CROSS-CULTURAL RESEARCH
The Journal of Comparative Social Science

Sponsored by the Human Relations Area Files, Inc. (HRAF)
Official Journal of the Society for Cross-Cultural Research

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The Journal of Comparative Social Scienes

Volume 35, Number 4 / November 2001

Sage Publications Thousand Oaks • London • New Delhi

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Submissiveness and Risk of Heart Disease

Edward Conduit
University of Birmingham

*This study explored statistical relationships between work values and risk of heart disease. Hofstede assembled a database of 117,000 questionnaires from employees of a multinational company. Country means for these data were compared with Coronary Heart Disease (CHD) mortality data published by the World Health Organization. It was found that the probability of CHD is strongly predicted by work values of low power distance index (*r = *–.68,* N = *29 countries), low uncertainty avoidance index (*r = *–.65,* N = *33), and high individualism (*r = *.59,* N = *33). Further analysis was used to identify factors at the individual level. Low probability of cardiac death over the next 20 years was found to be predictable from questions assessing tension at work, loyalty, deference, and high power-distance. The statistical factor that emerged might be called* submissiveness*, and its risky pole could be called* insubordination*. An individual-level study was designed to test for a relationship between work values and CHD risk factors. A cross-section of 62 healthy Japanese expatriates was compared with 53 British workers in the same employment. The two nationalities were remarkably similar, both in work values and probability of CHD. No protective CHD risk profile was found in the Japanese, contrary to the national base rates. Japanese men were unexpectedly found to be significantly more exhausted. The work values scales were found to be unreliable at the individual level. "Tension at work" and "fear of expressing disagreement" were found to predict several CHD risks.*

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Progress in understanding disease has often been made by progress from epidemiological methods to studies of individuals. Statistical associations between disease rates and other factors suggest hypotheses that are subject to refutation. These methods have been applied with some success to dietary influences on Coronary Heart Disease (CHD). There are probably also social influences on CHD such as cynical hostility, severe life events, or chronic work stress. This article considers whether data on work values can be used to identify psychosocial risk factors in the work environment.

Premature CHD death rates are reported by the World Health Organization (WHO) in terms of a standardized mortality ratio (SMR). The SMR is the ratio of the number of deaths observed in a country divided by those expected in a reference group. The WHO reports a country's mortality in each 10-year age cohort as a proportion of the number of people alive at that age in the whole world population.

There are large differences between countries in incidence of heart disease, as shown in Table 1: Russia and Baltic countries have extremely high mortality rates, Latin and Mediterranean countries are healthier than those in Northern Europe, and Japan and Korea have very low CHD rates. Some of these differences arise from known risk factors. CHD incidence was studied in Project MONICA, at the level of cities rather than countries. Collaborating centers in MONICA reported prevalence of the major risk factors: tobacco smoking, body mass index (BMI), hypertension, and elevated cholesterol. Calorie intake, median cholesterol and BMI statistically account for a substantial proportion of the variance between countries. However, much of the variation between countries remains unexplained. The upsurge in CHD in Eastern Europe in the 1990s is not explained by changes in known risk factors.

Many psychosocial factors have been statistically associated with cardiac events, although few such factors have been accepted by medical authorities as specific CHD risks. It has often been noted retrospectively that CHD incidence increases after severe and protracted life events such as bereavement or natural disasters (Conduit, 1992). Social isolation has been shown to predict CHD mortality in older adults (Berkman, 1984). Many personality traits have at some time been implicated in CHD. Cynical or suspicious hostility may be the most frequently reported trait. Barefoot (1992) argued that hostility of this kind is the pathogenic aspect of what was previously called Type A Behavior Pattern. There is a

TABLE 1
Heart Disease Mortality Compared With Food, Wealth, and Four Classic Risks

Country	*Standardized Mortality Ratio: Male (World Health Organization)* — *Coronary Heart Disease Death*	*Wealth and Food Intake (The Economist, 1990)* — *Fats Bought*	*Calories Bought*	*Gross Domestic Product*	*Risk Factor: MONICA Data (World Health Organization, 1988)* — *Smoker Current (%)*	*Body Mass Index*	*High Blood Pressure (%)*	*Cholesterol*
Argentina	78.9	111.8	3,191	2,759	—	—	—	—
Austria	130.8	—	—	16,675	—	—	—	—
Australia	133.3	137	3,226	14,083	36	25.5	25.1	5.8
Belgium	74.9	195.4	3,850	15,394	54	26.2	16	6.1
Canada	125.8	154.1	3,425	18,834	—	—	—	—
Chile	76.5	55.5	2,574	1,732	—	—	—	—
China (urban)	68.1	41.4	2,628	301	61.1	23.4	24.6	4.1
China (rural)	31.7			301				
Czechoslovakia	240.6	129.3	3,473	2,737	48.4	27.1	32.4	6.3
Denmark	147.8	168.4	3,512	20,988	61.1	25.4	14.9	6.2
Finland	186.6	130.3	3,080	21,156	40	26.6	40	6.2
France	53.7	135.5	3,273	17,004	42	26.5	34	5.7
Germany	134.7	148.4	3,800	19,743	39	26	31	6
Greece	80.7	150.5	3,688	5,244	—	—	—	—
Guatemala	17.2	42.6	2,296	858	—	—	—	—
Hong Kong	50.5	—	—	—	—	—	—	—
Hungary	223.1	141.5	3,541	2,625	51	26.6	21.6	5.9

(continued)

TABLE 1 Continued

Country	*Standardized Mortality Ratio: Male (World Health Organization)*	*Wealth and Food Intake (The Economist, 1990)*		*Gross Domestic Product*	*Risk Factor: MONICA Data (World Health Organization, 1988)*			
	Coronary Heart Disease Death	*Fats Bought*	*Calories Bought*		*Smoker Current (%)*	*Body Mass Index*	*High Blood Pressure (%)*	*Cholesterol*
Ireland	195.4	149.4	3,692	9,181	—	—	—	—
Israel	120.5	113.8	3,038	9,368	—	—	—	—
Italy	81.1	137.3	3,494	14,432	43.7	26.8	18.9	5.5
Japan	30.2	84.5	2,858	23,325	—	—	—	—
South Korea	21.2	50.3	2,875	4,081	—	—	—	—
Kuwait	118.9	99.3	3,078	10,189	—	—	—	—
Lithuania	346.0	101.6	3,394	2,055	41.7	27.5	30.4	5.9
Mauritius	197.0	55.6	2,736	1,855	—	—	—	—
Mexico	74.1	87.1	3,148	2,102	—	—	—	—
The Netherlands	103.7	149	3,258	15,421	—	—	—	—
Norway	145.8	139.2	3,219	21,724	—	—	—	—
New Zealand	165.8	142.8	3,407	11,544	34.3	25.4	20.1	5.7
Poland	117.5	108.8	3,298	1,719	59.9	26.4	37.5	5.5
Portugal	66.0	99.6	3,134	4,017	—	—	—	—
Russia	394.4	101.6	3,394	2,055	54	25.8	33	—

Singapore	126.9	77.1	2,854	9,019	—	—	—	—
Spain	67.6	141.6	3,365	8,668	57.7	26.5	8.4	—
Sweden	149.4	126	3,049	21,155	37	25.3	20.4	6.1
Switzerland	88.0	163.2	3,432	27,748	38.5	25.9	18	6.3
United Kingdom	166.8	143.4	3,257	14,477	45.7	25.5	23.7	5.9
Uruguay	94.0	95.6	2,676	2,595	—	—	—	—
United States	138.7	164.4	3,642	19,815	—	—	—	—
Venezuela	94.0	72.4	2,532	3,400	—	—	—	—
Variable versus standardized mortality ratio (*r*)		.18	.37	–.15	–.08	.42	.33	.31

burgeoning literature on these issues, which is beyond the scope of this article. Barefoot's review provides a good starting point. Concurrent correlations between psychological factors and disease could be consequence rather than cause of an emerging physical disease. More convincing evidence is provided when a psychological variable is shown to predict the probability of a future cardiac event.

Many lay people believe that work stress is a cause of heart attacks. In the United Kingdom, such beliefs have little reflection in official recommendations about heart disease. In Scandinavia, it is more widely accepted that the work environment has adverse effect on the circulation. Kristensen (1989) cites eight studies in favor of Karasek's job-strain model. High reactivity and low control together form the pathogenic quadrant, where people who later developed CHD were most likely to be found.

The operational definition of psychosocial variables for international comparisons remains difficult. The existence of a large international database of work values provides an unusual opportunity to study the effect of work on CHD. Geert Hofstede was interested in how management differed in IBM subsidiaries in all parts of the world. He collected questionnaires from engineers and sales staff between 1968 and 1972. The questionnaire was translated into local languages. This database has been published under the title *Culture's Consequences* (Hofstede, 1980). It provides a fascinating data set on work values for every country where IBM computers were sold. These 100 countries excluded only the Soviet bloc, Africa, and less developed areas of Asia and Latin America.

Factor analytic procedures were used to classify the responses, and four main factors were identified. *Power distance index* (PDI) describes the extent to which less powerful individuals expect that power will be distributed unequally. *Individualism* (IDV) describes a society in which connections between members are loose and individuals are expected to look after themselves and immediate family only. Its opposite is *collectivism*, which describes societies in which people are integrated into cohesive in-groups, which through life continue to protect them in exchange for unquestioning loyalty. The *uncertainty avoidance index* (UAI) is the extent to which the members of institutions and organizations within the society feel threatened by uncertain, unknown, ambiguous, or unstructured situations. *Masculinity* (MAS) describes a

society in which men are supposed to be tough, assertive, and focused on material success, and women to be modest, tender, and concerned with the quality of life. *Femininity* describes societies, notably those of Scandinavia, where the latter values prevail. Recent studies in Asian countries have led to the addition of a fifth factor, associated with long-term orientation or Confucian dynamism. Individual question results were added to give a national score for each of the five scales. For example, power-distance was calculated as

PDI = 135 – 25 (mean score employees afraid to criticize)
+ (% perceiving manager as autocratic or persuasive/
paternalistic) – (% preferring manager consultative).

The arbitrary constant 135 was added to give a mean score in the range 0 to 100 for each country.

Many statistical associations in CHD research, for example, coffee intake and CHD, have turned out to be statistical artifacts of a third variable, smoking, on closer examination. Some associations, such as milk consumption (protective) and soft water (harmful), remain obscure and possibly artifacts. To be convincing, studies at the individual level need to be undertaken. A classic of this kind is the report of Ancel Keys (1980) on diet and cholesterol. In the *Seven Countries* study, the eating habits of workers were closely monitored. The worker's dietary intake of fats was found to be predictive of later heart disease.

