1970).

Table 4. Relationship between Hide Preparation and the Presence of Domesticated Animals

	-	aration (#26)
	Eq	ual or Mainly
	Mainly Female	Male
Large Domesticated		
Animals	8	27
Small or No Domestica	ated	
Animals	28	17
	$\chi^2 = 12.33$	p < .001

Here we see that men tend to prepare hides where large domesticated animals are present, and that women tend to prepare hides where large domesticated animals are absent.

# Cluster III. Agricultural Activities

This cluster includes eight activities which pertain to agriculture. They are listed below in order of performance by women:

	Task	% Female Assignment
	Land clearance Soil preparation	3% 20%
28.	Planting crops	32%
	Harvesting Crop tending	43% 47%
	Burden carrying	48%
48.	Water fetching	90%
49.	Cooking	97%

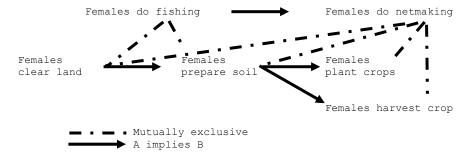
The head item is land clearance, which is almost always a male activity, and the structure branches from the soil preparation variable, which has direct entailments to four other activities (crop tending, harvesting, planting crops, and burden carrying). Clearly, soil preparation (#21) is a key variable for understanding the division of labor in agricultural societies. That women do not do plowing can be seen in Table 5, which tabulates the presence of the plow against the sexual division of labor in soil preparation. There is only one exception to the generalization. Note that there are many cases where the plow is absent and men prepare the soil.

Table 5. Relationship between Presence of the Plow and Sexual Division of Labor in Soil Preparation

		Soil Prepar	ration
		Equal	or Mainly
		Mainly Female	Male
Plow	Present	1	35
	Absent	26	72
		Yule's $Q =85$	
		$\chi 2 = 9.23$ p < .01	=

There are a number of mutually exclusive relations between items in the agricultural production sequences (Cluster III) and those in the fishing production sequences (Cluster II). These were not shown in the entailogram in Table 2, because mutual exclusion relations (If females predominate in Task X, they do not predominate in Task Y) occurred much less frequently than expected by chance. Some of these relationships warrant discussion here, however, because they showed highly consistent (nonrandom) patterning. Female netmaking (#22), for example, is mutually exclusive to female planting (#28) and female crop harvesting (#30), and. by implication, female fishing (#18) is also mutually exclusive to the latter two activities. By further implication, female fishing and netmaking are mutually exclusive to female land

clearing (#17) and soil preparation (#21). The entailment structure is thus:



These mutually exclusive relationships have the effect of constraining female activities; If women do netmaking or fishing, they do not do any of the set of four agricultural activities, and if they do any of the set of agricultural activities, they do not do netmaking or fishing. Men, however, may participate in one or both activities (see Table 6).

Table 6. Relationship between Sexual Division of Labor in Planting and in Netmaking

			Planting
Netmaking	Equal Male	or Mainly Male 19	Mainly Female 18
Wechiaking	Female	9	1
			's Q =79 4.88 p < .05

The effect of these mutual exclusion constraints on women's activities is that women may not participate in the primary productive activities in the fishing and agricultural sequences simultaneously. We did not find, however, any analogous restrictions concerning men's simultaneous participation in more than one set of primary productive activities.

# Cluster IV. Animal Husbandry

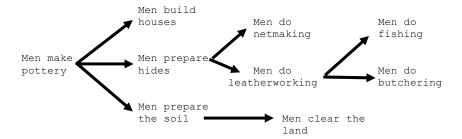
The fourth cluster has no strong connections to the first three clusters. The head item, tending large domesticated animals, is usually done by men. If women tend large animals, they also tend small animals, do the milking, and manufacture dairy products. If men tend small animals, then they tend large animals. Below are listed the frequencies of performance by women for these four variables:

Task	응	Female	Assianment

19.	Tending large domestic animals	6%
	(cattle, sheep, horses, camels, etc.)	
32.	Milking	48%
36.	Tending small domestic animals	58%
45.	Dairy production	86%

# Cross-Cutting Cluster V

One interesting sequence of activities cuts across the three clusters of the first graph, and is most economically stated in terms of entailments for male assignment to tasks. The head item for this cluster is potterymaking.