In studying differences between countries, the issue of ecological influences may be relevant. Cross-cultural psychologists such as Berry (1980) distinguish ecological influences such as climate and patterns of food accumulation. These ecological factors influence socialization and affect the behavior of collectives. They also affect atherogenesis. In the present study, group behavior is of little interest, as an illness affecting individuals is the principal focus.

The study reported here first explores statistical associations in published data between work value metavariables and CHD rates at a country level. Next, individual work values and risks are separated out. Finally, a study of individuals is reported, which tests a hypothesis about CHD risk and the work values emerging from the first phase.

NATIONAL CHD MORTALITY IN RELATION TO HOFSTEDE VARIABLES

METHOD

The first question focused on coarse statistical associations between the values of a country and the CHD rates of its citizens. The five Hofstede value clusters were explored, without any hypothesis about their relative importance. The SMR was the variable chosen as the outcome at this stage. The CHD data used are those collated annually by the WHO (1995). This publication generally gives 1994 data but may be as old as 1989 (Belgium).

The data on work values by country were compared with data on CHD for the same countries. Published economic and demographic measures (The Economist, 1990) for developed countries allow some comparisons to be made between each measure and the heart disease rate. The gross domestic product (GDP), expressed as dollars per head of the population, was found from the same source. Estimates of each citizen's fat and caloric intake may be made from food sales data.

RESULTS

The coarse correlations between work values and SMR are

- UAI = –.65 (33 countries),
- IDV = .59 (33 countries),
- MAS = –.12 (33 countries), and
- PDI = –.68 (29 countries).

Food purchases have a moderate correlation (.37) with CHD mortality, but GDP does not (–.15). In the MONICA data on a smaller number of countries, two food-related measures have similar predictive value: BMI (.42) and serum total cholesterol (.31). The proportion of smokers in a country has no systematic relation to the CHD rate and emerges paradoxically as a negative predictor of national heart disease rates. The proportion of hypertensives also has a modest correlation with CHD, although high blood pressure is probably more significant for cerebrovascular events.

The partial correlations with diet were removed by constructing a regression equation for SMR against calories purchased per caput, fat purchased per caput, GDP, and latitude of capital. The

Hofstede variables were then regressed against this prediction. The correlation between diet-predicted SMR and power distance declines to –.51, and that for UAI declines to .57.

DISCUSSION

Three work values remain significant predictors of CHD, and each accounts for more variance than does diet. The statistical associations between national CHD and Hofstede variables might arise from many other factors, including nonequivalent measurements, and the distribution of known risk factors, or factors as yet unidentified. Nonequivalence would occur if deaths were registered as caused by CHD in North America but as caused by infections in Latin America. The world comparison population used to calculate SMR might create statistical bias between long-lived and short-lived countries. Known individual factors such as smoking might be lost from view in national data. Unknown factors may include infective agents or variations in the gene pool, which have yet to be identified. The prediction from the Hofstede variables is surprisingly strong but needs careful examination.

Of the known risk factors, several dietary components emerge as the main discriminators between countries. The proportion of calories consumed as fat is probably the best predictor. Being overweight or obese is also strong. Calories purchased per head of the population give some clue to eating in excess of nutritional requirements, and the correlation here is .37. Intake of marine oils is thought to have a protective effect. The quantity of fish landed in each country per caput does not discriminate CHD mortality. Calories and fats purchased per person account for 11% of the variance in SMR.

Tobacco smoking accounts for most of the difference between individuals, but the percentage of smokers in a country does not account for national variation in SMR. Inactivity is a risk factor with a small discriminative value in studies of individuals. Percentage of urban dwellers is a weak index of inactivity, but this had no relation with SMR. Climate is an ecological variable that has often been used in cross-cultural studies. Using latitude of the capital city as an indicator of climate, the correlation with SMR across 44 countries is .49. The addition of latitude to calories and fats in regression raises the variance explained to 25%. The ecological influence of colder climate is clearly partly associated with

consumption of preserved meats. There is no compelling hypothesis for the additional shared variance between high latitude and SMR.

CHD is often described as a disease of affluence because of its prevalence in economically advanced countries. GDP was found by Bond (1991) to account for 31% of the variance in CHD deaths between 12 countries. In the present analysis, data on GDP and mortality for 38 countries were available. Inclusion of northeast Europe (high CHD, low GDP) and Latin America (low CHD, low GDP) gives a near-zero correlation between GDP and SMR. Paradoxically, people of lower socioeconomic status in advanced countries seem to have higher risk than more affluent individuals. The size of the gap between the wealthy and less well off, as distinct from the absolute standard of living enjoyed by the poor, has been shown to affect mortality in the United States (Kennedy, Kawachi, & Prothrow-Stith, 1996). The calculation of the Robin Hood and Gini indices of income disparity was made on states of the United States. The data required for international comparisons of income disparity are probably not available for most other countries.

CHD PROBABILITY AND DISCRETE WORK VALUES

METHOD

The next question required refinement of the data as descriptions of the work values and illness risks of individuals. Calculation of an individual's risk creates a continuously distributed variable at the individual level. CHD mortality describes discrete events, which are distributed around a median age of about 60. The SMR for a country is the number of deaths d_j in that country divided by e_j, the number expected in that age group in the world population. Because e_j is a constant, the probability of an individual's heart disease mortality, P_{CHD} may be directly inferred from SMR. The Hofstede metavariables cannot with validity be used for research at the individual level. Refinement of the IBM data at the level of individual questions is therefore required.

It is argued that work values of IBM staff in 1968 to 1972 can be used to predict probability of CHD mortality over the next 20 years. The Hofstede data were collected in 1968 to 1972 and the

WHO data in 1989 to 1994. The follow-up interval averages 20 years, with a range of 17 to 26 years. Calculation of 20-year P_{CHD} was therefore chosen. Assuming risks for age cohorts are additive, the 20-year probability for a U.S. male aged 40 to 44 is .20. The data were collected on somewhat similar cohorts: IBM staff had ages in the young adult range, and there were more males than females. Fortuitously, these demographic properties are somewhat similar to those experiencing CHD about two decades later.

Cardiac death is a discrete event (deceased or healthy), but the probability of that event in the future is a continuous variable applicable to all citizens. Heart disease risk is usually estimated by multiple regression equations. Linear regression, and more recently logistic regression, is used to calculate P_{CHD}. Anderson, Wilson, Odell, and Kannel (1991) used parametric regression with data from the Framingham study. These authors calculate probability of a cardiac death by an exponential equation of the following kind:

$$P_{CHD} = 1 - \exp(-\exp(\log(\text{years of follow-up}) - \mu)).$$

The μ term is the sum of risk factors multiplied by their coefficients, that is,

$$\mu + \beta_0 + \beta_1 \times \text{female} + \beta_2 \times \log(\text{age}) + \beta_3 \times \text{SBP} + \beta_4 \times \text{ECG} + \beta_5 \times \text{Risk}_5 + \beta_6 \times \text{Risk}_6.$$

(These authors use a scaling parameter σ in the denominator to improve the goodness of fit.)

Age makes a very large contribution to μ. For all American males in their early 30s, the 10-year P_{CHD} is 3%; at age 40 to 44, it is 6%; and in their early 50s, it is 14%. At age 70, all men with no risk factors have high risk (0.2-0.4), and all women have moderate risk (0.1-0.2). Other risk factors can double or halve the age-related risk. A 32-year-old male who smokes, has diabetes, and has elevated cholesterol has a 10-year P_{CHD} of 5%. The same man without these three risks has a probability a little less than 2%.

Particular work value statements were used for the comparison with P_{CHD}. Appendix 2 of *Culture's Consequences* (Hofstede, 1980) publishes the results for many questions as means for 40 countries and seven occupations. Appendix 3 gives standardized country and occupation scores for Questions A5-A18 and C1-C8 for 65,378 respondents. Some of the C questions were discontinued after 1968. The questions were restored to their original 1 to 5 scale by dividing by 100 in most cases. Variables A54 and A55 report

perceptions of manager in percentages and cannot easily be used as interval scales. Questions were identified by their loading initially on PDI and, thereafter, on UAI or IDV. Each country mean was separately correlated with the criterion.

CHD data are not available for some Asian countries reported by Hofstede, and work values data are not available for any country of the Eastern Bloc of that time (except Yugoslavia). The combined data set therefore consists of 28 countries for most items.

RESULTS

This phase of the analysis of national data concerned relationships between P_{CHD} and particular work values. Those that discriminated best are shown in Table 2.

Multiple linear regression was used to predict P_{CHD} from individual questions. The 10 questions listed in Table 2 together accounted for 75% of the variance in country means for 20-year risk of cardiac death. The best single question was A37. The scatter of 20-year P_{CHD} against "frequency of tension at work" is shown in Figure 1.

In regression analysis, A37 dominated the equation and appeared to subsume the "loyalty" and "fear of complaining" values. "Dislike of work" was a nearly significant predictor, independent of A37.

DISCUSSION

The items that remained discriminative individually of P_{CHD} also generally loaded on PDI. The predictive value of IDV reduced to the question "importance of personal time outside work." The variation associated with UAI is nearly all attributable to A37, "tension at work." This emerges as the strongest single predictive question, but in a direction opposite to common sense. The Japanese mean for A37 was between "usually" and "sometimes" tense, whereas that for Singapore was closest to "rarely." The difference is about 1.5 *SD*. If tension at work has any meaning as protective factor, it might describe watchfulness in maintaining social structure. The worker who is rarely tense might be inattentive to social cues and perhaps prone to hostile avoidance if offense were taken.

Inspection of these items shows similar values of anxiety, compliance, and deference to authority. Only A52 taps benign aspects

TABLE 2
Individual Work Values That Predict 20-Year Probability of Coronary Heart Disease (CHD) Death

				Regression of P_{CHD} Beta Weight				M	
Number	*Text*	R	P	β	*Significance of* T	*Grand* M	*Grand* SD	*Minimum / Country*	*Maximum / Country*
A37	How often do you feel tense or nervous at work? (1 = *always*)	.70	.00	.73	.02	3.14	.29	2.55 Japan	3.68 Denmark
C9	A good manager gives detailed instructions, not merely general directions (1 = *strongly agree*)	.55	.02	.17	.38	3.38	.33	2.53 France	3.92 United States
C13	Most employees have an inherent dislike of work and will avoid it if they can	.41	.05	–.52	.07	3.91	.13	3.66 Belgium	4.18 Sweden
C17	A large corporation is a more desirable place to work than a small company	.58	.01	.15	.63	2.81	.30	2.38 Mexico	3.42 Norway
B60	Company rules should not be broken, even if employee thinks it in company's interests	.40	.03	–.24	.29	2.96	.33	2.35 Portugal	3.57 Denmark
B55	Employees lose respect for a manager who seeks advice before he decides (1 = *strongly agree*)	.24	.22	.10	.63	4.10	.19	3.44 Japan	4.40 Portugal

(continued)

TABLE 2 Continued

Number	*Text*	R	P	*Regression of P_{CHD} Beta Weight* β	*Significance of* T	*Grand* M	*Grand* SD	M *Minimum / Country*	M *Maximum / Country*
C12	There are few qualities more admirable than dedication and loyalty to the company	.62	.00	–.02	.93	3.01	.38	2.36 Venezuela	3.57 Finland
A9	Importance of training opportunities for improving or new skills (1 = *utmost*)	–.44	.02	–.19	.42	5.61	.56	4.75 United States	6.59 Venezuela
A18	Importance of job leaving time for personal or family life	.38	.04	–.01	.95	4.66	.72	3.07 Hong Kong	5.72 New Zealand
B46	Nonmanagerial employees perceiving that employees are afraid to disagree (1 = *very frequently*)	.59	.00	.13	.68	3.10	.33	2.49 Greece	3.64 Austria

SOURCE: Work value question data taken from Hofstede (1980, Appendices 2-3).

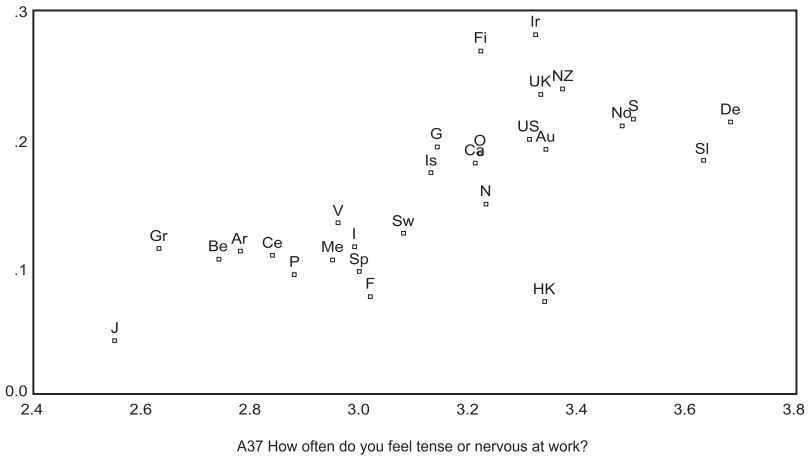

Figure 1: P_{CHD} Versus Often Feel Tense or Nervous at Work
NOTE: CHD = coronary heart disease.

of authority at work. The term *watchful deference to authority* was chosen to describe the emergent pole. The implicit pole is associated with values that are normally held in esteem: relaxed style, personal initiative, and forthrightness. These traits may also imply covert or overt hostility, insensitivity to protocol, or avoidance. If these values are indeed pathogenic rather than statistical artifacts, a negatively loaded term such as *insubordination* might be appropriate.

The combination of low power-distance and absence of tension does not correspond to any well-known CHD risk factor in humans. The trait of "cynical hostility" could conceivably be equated with "insubordination." Low power-distance may also be implied in the "chronic struggle against time and other people" of Type A behavior. "Submissiveness" has been identified as a protective factor against nonfatal MI in women in a single study (Whiteman, Deary, Lee, & Fowkes, 1997). The combination of values will be tentatively described as "submissiveness" and its pole as "insubordination." If this has any meaning, clues might be found in primate research on dominance and atherogenesis.

Kaplan and Manuck (1997) report a series of studies of the cardiovascular effect of stress in cynomolgus macaque monkeys. This primate lives in troupes that develop a strong internal hierarchy. In an unstable situation, dominance is achieved by aggression, but

the hierarchy soon becomes ritualized. In captivity, the natural hierarchy develops. Moving animals between cages is highly stressful, as the individual has to reestablish its position in the dominance hierarchy. Macaques eat very little fat in the wild but were fed an atherogenic diet for these experiments. In one study, some macaques were rotated frequently between cages, while controls were left alone. At postmortem 22 months later, it was found that the animals that had been moved frequently had twice the level of coronary atheroma of the low-stress animals in the stable environment. In other studies, beta-blocking drugs or the contraceptive pill were found to prevent atherosclerosis in chronically stressed monkeys.

Sapolsky and Ray (1989) also studied dominance hierarchy in wild olive baboons in Kenya. The stress event was the reaction (prior to unconsciousness) to an anesthetic dart fired by the researcher. Social rank was rated according to the number of fights won and the ability to harass and supplant other males, and animals were classified according to a median split. Subordinates were found to have persistently higher levels of the stress hormone cortisol. Later studies found that dominant position per se was less important than social perception. Those with low cortisol could distinguish between neutral behaviors and threats, would initiate a fight if a threat were actually present, and would displace aggression onto a subordinate if the fight were lost.

Submissiveness might imply avoidance of status conflicts. Insubordination would then reflect the tendency to engage in power struggles, which are more likely to be lost than won, with consequences for unexpressed hostility. The existence of statistically significant correlations does not of course demonstrate causation, and paradoxes often arise. Subjective well-being (SWB) has also been compared between countries using Hofstede data (Arrindell et al., 1998). A strong correlation of .76 between SWB and CHD mortality emerges. This leads to the unlikely conclusion that countries with high well-being have high rates of heart disease!

Regression equations with 28 data points and 10 predictors are likely to generate spurious predictions. These correlations should therefore be used to generate hypotheses that could be refuted in studies of individuals. The study to be described next was an attempt to study individuals using the novel submissiveness scale.

JAPANESE AND BRITISH WORK VALUES AND CHD RISK

Japanese working abroad are of particular interest in terms of CHD risk. First, Marmot, Syme, Kagan, Kato, Cohen, and Belsky (1975) showed that the protective effect of being Japanese largely disappears in the children of emigrants to California. Second, prolonged residence in a foreign country confers marked risk for CHD and diabetes (Cruickshank & Beevers, 1989), for reasons that remain obscure. Migration is generally to a higher GDP country and involves a better fed and less active lifestyle. This is not the case with Japanese working abroad. Third, employment for men in Japan has been a pattern of "work-as-family," at least until the last decade. A Japanese man joined a company on leaving education and expected to stay with it throughout life. Although work involves a strong hierarchy, it also has features of parent-child (*oyabun-kobun*) relationships and valued patronage (*amae*). Japanese people are anxious to avoid offense and have numerous patterns of ritual politeness for maintaining the social structure. Complaints and impolite speaking are permitted, often when the work group continues as a social event during the evening. Where transgression of roles occur, the senior person can reprimand or even strike the subordinate to restore conformity. This does not usually threaten the continuity of group membership. This social structure has some interesting parallels with the social structure of the primate troupe.

The study to be described measured work values and CHD risk in a cross-section of healthy managers and engineers working in Japanese companies in the United Kingdom.

PARTICIPANTS

Cooperation of multinational companies with branches in the English West Midlands were obtained. The questionnaire language was according to citizenship. The translation was undertaken by Aya Lewis, a lecturer in Japanese in the United Kingdom. Previous translations were incorporated where possible. Japanese men with a particularly strong command of English were asked to additionally complete the alternate form. Hardly any items had to

be revised as a result of this reliability check. One questionnaire from a Japanese in English and one from a female respondent were discounted. A total of 115 participants returned valid questionnaires, of which 53 were U.K. citizens and 62 Japanese.

MATERIALS

A CHD risk profile composed only of data that could be retrieved by self-report was constructed. Risk factors were considered as the components $Risk_5$ to $Risk_{10}$ in the calculation of μ described above. The risks were self-report of hypercholesterolaemia, hypertension, smoking, fat intake now, fat intake as a young person, BMI, adverse family history, infrequent exercise, and vital exhaustion. Each factor was categorized as present or absent. The risk associated with sex was held constant by reporting only on males. The age term was not calculated. Three questions on alcohol and socialization were devised, which are reported elsewhere (Conduit, Appels, & Lewis, 1998). Fat intake was assessed by frequency of consumption of 11 foods with a high fat content. The Maastricht Vital Exhaustion Scale (Appels, 1980) was also included. A cumulative risk factor score was found by addition, with cholesterol, blood pressure, and smoking assigned twice the weight of other factors. For illustration only, P_{CHD} was calculated as a distribution around the theoretical mean of 0.23.

Assessment of work values in the present study was by Values Survey Module (VSM) 94 (Hofstede, 1994). It has 20 questions in which five factors are tapped by 4 questions each. Question A37 is imported with unchanged text, but reverse scoring, as Question 13 in VSM94. A scale for submissiveness from VSM94 cannot use all the items from the 1968-1972 version. The highly discriminative question A54 "preference for manager" cannot be used. The most relevant questions are the following:

Question 3: to have a good relation with superior (of utmost importance = 1)
Question 13: nervous or tense at work (always = 5)
Question 14: afraid to disagree (very frequently = 5)
Question 16: manager can be imprecise (strongly disagree = 5)
Question 19: rules should not be broken (strongly agree = 1)

VSM94 also includes biographical questions for age, job seniority, and education. An acculturation question was added. For the

Japanese, this was "How many years have you worked in the United Kingdom?" and for the British, the item was "How many years have you worked in a company with Japanese connections?" A hostility scale (Buss & Durkee, 1957) was included, which will not be reported in detail here.

A covering letter in English was attached to either language version. Questionnaires were distributed at the place of work, with a stamped addressed envelope for return. Scoring was entirely in multiple-choice format. This is common practice in Japan and allowed the author with limited Japanese to tabulate the responses.

ANALYSIS

The main statistical analysis was undertaken in Statistical Package for the Social Sciences. VSM and Buss-Durkee items were also tabulated using a spreadsheet, Microsoft Excel. The spreadsheet algorithm used categorical rather than integer values, so the use of two algorithms detected data-entry errors. VSM94 has not been standardized for use in studies of individuals, so its psychometric properties were calculated.

A cumulative risk factor score was calculated by adding the 10 risks. Cholesterol, blood pressure, and smoking have quantitative values derived from Framingham data and were given weights of 2 where reported, and 3 for heavy smoking. Other risks are recognized by medical consensus only (Wood et al., 1998). Being overweight, fat intake now, fat intake when young, indolence, adverse family history, and alcohol excess were each given a weight of 1. Scores above the median on vital exhaustion were also given a weight of 1. Age was not included, sex was held constant, and pathological factors such as diabetes and left ventricular hypertrophy were unknown.

RESULTS

The prevalence of each risk factor by nationality is shown in Table 3.