If men make pottery, they also do each of eight other activities, provided that those activities exist for the given society. Potterymaking is a female activity in most societies, and male potterymaking is highly correlated to the level of societal complexity. In Table 7, we have tabulated the division of labor by sex for potterymaking against the Murdock-Provost index of societal complexity (Murdock and Provost

Index of societal

1973b). Here we find that women do not make pottery in the most complex societies, and that men tend not to make pottery in the least complex societies.

Table 7. Relationship between Societal Complexity and the Division of Labor by Sex for Potterymaking

Complexity	Pottery	Potterymaking		
	<i>Mainly</i> <i>Female</i>	Equal or Mainly Male		
34-40	0	14		
21-33	28	6		
0-20	52	5		
$\chi 2 = 52.67$	p < .001			

Cluster VI. Tasks Nearly Universally Done by Males Which Cannot Form Statistically Significant Entailments

Nineteen of the fifty activities analyzed do not appear in the entailogram. Inspection of Table 1 will show that fifteen of these tasks (#1-14 and 16) are almost never assigned to females, with two or less exceptions in the sample. Most of these tasks involve work in dangerous situations or long-distance travel. This is consistent with our theory of role constraint.

Cluster VII. Tasks Which Do Not Have Entailments

There remain only four activities which do not appear in the structure. In increasing order of female participation, these are:

	Task	응	Female	Assignment
24.	Firemaking			28%
39.	Gathering shellfish			69%
40.	Fuel gathering			71%
42.	Preparation of drinks			75%

These are all activities which do not have associations with other activities in terms of common technologies, and which do not involve danger or distant travel. Their absence from the structure does not contradict any of our predictions.

Constraints on the Division of Labor by Sex

In the preceding analysis, we have discussed four general kinds of constraints, which account for most of the entailments in the data. These constraints are discussed below.

- 1. Constraints on the performance of adjacent tasks in production sequences. Adjacent tasks in production sequences tend to be performed by the same sex. As a consequence, there is at most one transition per production sequence from male-dominant activities to female-dominant activities. We do not find cases where activities in a production sequence are repeatedly passed back and forth between the sexes.
- 2. Constraints on processing raw materials into finished goods. Probably because most of the societies in our sample are preindustrial, it is a characteristic of their production sequences that one raw material is used for several secondary products, but not vice versa. For example butchering leads to leatherworking, preserving meat and fish, and preparing hides. We do not find a multitude of primary economic activities leading to a single secondary activity, as would be the case in such industrial activities as synthesizing chemicals or manufacturing automobiles.
- 3. Constraints on female participation in production sequences. Due to considerations of distance and danger, women tend not to engage in the early stages of production sequences. This tendency leads to the generalization that if women perform any early task in a production sequence they will perform all later tasks in the same sequence. That generalization stands up well under the empirical test using entailment analysis. It applies to each of the following sequences:

- a. Vegetal foods sequence: Items 44, 50, 49 (Cluster I)
- b. Fishing sequence: Items 18, 22, 37 (Cluster II)
- c. Cloth sequence: Items 46, 38, 41 (Cluster II)
- d. Animal products sequence: Items 15, 26, 29, 37, 41 (Cluster II)
- e. Land cultivation sequence: Items 17, 21, 28, 31, 30 (Cluster III)
- f. Domesticated animals sequence: Items 19, 32, 45 (Cluster IV)

In addition, we have found that the constraint on women's simultaneous participation in fishing and agriculture is not matched by any analogous constraint on men's simultaneous participation in more than one set of tasks in the early part of production sequences.