Demographic data and sources of response bias were examined for comparability of the samples, which were intended to be similar. Similarity was achieved in terms of job seniority ($p = .16$). The Japanese were slightly older ($M = 43$ vs. $M = 39$, $p = .05$). The age

TABLE 3
Coronary Heart Disease Risk Factor Prevalence in 115 Individuals

	National Sample M or % Reporting		*Afraid to Disagree (Question 14) Versus This Risk Correlation*		*Tension (Question 13) Versus This Risk Correlation*		*Risk*
	British	*Japanese*	*British*	*Japanese*	*British*	*Japanese*	*Weight*
Current smoker	30.2%	33.9%*	–.19	.04	–.03	.04	3
Fatty foods now, number	9.11	9.93	–.18	.22	.07	–.04	1
Fatty foods, age 20 to 25	11.45	10.37	.21	.18	.07	.04	1
Family history adverse	36%	8.4%**	–.11	.03	–.04	–.06	1
Exercise less than once a week	60.3%	11.3%**	.10	.15	.25	.16	1
Overweight	16.1%	59%	.16	–.09	.26	–.19	1
Vital exhaustion	26%	48%	.11	.26*	.40*	.34*	1
Hypertension	4.0%	4.8%	—	—	—	—	2
High cholesterol	12.2%	14.5%	.11	.23	.20	.05	2
Alcohol excess	6%	7%	.14	.23	.24	.12	1
Risk factors	4.08	4.10	.01	.25*	.43*	.05	Maximum = 14

*p = .05. **p = .01.

discrepancy would be expected to increase the Japanese morbidity slightly. The Japanese men are expatriate managers or engineers, and therefore, nearly all have university degrees. They were considerably more educated (16 years vs. 14 years, $p < .001$). There might be cultural differences in answering questionnaires that would skew the response set of British and Japanese men in different directions. Tests for embarrassment, modesty, avoidance of extremes, and favor seeking did not show any significant differences. The cultural similarity was surprising, and further details are available on request.

VSM94 was examined psychometrically. It uses 5-point scales, and the participant has to ring a number; 1 = *of utmost importance*

or *strongly agree*. Some answers are negatively weighted in the calculation of metavariables. The distribution of responses on most items of VSM94 was found to be skewed toward the left-hand column. The mean response for the first nine questions was more than 1 *SD* below the midpoint of the scale. Cronbach's alpha for each of the five subscales was found to have a value below 0. The novel submissiveness scale would be mainly composed of the four PDI items. Correlations between these item pairs did not reach significance in the predicted direction. The VSM94 scales could not therefore be used in further analyses. Question 14 ("subordinates afraid to disagree") had a *M* of 2.96 and *SD* of 0.68 and was retained. The most discriminative Question 13 ("nervous or tense at work") had a *M* of 2.58 and *SD* of 0.80 and was also used as an individual predictor.

Prevalence of risk factors for CHD is shown as group means in Table 3. It can be seen that risks for the two nationalities are similar in respect of dietary fat, smoking, cholesterol, and blood pressure. The Japanese were less active but less likely to be overweight. The total risk factor score was also not significantly different. Adjustments were made to the weights in the risk factor score, such as increasing the weight for BMI or removing vital exhaustion. No adjustment resulted in a risk profile favoring Japanese. The Japanese were significantly more exhausted than the British, contrary to hypothesis. The distribution of CHD risk is therefore the same in the expatriate Japanese and the British.

The prediction of risk factors from the two reliable work values was in the opposite direction to that predicted by submissiveness. The distribution of all work values was similar in the two nationalities, except that tension at work was higher in the Japanese (3.2 vs. 2.6, $p < .00$). Exhaustion, high cholesterol, alcohol excess, and total risk were predicted by fear of expressing disagreement in the Japanese. Exhaustion, alcohol excess, high cholesterol, indolence, and overweight were predicted by tension at work in the British. Total risk was significantly predicted by tension in the British but not in the Japanese.

CONCLUSION

National comparisons suggest that submissiveness may reduce the risk of dying from CHD. IBM workers who accepted hierarchy and worried about breaking rules were statistically less likely to

die from heart disease 20 years later than those who were casual at work and challenged authority.

A study of 115 individuals found no evidence of a CHD protective factor in the Japanese, whose CHD risk profile was the same as that of the British. VSM94 scales were found to be unreliable for research at the individual level. Tension at work predicted several CHD risks in the British. The prediction of CHD risk from tension and fear was in the opposite direction to that predicted by the submissiveness factor. Vital exhaustion was strongly predicted by tension and fear of disagreement in both nationalities. The Japanese were much more likely to be exhausted.

The high CHD risk in the Japanese suggests that any cardioprotective factor is rapidly lost in exiles. This tends to support the findings of Marmot et al. (1975) about Japanese emigrants. The high diabetes and CHD risk in immigrants to Britain has been reported repeatedly (Cruickshank & Beevers, 1989). Migration and CHD risk warrants further research.

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Edward Conduit, B.Sc., M.Sc., is a clinical psychologist of 27 years experience, 10 of them working with cardiac patients. This article was written while he was an honorary lecturer at the School of Health Sciences, University of Birmingham, United Kingdom. Psychological influences on heart disease are not well described, so he is currently researching some of these influences in association with Professor Ad Appels at Maastricht. Appels' concept of "exhaustion" provides a useful integration of many diverse findings. Previous publications on this issue have demonstrated a U-shaped relationship between alcohol and heart disease risk.

Economy and Religion in the Neolithic Revolution: Material Surplus and the Proto-Religious Ethic

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Does economic change stimulate religious transformation, or do new religious ideas inspire economic innovation? Since Marx and Weber, social theorists have considered this question, most often in regard to modern societies. Here, the authors examine archaeological evidence from 40 ancient sites in the Near East, where horticulture and herding first arose. Results suggest that economic surplus preceded two types of religious artifacts. In the authors' data, utilitarian grave gifts never appeared without surplus—in herds or especially in grain. Although their timing is less conclusive, animal figurines rarely appeared without herding. These two types of artifact are more strongly related to surplus than artifacts tapping wealth or social complexity generally (decorative grave gifts and human figurines). Hence, although the data prohibit elaborate statistical controls, the hypothesized associations seem nonspurious. Apparently, religious ideas did not prompt new methods of economic production. Rather, economic facts were crucial in shaping Neolithic social institutions, including religion.

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Revolutions in basic institutions redirect social history. In the Industrial Revolution, for example, economic production was mechanized and bureaucratized, whereas religion grew more individualistic (Crippen, 1988). From Marx (1859/1986) and Weber (1905/1958) to Lenski (1966) and Mann (1993), major theories of social structure and enduring theoretical disputes have come from examining the institutional transformations of the Industrial Revolution.

Much earlier, the Neolithic Revolution marked one of humanity's first great turning points (Sherratt, 1997). As food production shifted from hunting and gathering to herding and horticulture, permanent settlements arose (Kelly, 1995), strategies of warfare were refined (Cioffi-Revilla, 1999), and religion was elaborated (Maryanski & Turner, 1992).

If theories inferred from the Industrial Revolution offer fundamental principles, we might be able to generalize them to understand the transformation of institutions in the Neolithic. This article contrasts two such theoretical positions, with a focus on the relationship between economic and religious institutions. We then test the resulting predictions with archaeological data from 40 Neolithic sites in the Near East. Simply stated, we seek to examine whether (1) economic surplus preceded, and perhaps helped to cause, more elaborate religious beliefs; or (2) new religious ideas and practices preceded, perhaps causally, the accumulation of surplus.

This theoretical question is quite ambitious. In contrast, our empirical basis for addressing it is unavoidably modest. The question absolutely dictates the use of archaeological evidence from prehistoric times. Inevitably, such evidence entails problems: small sample size, uncertainties in dating, coincidental trends, physical artifacts that may survive only as fragments, if at all, and the absence of direct information about intangible ideas, beliefs,

Authors' Note: *We acknowledge with thanks the useful comments from several anonymous reviewers and from David Ashley, Randall Collins, James Hester, Robert Kelly, Mark Lupher, and Richard Machalek. The support and facilities provided to Grandjean by the Department of Mathematics and Statistics at the University of Otago in Dunedin, New Zealand, are also gratefully acknowledged, as is the assistance of Joshua Johnson of the Spatial Data and Visualization Center at the University of Wyoming.* *Direct correspondence to Jill E. Fuller at the Department of Sociology, University of North Carolina at Greensboro, Greensboro, NC 27402; e-mail: jefuller@uncg.edu.*

and patterns of social life (see Spencer, 1992). Like other long-range analyses based on primary archaeological sources (e.g., Cioffi-Revilla, 1999; Denton, 1993), our research rests on the premise that an important theoretical question justifies seeking at least a tentative empirical answer, despite shortcomings in the data. The consistency of our results across several quasi-independent tests argues against some plausible rival hypotheses, both methodological and theoretical. Still, as Matlock (1995) notes, "When a study seeks to break new ground, its results should be treated with due qualification until they are confirmed in replication" (p. 173).

FROM THE OLD STONE AGE TO THE NEW

Neglect of the Neolithic in some of the social sciences (see Wallerstein, 1974, p. 3) is now being redressed (e.g., Cioffi-Revilla, 1999; Crippen & Machalek, 1989; Diamond, 1997; Mann, 1986; Maryanski & Turner, 1992). Meanwhile, archaeology's long-standing interest in the period (Childe, 1939) is yielding deeper understanding (Henry, 1989; Sherratt, 1997).

AN APPROXIMATE CHRONOLOGY

For 100,000 years or more, humanity's basic social units were probably kin-based bands of hunter-gatherers. Settlements were mainly seasonal camps, as the band followed the yearly cycles of game, plant foods, and water. But, foraging was not necessarily arduous (Kelly, 1995), and social life was surely more than just subsistence. At least 60,000 years ago, Neanderthals adorned their dead in ways that suggest wonder at mortality and perhaps religious ritual. By 30,000 BC, carvings and cave paintings by anatomically modern humans showed a fascination with the animals they hunted, probably expressed not only in art but also in religious beliefs (see Barton, Clark, & Cohen, 1994; Rice & Patterson, 1996).

As early as 15,000 years ago, there were the scattered beginnings of horticulture: irrigating wild grains and even deliberate planting in a few places. Domestication, at least of the dog, was known by then as well. In short, there were precursors to the Neolithic Revolution (Collins, 1986), just as there were precursors to capitalism before its takeoff in the Industrial Revolution (Weber, 1905/1958). Like capitalism, neither horticulture nor herding

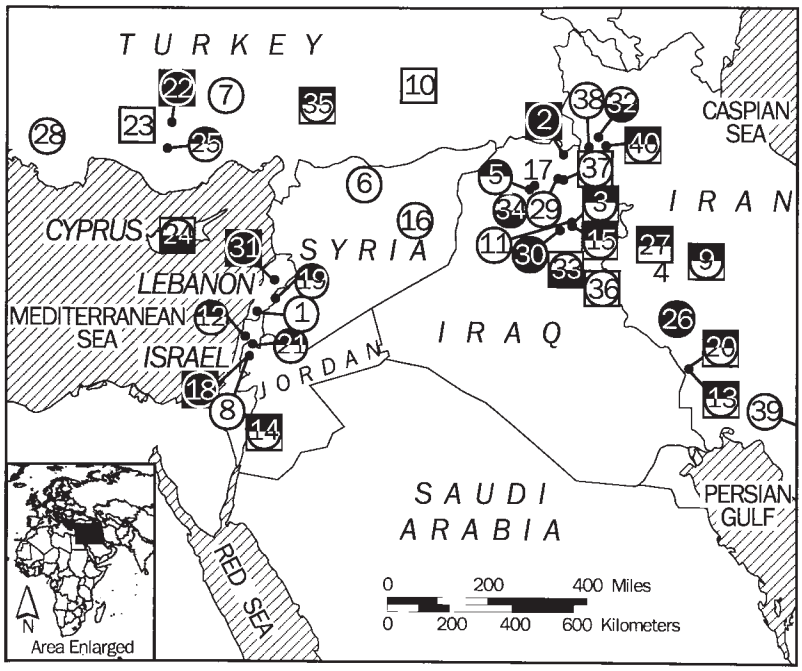

Figure 1: Map of the Ancient Near East, Showing Modern National Borders and 40 Neolithic Archaeological Sites (Mercator projection by the authors with Joshua H. Johnson using ArcView 3.2 software)

NOTE: The sites, named in Table 1, are numbered in chronological order from earliest (1 = 9000 BC) to most recent (40 = 3750 BC). Circled numbers indicate sites with grain surplus; boxed numbers are herding sites; and circles within boxes signify both types of surplus. Bottom-filled circles or boxes indicate functional grave gifts; top-filled circles or boxes represent animal figurines; completely filled signifies both; and unfilled means neither type of religious artifact was found at the site. Two sites (4 and 17) lack all of these characteristics and are shown as numbers only. To conserve space, one site (39) is shown about 500 miles west of its actual location.

became predominant until being institutionalized through cultural and political supports.

For the Neolithic, the institutional takeoff began about 10,000 years ago and spread by diffusion and independent discovery throughout the world. Figure 1 shows the area of the ancient Near East where the Neolithic Revolution first took hold, and locates the 40 sites that we analyze below.

Some details of the takeoff remain subject to debate (see Wright, 1993), but the broad outlines are clear. A widely accepted scenario

involves a changing climate in the uplands of the Near East at the end of the last Ice Age. Wild grains became more reliably available in some places, although in other spots grazing animals such as wild goats were abundant (cf. Diamond, 1997). These locations allowed more permanent residence (Kelly, 1995), and the basic social unit enlarged from the band to the settlement of 100 or more people. A cluster of several dozen small houses, often with stone foundations and walls of stone or mud, might cover a few hundred square meters. Sometimes, a ditch or wall would enclose the entire cluster, reflecting the residents' intention to defend the permanence of their homes (Cioffi-Revilla, 1999; Diehl, 1992).

However, intensive foraging around fixed settlements would eventually deplete nearby resources. No doubt some groups simply died out, whereas others reverted to classic foraging in small, migratory bands. But, some found ways to increase the carrying capacity of the land.

ECONOMIC CHANGES

The Neolithic Revolution saw two major advances in human productivity. First, it became possible to accumulate a significant surplus of grains, beyond daily subsistence needs. Improvements in the stone-toothed sickle, along with the use of large storage pits, contributed to more efficient harvesting and storing of cereals. Even groups still dependent on wild grains could amass some surplus—enough to see them through the lean season and more (Binford, 1980; cf. Divale, 1999). The new methods of harvest and storage also provided a strong genetic selection for grains that adhered most firmly to their stalks during transport to the settlement—and it was precisely such strains that were first actively cultivated (McCorriston & Hole, 1991).

A second advance was domestication of livestock. Some time after the rise of grain storage, animals such as goats, pigs, sheep, and cattle all came under human dominion (Crabtree, 1993). The climate and terrain best suited for herding were typically not ideal for grain, so these tended to be alternative rather than complementary ways of life. But, both allowed the accumulation of surplus. Besides providing food for immediate consumption, domestication meant that extra meat, milk products, and clothing material could all be stored on the hoof.

RELIGIOUS CHANGES

There were also religious innovations in the Neolithic, although they are open to more varied interpretations. Inferring ancient beliefs and practices from surviving physical evidence or from ethnographic analogies is inherently ambiguous (see Peregrine, 1996b).

Maryanski & Turner (1992) view the changes as mainly in cult structure and in ritual: a more organized structure, including specialized buildings for religious activity led by religious functionaries; and more elaborate rites, using artifacts to symbolize aspects of the supernatural. They see the belief system as retaining much of its earlier simplicity: little more than a set of myths depicting supernatural forces. If so, then the mythology contained only "the seeds of the kinds of belief system [in] . . . advanced agrarian systems" (p. 106), in which a clear conception of an afterlife would become central. Similarly, Bellah (1970) notes[1] that "the overriding goal of salvation that dominates [later] religions is almost absent in primitive religion, and life after death tends to be a shadowy semiexistence in some vaguely designated place in this world" (p. 23) (cf. Child & Child, 1993).

Recent archaeological studies support the view of growing complexity in structure and ritual (Byrd & Monahan, 1995; Kujit, 1996). Neolithic buildings with no signs of mundane habitation may have been specialized centers for religious activity, just as artifacts with no apparent utilitarian purpose suggest symbolic use. Human figurines could have been used in religious rituals to represent ancestors (Byrd, 1994) or the personification of supernatural forces. Animal figurines could have been tangible symbols of human efforts to control nature.

Yet, Neolithic beliefs about an afterlife may not have been as vague as some scholars think. According to Isaac (1970), new death-and-resurrection myths arose at about that time, based on "the belief that the world emerged from the death of a primeval being or god" (p. 107). Such ideas might have been a response to a rising death rate if the sanitation problems, risk of communicable disease, and high fertility in fixed settlements reduced the life expectancy of Neolithic villagers compared to their low-fertility nomadic ancestors (Spooner, 1972). Burials from the immediate pre-Neolithic Near East show little adornment of the deceased (Byrd & Monahan, 1995), whereas in the Neolithic proper, the dead

were often decorated with red pigment, flowers, or jewelry. Neolithic graves might also be furnished with functional grave gifts such as tools, food, or weapons.

Decorating the dead indicates ritualized ways of expressing grief. Functional grave gifts suggest the same but may also provide evidence for more developed beliefs about life after death (see Campbell, 1995). That is, detailed expectations about an afterlife seem the most likely explanation for burying functional goods for use by, or to appease, either the dead or the spirits of a nether world.[2]

Whatever the specific content of Neolithic religion, its growing complexity was closely entwined with the economic advances described above. For example, religious functionaries may have coordinated group tasks like planting, harvesting, storing, and distributing grain, or adjudicated conflicts over possession of livestock and distribution of meat (cf. Child & Child, 1993). A special building might have served as a venue for quasi-political and economic decision making as well as for religious ritual (Byrd, 1994). Indeed, the sociopolitical forms of the day may even have shaped conceptions of the pantheon of prehistoric gods (see Peregrine, 1996a; Swanson, 1960). In short, religious changes were part of the general institutional transformation by which the Neolithic Revolution became imbedded in social structure.

CAUSAL CONJECTURES

As Wright (1993) notes, "The where and when of agricultural origins in the Near East are thus being narrowed down to well-supported reconstructions. The why will always be problematical" (p. 467). We summarize two points of view, highlighting their contrasts.

A MATERIALIST ACCOUNT

In one view (e.g., Cohen, 1977), the main impetus to cultivation and herding was material need. "Hunters and gatherers were compelled to turn to farming when they could no longer support themselves by the old techniques" (Maryanski & Turner, 1992, p. 92). Other institutional changes followed. "To become horticulturists,

then, necessitates the elaboration of culture and social structure" (Maryanski & Turner, 1992, p. 92).

This viewpoint parallels Marx's argument (1859/1986) that "the mode of production of material life conditions the social, political, and intellectual life process in general" (p. 187). His main case in point was the Industrial Revolution, wherein the belief in individual salvation helped to justify atomized wage-labor and capitalist commodity production (Marx, 1867/1964, p. 135). But, a similar logic has also been applied to the Neolithic Revolution (e.g., Harris, 1977, 1979; Mann, 1986).

Key elements of such a materialist position can be synthesized as follows: In pre-Neolithic bands, with economic production at the subsistence level, everyone shared in roughly equal measure or the group did not survive. However, once there was a surplus, some people could use talent, coercion, or guile to obtain disproportionate material comfort (Lenski, 1966). The more fortunate might then adopt, promote, or originate an ideology that justified their advantages. Furthermore, "a surplus of food supply . . . gives opportunities for occupations that are not absolutely necessary for . . . everyday life," including religious roles (Boas, 1920/1948, p. 285). Accumulation thus provides a means for its own ideological justification.

Religious beliefs dictating functional grave gifts could serve that purpose. If extra tools, food, and clothing were needed for an afterlife or to appease the spirits of death, that need would legitimate amassing more of them than was required for present consumption. Accumulation would be understood, not for the worldly comforts it brought, but as simple prudence for future funeral demands.

For herders, there was an additional way in which religion could justify accumulation. Human control over animals might at first have seemed a profanity. Animals had been sacred mysteries of nature—objects of awe and reverence, even as they were hunted (cf. Child & Child, 1993; Durkheim, 1915/1965). To take them from the wild and put them under human control was to disrupt the natural order. But, herders might legitimate domestication through rituals involving animal figurines. These were images of animals symbolically controlled by human beings. Their ritual manipulation, combined with suitable legitimating beliefs, could help to make the physical control of the actual animals seem less unnatural, even laudable.

Thus, a generalized materialist logic views the accumulation of economic surplus as a precondition to religious transformation. Material surplus in grain or herds could promote functional grave giving, and herding could also promote rituals with animal figurines.

A CONTRASTING VIEW

Obviously, we have exaggerated the materialist position. As Mann (1986) argues, "Economic power relations, modes of production, and social classes come and go in the historical record. In occasional world-historical moments, they decisively reorganize social life; usually they are important in conjunction with other power sources; occasionally they are decisively reorganized by them" (p. 523). That is, under appropriate historical conditions, cultural institutions such as religion can shape the economic no less than the reverse (e.g., Bellah, 1970; Collins, 1997).

A case in point is the effect of the Protestant ethic on the spirit of capitalism. According to Weber (1905/1958), the Calvinist doctrine of predestination generated anxiety over who was destined for heaven. Economic effort could not affect the outcome, but it could reduce anxiety because worldly success was viewed as a sign of divine favor for the hereafter. This and other elements of Protestant belief, along with several unique historical circumstances, contributed to the takeoff of industrial capitalism. Thus, the impact of culture on the economy was substantial and perhaps decisive, although Weber (as well as Marx) recognized that causation did not flow exclusively in either direction (Collins, 1980; Engels, 1890/1964).