4. Constraints on the performance of crafts or occupational specialties. We have found one cross-cutting cluster, which begins with potterymaking and is best stated in terms of entailments for predominant male participation. Murdock and Provost (1973a) suggest that occupational specialization will result in tasks being done by men in complex societies which are done by women in less complex societies. A good example of this effect can be found with potterymaking (Cluster V), which is usually a female task, but which is done by men in the most complex societies. Other tasks in the cross-cutting cluster can also be shown to have strong relationships to societal complexity and to agricultural intensity. For example women do not do plowing, therefore men prepare the soil when agriculture is intensive. Murdock and Provost note that housebuilding is a female task in nomadic societies and a male task in sedentary societies. We have shown that hide preparation becomes a male task in complex societies. Similar relationships may hold for the other tasks in Cluster V. Further study is needed of the relationships between societal complexity and the division of labor by sex.

#### Conclusions

We have attempted to understand patterns of division of labor by sex in terms of a theory of constraints on role behavior, using assumptions about child-care responsibilities, the nature of production sequences, and continuities in the investment of time in the acquisition and utilization of skills. These theoretical notions, when combined with assumptions about shifts in the division of labor in complex societies, account for most of the entailments in the data. When statistically significant entailment relationships are present, significant correlations can also be computed. However, we take the position that correlational analysis is often a weaker tool than entailment analysis for crosscultural studies. In the present case, the predictions of the theory were stated in terms of entailment relationships. An entailment (If women do A, then they do B) and its opposite (If women do B, then they do A) will both correspond to a positive correlation. Given the positive correlation, there is no way to know if an entailment holds, or if so, what the direction of the entailment relationship is. In the present example, entailment Clusters II (Animal Products and Crafts) and III (Agriculture) are nearly identical to two factors resulting from a factor analysis of the fifty variables, as reported in Murdock and Provost (1973a: 213-15). The factor analysis was based on a matrix of correlation coefficients. The difference between the entailment analysis and the factor analysis is that the factor analysis merely clustered the variables, while providing little information about relationships among members of the same cluster. The entailment analysis produced clusters and also produced a structure of relationships among members of the clusters.

More generally, a constraint theory is fundamentally different from a causal theory. A constraint of the form: "If women do A, they do B" does not "cause" women to do any particular activity. They may still do any one of three possibilities, not A and not B, both A and B, or B but not A. By contrast, a causal model would have the performance of one

activity in some way caused by the performance of another. It is the constraint model, rather than a causal model, that leads to a formulation of predictions in terms of entailments, rather than correlations.

In terms of a theory of role behavior, then, the present research favors a model of optimal allocation of human resources by social actors with goal objectives. This allocation occurs within certain constraints. From these conditions can be derived entailments of the sort described above for the division of labor by sex. Given this perspective, entailment analysis offers an approach to the study of human adaptation which has not previously been utilized. It has the advantage that the form of theoretical propositions in the theory of constraints is identical to the form of entailments found by the data analysis. In the present example, a high degree of fit is found between theory and data. Using entailment models, theories can be tested and refined in a much more precise manner than has heretofore been the case.

Our theory of role constraints on the division of labor stated that efficiencies in the utilization of learned skills would tend to favor allocation of adjacent tasks in a production sequence to the same sex, but that because of nursing and child-care constraints on women, men would be more likely to be assigned tasks which require distant travel and exposure to danger. Because production of raw materials generally requires more distant travel and/or exposure to danger than does the production of secondary products, the theory predicts that (1) men will be more likely than women to perform tasks which are early in production sequence, and (2) if women perform a task at an early stage of a production sequence, they will perform all tasks at later stages of the same sequence. These predictions were strongly supported by the entailment analysis of the distribution of tasks by sex in the cross-cultural sample of 185 societies.

#### NOTE

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