A parallel logic has been applied to the Neolithic Revolution (e.g., Isaac, 1970; cf. Wallace, 1994). What we will call a "culturist" position can be summarized as follows: Humans seek meaning in the mysteries of life, a drive hardly less compelling than the need for food. Ancient peoples therefore developed myths about death, birth, prey, vegetation, celestial bodies, weather, and the like (cf. Child & Child, 1993). As this "proto-religious ethic" grew more complex, so too did beliefs and rituals. Burial rites were increasingly prescribed, such as the inclusion of functional items in the grave to provide for an afterlife or to appease the dead.

The idea that goods were needed for burials could create anxiety about accumulating enough to meet those needs. In turn, the

anxiety could drive a "spirit of accumulation" that would be a powerful motivator to human ingenuity. The result would be new methods for harvesting, storing, and cultivating crops and for domesticating animals.

Thus, religious ideas might have motivated the technological advances that made economic surplus possible. Furthermore, "to transform that possibility into a reality requires an ideology that motivates farmers to produce more than they need to stay alive . . . [A] system of beliefs that defined people's obligations with reference to the supernatural was best suited to play this critical role" (Lenski & Lenski, 1982, p. 173).

Beliefs dictating functional grave gifts could have done so alone, but other ideas might also have been at work. The symbolic control of animal spirits (through figurines) could foster the idea of domestication. Or, domestication might have been a result of death-and-resurrection myths, with both animal figurines and live animals likely to be involved in the associated rituals. "Crescent-horned animals, an epiphany for both the lunar goddess and her consort, became a favorite substitute for the god in the reenactment of the myths, and the necessity for a permanent supply of sacrificial stock led to . . . domestication" (Isaac, 1970, pp. 108-109).

In short, from an exaggerated culturist viewpoint, the development of certain religious ideas was a precondition to economic surplus. The need for functional grave gifts could motivate the accumulation of surplus in grain or in herds. In addition, rituals involving animal figurines could lead to conceiving and implementing control over livestock.

SOME RIVAL HYPOTHESES

In the spirit of "conjecture and refutation" (Popper, 1962), we have contrasted two simplified but plausible conjectures on the dynamics of economic and religious developments in prehistoric times. "Simple hypotheses boldly defended are often . . . the best spurs to research" (Cohen, 1977, p. ix). Suitably refined, each of the two basic positions has its proponents (e.g., Isaac, 1970; Maryanski & Turner, 1992). Within the limits of the archaeological record, we seek to determine whether the evidence refutes either conjecture.

Any interesting social phenomenon is open to alternative explanations. The value of a particular study lies in how it narrows the

alternatives by showing that some are contradicted by the evidence (Popper, 1962). The limitations of our data argue against complex statistical controls. Still, our research design permits examining some plausible alternative explanations.

For example, consider wealth as an explanation. If we find economic surplus associated with grave gifts, perhaps a prosperous people simply have more extra goods that they can afford to bury. Despite more burial offerings, the underlying religious sentiments might be no different from those in a less prosperous group. We can shed some light on this possibility by comparing grave gifts that are utilitarian to those that are merely decorative. If wealth alone were the driving force, surplus should be associated to about the same degree with both types of grave gift because a prosperous people could afford to bury more goods of all sorts. By contrast, our materialist and culturist conjectures predict surplus to be related specifically to utilitarian gifts, implying a weaker association, if any, with decorative gifts.

Relationships in the data might also be explained away as coincidental trends in social complexity (see Chick, 1997) or as due to differential survival of some artifacts (cf. Cioffi-Revilla, 1999). Of course, we cannot rule out all potential sources of spurious association, but as discussed below, our design does consider a number of plausible rival hypotheses.

Yet, not all hypotheses involving similar variables are strict rivals. Some may be complementary, addressing related but separate aspects of the phenomenon. For instance, Swanson's (1960) focus on the "birth of the gods" dovetails with our own concerns, but tests of his hypotheses (e.g., Peregrine, 1996a) do not address our materialist or culturist conjecture per se. In our conclusion, we will discuss some implications of such related but distinct research.

Finally, we note that the materialist and culturist conjectures do not require that a society independently invent its characteristic economic or religious forms. By either logic, imitating other times or peoples is perfectly suitable. In the culturist [or materialist] view, economic [religious] forms may be developed through invention or imitation but will take hold only if they are consistent with the preexisting religious [economic] forms. The preexisting forms may themselves have been acquired independently or by diffusion (cf. Hendrix, 1997).

METHOD

SELECTING THE CASES

Our investigation focuses on the area in the Near East where the transition to grain storage and herding first took off: Cyprus, Israel, Iran, Iraq, Jordan, Lebanon, Syria, and Turkey (Wright, 1993). The unit of analysis is the *site*, a single settlement ranging in size from a small camp to a substantial town. We use archaeological evidence from all such sites for which systematic descriptions or inventories of site attributes were found in the published literature. Data spanning roughly 5000 years were obtained for the 40 sites in Figure 1 and Table 1.

DATING THE SITES

We rely on averaging the site dates reported in the literature, based on expert judgments. Such judgments rest in part on carbon-14 results (see Michels, 1973) and in part on other evidence, such as the geological stratum of the site. For our 40 sites, these average dates correlate almost perfectly with dates based solely on the carbon-14 method ($r = +.97$).

CODING THE VARIABLES

Grain surplus. Archaeology is more prone to false negatives (evidence does not survive or is not found) than false positives (evidence suggests an attribute at a site that lacked it). Accordingly, we combine two different indicators for our operational definition of grain surplus. Harvesting was greatly improved in the Neolithic by refinements in the sickle—a blade of wood, bone, or horn inlaid with small chipped stones called microliths. The presence of such sickles or sickle parts is our first indicator. Second, extra grain demanded special rooms, bins, or pits for its storage. We code a site as having a surplus if there is evidence of sickles, storage, or both.

A grain surplus did not require actual crop cultivation (Henry, 1989). Wild-grain foragers could be as effective as cultivators in accumulating a surplus, provided that they had advanced sickles for the harvest and facilities for storage (Binford, 1980). From the available evidence, it is not possible to differentiate sites with

TABLE 1
Economic Surplus and Religious Attributes for 40 Neolithic Sites

			Surplus		*Grave Gifts*		*Figurines*	
Site Number and Name(s)	*Area*	*Date*	*Grain*	*Herds*	*Functional*	*Decorative*	*Animal*	*Human*
1. Ein Mallaha/Eynan	Levant	9000[a]	Y			Y		Y
2. Zawi Chemi/Shanidar	Iraq	8750	Y	Y	Y	Y	Y	
3. Karim Shahir	Iraq	8500	Y	Y		Y	Y	
4. Tepe Asiab	Iran	8500				Y		Y
5. Tell M'Lefaat	Iraq	8000	Y				?	?
6. Mureybit	Levant	7875	Y					
7. Asikli Huyuk	Turkey	7500	Y					
8. Jericho	Levant	7300	Y					
9. Ganj Dareh Tepe	Iran	7100	Y	Y			Y	Y
10. Cayonu Tepesi	Turkey	7000		Y				Y
11. Khora Namik	Iraq	7000	Y					
12. Nahal Oren/Wadi Fallah	Levant	7000	Y			Y	Y	
13. Bus Mordeh	Iran	6900	Y	Y			Y	
14. Beidha/Seyl Aqlat	Levant	6850	Y	Y		Y	Y	Y
15. Qalat Jarmo	Iraq	6750	Y	Y		Y	Y	Y
16. Bouqras	Levant	6500	Y					Y
17. Gird Ali Agha	Iraq	6500						Y
18. Jericho	Levant	6500	Y	Y	Y		Y	Y
19. Ramad	Levant	6500	Y			Y	Y	Y
20. Ali Kosh	Iran	6375	Y	Y		Y	Y	Y

21. Munhata	Levant	6250	Y				Y	Y
22. Catal Huyuk	Turkey	6100	Y	Y	Y	Y	Y	Y
23. Erbaba	Turkey	6000		Y				Y
24. Khirokita	Cyprus	6000	Y	Y	Y	Y		Y
25. Suberde	Turkey	6000	Y				Y	Y
26. Tepe Guran	Iran	6000	Y		Y	Y	Y	Y
27. Tepe Sarab	Iran	5800		Y			Y	Y
28. Hacilar	Turkey	5675	Y					Y
29. Shimshara	Iraq	5675	Y					
30. Tell Matarrah	Iraq	5600	Y		Y	Y	Y	Y
31. Byblos	Levant	5575	Y	Y	Y		?	?
32. Hajji Firuz	Iran	5250	Y		Y	Y		Y
33. Tell es-Sawwan	Iraq	5175	Y	Y	Y	Y		Y
34. Hassuna	Iraq	5100	Y		Y			Y
35. Jeitun	Turkey	5000	Y	Y			?	?
36. Choga Mami	Iraq	4900	Y	Y				Y
37. Gird Banahilk	Iraq	4750	Y	Y				
38. Dalma Tepe	Iran	4400	Y					
39. Tepe Yahya	Iran	4150	Y					Y
40. Pisdeli Tepe	Iran	3750	Y	Y			Y	

SOURCE: Braidwood and Howe (1960), Henry (1989), Mellaart (1967), and Singh (1974).
NOTE: Y = evidence reported at site (blank if no evidence); ? = fragments reported, uncertain if animal, human, or both (coded as both). The Levant area includes modern Israel, Jordan, Lebanon, and Syria.
a. All dates shown are BC.

advanced foraging from those with cultivation, and in any event, the transition from one to the other may have occurred quite rapidly (McCorriston & Hole, 1991). Our theoretical concern here is the fact of a grain surplus, not the specific manner by which it was obtained. We use the term *agro-culture* to encompass both cultivation and advanced foraging, as indicated by our measures of grain surplus.

Domestication. Domesticated livestock differ from wild counterparts in identifiable ways, such as the size of teeth and bones. Other evidence of domestication includes the remains of harnesses, drawings of corralled animals, and a high proportion of young animals killed for consumption (Crabtree, 1993). Whenever a site showed any of these signs of domesticated goats, sheep, cattle, and/or pigs, we classify it as displaying economic surplus through herding.

More refined measures of surplus would take into account not only the capacity to accumulate grain or meat but also the size of bins or herds relative to the population at the site. Our data do not permit that level of precision. The resulting measurement error is likely to depress our estimates of the associations of surplus with our (no less crude) religious indicators.

Note too that herding and agro-culture were distinct ways of amassing surplus and, as such, are almost uncorrelated in these data (*tau-b* = –0.09). Thus, they provide nearly independent evidence in our tests. Because the two kinds of surplus are not strongly correlated with each other, there is no mere statistical reason to expect them to correlate similarly with religious attributes.

Grave gifts. How does one infer the beliefs of people who left no written record of their thoughts? With great difficulty and approximately at best. We follow Durkheim's (1915/1965) lead, assuming that religious ideas are represented in rituals and that rituals often make use of artifacts. The artifacts may survive in the archaeological record. We can then try to reason backward from artifact to ritual to belief, mindful of the risk of imposing modern ways of thinking on the past (cf. Peregrine, 1996b).

As noted above, burying the dead with utilitarian items suggests a belief system in which the dead or other spirits were thought to need or want such goods (see Campbell, 1995). Sites are classified as displaying functional grave gifts if bodies were found

intentionally buried with a tool, weapon, food, or extra garment. As a separate variable, we also code decorative grave gifts: the application of red pigment (ochre) or burial with any nonutilitarian item, such as flowers, a headdress, or jewelry. These burial adornments probably reflected religious rituals and beliefs, perhaps including ideas of an afterlife (but see Ucko, 1969). However, they were used in Western Europe long before the Neolithic Revolution in the Near East, and they may indicate a less fully elaborated belief system than functional grave gifts. We include adornments in the analysis precisely because we do not expect, under either the materialist or the culturist conjecture, that these should be as strongly related to surplus as functional gifts.

What would it imply if functional and decorative grave gifts were equally related to surplus? Plausibly, a wealthier people could simply afford to bury more goods of all sorts. Or, perhaps both economic and religious elements merely increased in variety over time. That is, as the population grew, so did social differentiation in general (see Chick, 1997). More effective food production and all manner of intricate burial rituals would then be coincidental results of greater social complexity, not mutually causal at all. By including both kinds of grave gifts in our analysis, we can provide a partial check on such possibilities. A stronger relationship for functional than for decorative grave gifts will argue against the idea of a coincidental trend, whatever the source.

Figurines. For similar reasons, we code both animal and human figurines found at the sites (not necessarily, or even typically, in burials). A symbolic purpose is suggested by their lack of any obvious utilitarian value. Animal figurines seem to imply religious beliefs involving symbolic control of animals. This assumption is supported indirectly by paintings of animals found in earlier (mainly European) Stone Age sites. Such paintings have generally been found in the dark interiors of caves, where both the creation and the viewing of the work would have been quite difficult. This suggests that they were not merely artistic or decorative but instead were meant for some magical or religious purpose (cf. Barton et al., 1994). By analogy, we assume a religious significance for animal figurines in the Neolithic Near East (but see Rice & Patterson, 1996), although there are no direct clues to their symbolic meaning.

Under either the materialist or culturist conjecture, the religious use of animal figurines should be associated with herding,

whether as consequence or cause. Although human figurines may also have had religious meanings (but see Ucko, 1968), there are no specific grounds for expecting such beliefs to be associated with herding. If human and animal carvings are found to be equally associated with domestication, all three increasing over time, that might simply mean that the physical remnants of figurines are more likely to have survived in more recent sites. Again, including both kinds of figurines in our analysis permits a check on this possibility.[3]

Like agro-culture and herding, functional grave gifts and animal figurines are only weakly correlated (*tau-b* = +0.12), so there is little statistical reason for them to relate similarly to other variables. Theoretically, neither the materialist nor the culturist conjecture claims that rituals with these two very different kinds of artifacts were based on similar beliefs. Rather, the respective beliefs could have been distinct, alternative mechanisms for justifying or motivating accumulation. Functional grave gifts should be related to surplus regardless of whether that surplus came from grain or from herds. Animal figurines should be related to herding only.

ANALYZING THE DATA

Our design thus allows several nearly independent tests of the basic conjectures, enhancing the empirical leverage of our analysis. How is agro-culture related to grave gifts? How is herding related to grave gifts? How is it related to figurines? And what is the time sequence of agro-culture, herding, grave gifts, and figurines? Because our measures are crude and our cases few, we use simple cross-tabulations. First, we present the relationship between a site's economic or religious attributes (coded absent/present) and the date of the site (dichotomized at the median). This temporal analysis sheds light on whether economic developments preceded or followed religious developments. Then, we analyze cross-sectional associations between the economic and the religious attributes. By percentaging these associations in both directions, we examine whether economic attributes predict religious attributes (statistically) or the reverse.

We also present correlations and significance tests. In 2×2 tables, Kendall's *tau-b*, Pearson's *r*, and the *phi* coefficient are all

TABLE 2
The Timing of Economic Surplus and Religious Attributes

	Percentage of Sites With Characteristic			
Site Characteristic	*Before 6300 BC*	*After 6300 BC*	*tau*	p
Any economic surplus	90	100	0.229*	.25
Grain	85	90	0.076	.50
Herds	45	50	0.050	.50
Any grave gifts	50	40	–0.101	.38
Functional	10	40	0.346***	.04
Decorative	45	30	–0.155	.26
Any figurines	80	85	0.066	.50
Animal	55	45	–0.100	.38
Human	60	80	0.218*	.15
Number of sites	20	20		

NOTE: The column of tau values reports Kendall's tau-b (which equals Pearson's *r* and also phi for two by two cross-tabulations such as these) between each attribute (present/absent) and site date (before/after 6300 BC). Also indicated in that column are one-tailed significance levels from asymptotic tests on tau-b.
*$p < .10$. ***$p < .01$. Otherwise, $p > .10$. The last column provides p values from one-tailed Fisher's exact tests. As discussed in the text, significance tests should not be interpreted rigorously because the sample is not random (see also note 5).

equal, so the correlations may be interpreted in terms of whichever is most familiar. Significance tests must be treated with great caution because archaeological sites are not sampled randomly (cf. Dow, 1993; Ember & Otterbein, 1991). More accessible locations may be studied more, and there is a tendency to dig for sites in areas where previous research has found evidence of habitation. Also, our sample is small, and an association strong enough to be important might not meet a rigid criterion of significance. We report two different kinds of one-tailed p values, the asymptotic (normal) approximation and Fisher's exact because the "exact" test is in fact conservative in small samples (Agresti, 1990, p. 65). However, for the reasons just noted, our interpretations rely on overall patterns and consistency in the data, not statistical significance. "The poorer the samples, the more we should direct ourselves to discernible broad generalizations that emerge" (Cohen, 1977, p. viii).

RESULTS

TIME ORDER

Table 2 divides the 40 sites at the median date of 6300 BC or about 8300 years before the present day. This date corresponds roughly to the end of what archaeologists call the *Pre-Pottery Neolithic-B* period, after the invention of cultivation and domestica- tion but before their complete dominance in the region (Byrd, 1994).

Overall, economic surplus seems to have been well established before any of the religious elements for which we have measures. After 6300, every site had one or both kinds of surplus (grain-based or herd-based), whereas fewer than half the sites used grave gifts of any sort or animal figurines, and several lacked human figurines as well.

In particular, agro-culture was widespread well before functional grave gifts. For the 13 sites before 6850 (see Table 1), all but 2 already had a grain surplus, but only 1 had functional offerings. By 6300, 85% of sites had a grain surplus but only 10% buried functional gifts (see Table 2). After 6300, the percentages rose to 90 and 40, respectively. These results on time order support the materialist conjecture and contradict the culturist.

In a similar if less striking pattern, domestication also preceded functional grave offerings. Herding was already evident in nearly half the sites before 6300, when the figure for functional gifts was still only 10%.

Functional grave giving is the most strongly time-trended attribute in the table (*tau* = +0.35). If it does reflect detailed ideas about an afterlife, then such beliefs were still spreading well after agro-culture and herding were common in the region. Furthermore, it appears to be functional grave offerings that were on the upswing, not just more elaborate burial practices in general. Decorative grave gifts do not show the same increase over time as functional grave gifts, contrary to the wealth explanation. If anything, decorative grave giving was on the decline.

Our data also permit a fortuitous case study of one location, which further supports the materialist time sequence. Excavations at Jericho include two different Neolithic strata, separated by about 800 years. In 7300 BC, Jericho already had a grain surplus but no evidence of functional grave gifts. By 6500, the people of Jericho were burying functional goods with their dead. Hence, for

at least one location, economic surplus quite definitely came first, with the religious element following. This strengthens our conclusion from the aggregate data in Table 2.

On the other hand, Table 2 does not support either conjecture on the time order of figurines and herding. About half the sites in both time periods had domestication, whereas slowly decreasing numbers had animal figurines, and increasing numbers had human figurines.[4]

From Table 2 alone, we would conclude that only the materialist time sequence is confirmed relating surplus (in both grain and herds) to functional grave gifts, and neither conjecture is supported for herding with animal figurines. Yet, temporal analysis is not the sole informative approach to comparative research (cf. Ember, 1991). Accordingly, we defer a final conclusion about herding and figurines until we see how the various economic and religious attributes are related in a cross-sectional analysis of all 40 sites, regardless of date.

CROSS-SECTIONAL ASSOCIATIONS

In the extreme, if an economic element is a strictly necessary condition for a religious attribute, then the latter should never be found without the former. Conversely, if it is the religious attribute that is a necessary condition, then there should be no sites that had the economic element without the religious. More realistically, we expect the presence of one to increase the statistical likelihood of the other (see Lieberson, 1994). We next investigate these expectations by percentaging the cross-sectional associations in both directions. Following conventional terminology in archaeology (e.g., Henry, 1989), we refer to item A as a "necessary" or "statistically necessary" condition for item B if in our data, B does not appear unless A is present. Of course, this usage does not imply that B could never exist anywhere without A.

Predicting religion from surplus. Table 3 shows the percentage of sites displaying each religious attribute separately for those that do and those that do not have surplus. Of the 5 sites without grain surplus, none has functional grave gifts. Thus, agro-culture is a strictly necessary condition for functional gifts, in the sense just defined. The correlation is modest (*tau* = +0.22) but stronger than that between agro-culture and merely decorative gifts (*tau* =

TABLE 3
Predicting Religious Attributes from Economic Surplus
(percentage of sites with religious attribute)

	Type of Economic Surplus							
	Grain (%)				*Herds (%)*			
Religious Attribute	*No*	*Yes*	*tau*	p	*No*	*Yes*	*tau*	p
Functional gifts	0	29	.218**	.22	19	32	0.145	.30
Decorative gifts	20	40	.137	.37	33	42	0.090	.41
Animal figurines	20	54	.227*	.18	33	68	0.350***	.03
Human figurines	100	66	–.247***	.15	67	74	0.076	.45
Number of sites	5	35			21	19		

NOTE: The columns headed *tau* provide Kendall's tau-b and one-tailed significance levels from asymptotic tests, reported as follows: *$p < .10$; **$p < .05$; ***$p < .01$; otherwise, $p > .10$. The columns headed p provide one-tailed Fisher's exact tests.

+0.14). In other words, agro-culture has a somewhat larger effect on functional grave giving (a 29 percentage point difference between sites with and without grain surplus) than on decorative giving (20 percentage points). Hence, the former effect seems not to be just coincidental. To be sure, the number of sites without a grain surplus is small. Also, we cannot rule out the possibility of false negatives; for example, a group might hold detailed beliefs of an afterlife without burying artifacts durable enough to be found after thousands of years. Still, the evidence at hand again supports the materialist conjecture.[5]

The correlation of herding with functional grave gifts is also positive, as predicted. It is weak (*tau* = +0.14) but stronger than that with decorative gifts (*tau* = +0.09). Herding per se is not essential for functional gifts, because 4 of the 21 sites with no signs of domesticated animals do have such offerings (19%). However, all 4 of these sites have agro-culture (see Table 1). Therefore, some sort of surplus, whether in grain or herds, is statistically necessary for functional gifts. In sum, the cross-sectional results for surplus (grain or herds) and grave gifts support the materialist conjecture, although less strongly than the temporal findings.

The materialist conjecture receives stronger support from the cross-sectional results on herding and figurines. For the sites without herding, only a third have animal figurines, compared to two-thirds of the herding sites. Although herding is not essential

for animal figurines, the correlation is the highest yet (*tau* = +0.35) and much larger than that between herding and human figurines (*tau* = +0.08). This is as it should be, because human figurines bear no hypothesized relationship to domesticating animals. Thus, the strong association between herding and animal figurines is apparently not a coincidental result of better figurine survival at herding sites nor of generally increasing economic and religious complexity.

Predicting surplus from religion. We next examine the same cross-sectional associations percentaged in the opposite direction (sites displaying each economic element as a percentage of those that do or do not have the religious attributes). Because these results can be calculated from the information in Table 3, we will summarize them here without another table.

Functional grave gifts increase the likelihood of agro-culture, as the culturist conjecture predicts, but only a bit. All 10 sites with functional gifts have agro-culture (100%), but so do 25 of the 30 sites without functional gifts (83%). If functional gifts were strictly necessary for surplus, the latter ratio would be 0:30. Less stringently, functional gifts should make a much bigger difference than decorative gifts. Instead, the percentages just noted for agro-culture in sites with or without functional grave items are quite similar to the corresponding percentages in sites with or without decorative gifts (93% and 84%, respectively).

The story is similar for the effect of functional grave gifts on herding. Such gifts are far from essential for herds, contrary to the culturist conjecture. The majority of sites with functional gifts have herds (60%) but so do nearly half of those without such gifts (43%). The herding percentages with or without decorative gifts are again similar to these (53% and 44%), even though theoretically the stronger relationship should be with functional gifts.

Finally, the culturist conjecture receives some support from the cross-sectional results on herding and figurines. Among sites without animal figurines, nearly a third nevertheless do have domestication. There should be no such sites if animal figurines were statistically necessary for herding. But 30% is small compared to the 65% of sites with animal figurines that have herds. As predicted, animal figurines make a much bigger difference in the prevalence of herding than do human figurines. Although the presence of animal figurines more than doubles the percentage of sites with

herding (raising it from 30% to 65%), the presence of human figurines increases the percentage of herding sites only slightly (from 42% to 50%), compared to sites without such figurines.

SUMMARY AND DISCUSSION

Our design provides numerous partly independent tests of materialist and culturist hypotheses as well as a fortuitous case study. Cross-sectional analysis has reinforced most of the conclusions from temporal comparisons and from the case study. In addition, because the two kinds of surplus (grain and herds) are almost uncorrelated, the similarity in results between them is doubly convincing. We also built in partial safeguards against spurious or coincidental trends by showing that the hypothesized religious attributes (functional grave gifts and animal figurines) are more strongly related to surplus than are decorative grave gifts and human figurines. Hence, the findings cannot be ascribed in any simplistic way to wealth, to increasing social complexity generally, or to bias in figurine survivals.

Overall, the consistent results across multiple tests lend greater confidence to the associations than their strength or significance levels might suggest. Our findings are further corroborated indirectly by the ways in which they dovetail with related research. After summarizing our own results, we will briefly consider some of that related literature.

GRAVE GIFTS AND GRAIN SURPLUS

- Agro-culture became widespread before the use of functional grave gifts did, supporting the materialist and contradicting the culturist conjecture.
- Agro-culture was a necessary condition (in the narrow, statistical sense) for functional grave gifts and had a modest positive correlation, supporting the materialist conjecture.
- Use of functional grave gifts was not close to statistically necessary for agro-culture but had a modest positive correlation, providing some support for the culturist conjecture.

GRAVE GIFTS AND HERD SURPLUS

- Domestication became somewhat widespread before the use of functional grave gifts did, supporting the materialist and contradicting the culturist conjecture.
- Domestication was close to statistically necessary for functional grave gifts and had a weak but positive correlation, providing some support for the materialist conjecture.
- Use of functional grave gifts was not close to statistically necessary for domestication and had only a weak correlation, contradicting the culturist conjecture.

FIGURINES AND HERD SURPLUS

- Domestication and animal figurines showed no clear time sequence, supporting neither the materialist nor the culturist conjecture.
- Domestication was close to statistically necessary for animal figurines and had a strong positive correlation, supporting the materialist conjecture.
- Use of animal figurines was not close to statistically necessary for domestication but had a strong positive correlation, providing some support for the culturist conjecture.

Maryanski and Turner (1992) argue that the sociocultural institutions of the Neolithic were "inevitable in light of the nature of horticulture as an economic mode of adaptation to the environment" (p. 104). Our results are less sweeping but do support the priority of economic over religious developments. In five of the comparisons summarized above (and in the case study), materialist hypotheses are supported. In one of these, the support is weak, and a sixth comparison favors neither the materialist nor the culturist prediction. By contrast, four comparisons contradict culturist hypotheses, whereas only two show some support.

Our results are thus consistent with a growing body of evidence "for the broader notion that ideological systems of culture are influenced by technoeconomic and technoenvironmental adaptive requirements" (Divale, 1999, p. 361). Much of this research is based on ethnologic data rather than archaeological sources, adding another dimension of triangulation to help corroborate our own findings. For example, replications of Swanson's (1960) work have established a link between belief in a high god and socioeconomic complexity. There remains disagreement about whether the effect

of economic variables is direct (Underhill, 1975), is mediated through political organization (Swanson, 1975), or mainly reflects scale of social relations (Peregrine, 1996a). However, there is no dispute in these cross-cultural studies that the economic factors are causally prior to religion. Likewise, Divale's (1999) ethnologic research shows the effect of an economic variable, food storage capability, on another kind of cultural feature, numerical counting systems. Evidence he reviews (p. 344) establishes a similar link between food storage and the development of writing. Diehl (1992) makes a parallel case for the effect of economic strategies on architecture. In short, our archaeological findings in support of the materialist conjecture are buttressed by the way they dovetail with research applying different methods to related hypotheses. At the same time, our results add to that accumulating knowledge.

In our data, the culturist conjecture fares best in the association between animal figurines and herding. However, these two variables also give the most mixed results. Their cross-sectional relationship supports the materialist conjecture at least as strongly, and their time sequence supports neither. Just as cultivation and herding were distinct ways of life, their institutionalization may have involved different mechanisms. The possible joint influence of economic and cultural factors in the takeoff of herding warrants further study (cf. Mann, 1986).

So too does the rise of both herding and horticulture in other parts of the world. In the Americas, for example, fewer species of animals but more species of plants came under human control, with the transition starting later and taking longer than in the Near East (MacNeish, 1964). In part, as Diamond (1997) argues, this may reflect the distribution of suitable species across the globe. Yet, despite regional differences, MacNeish (1992) shows that similar material and environmental processes underlay the transition in the Near East, the Andes, Mesoamerica, and the Far East. Although neither Diamond nor MacNeish provides a detailed treatment of religion, their scattered comments on the topic are consistent with our own results. Still, because our study is limited to the Near East, a systematic replication in another region would provide an important test of the generality of our findings (see Burton & White, 1991; Ember, 1991).

Another topic for future research is the role of population size and growth. Some scholars have seen population pressure as stimulating economic advances (e.g., Cohen, 1977). For others, "neither population growth nor expansion could have precipitated the

evolution to complex foraging but were apparently by-products of complex foraging once it had developed" (Henry, 1989, p. 24). Research contrasting these two viewpoints would add further to our understanding of the Neolithic Revolution.

Finally, we have speculated that functional grave gifts may indicate relatively developed beliefs about an afterlife, although this possibility is not essential to our analysis. If Neolithic religion did include a detailed view of the hereafter, the roots of the legitimating ideologies of later agrarian empires in the Near East may go even deeper into prehistory than is often supposed (see Bellah, 1970; Lenski & Lenski, 1982; Mann, 1986). But, whatever the exact content of the ideas that inspired functional grave giving, those ideas seem to have taken hold most readily where they could justify preexisting economic arrangements, either agro-culture or herding.

CONCLUSION

The associations in our data apparently did not result from a protoreligious ethic that gave rise to a spirit of accumulation and in turn to advances in food production. We have provided evidence against several other explanations as well, such as wealth, spurious trends in social complexity, and bias in the survival of artifacts. To that extent, we have narrowed the list of theoretical conjectures to be considered. In the Near East some 10,000 years ago, the economy seems to have been the "engine of (pre)history."

Notes

1. Bellah refers in this passage to the "primitive" religion of hunter-gatherers, but he describes "archaic" beliefs under horticulture in similar terms (see Bellah, 1970, pp. 29-32).

2. For a contemporary instance of functional grave gifts expressly intended to provide for an afterlife, see Sudetic (1991).

3. For three sites, it could not be determined from the fragments found whether figurines represented humans, animals, or both. These sites were coded as having both human and animal figurines, but results are much the same if they are simply excluded from the analyses.

4. Our case study is of no help in sorting out these chickens and eggs. The earlier Jericho had neither domestication nor animal figurines,

whereas the later Jericho had both. Hence, it is impossible to say which came first in Jericho. Two other sites in Table 1 also represent different times for the same location (Bus Mordeh and Ali Kosh). Unfortunately, this case sheds no further light on the hypotheses. In 6900, Bus Mordeh had both kinds of surplus and animal figurines but no functional grave gifts; in the same spot 500 or so years later, Ali Kosh also had grain, herds, and animal figurines but still lacked functional gifts. Without change over time in the relevant variables, a case is of no help in establishing time order.

5. The correlations of agro-culture with animal and human figurines are irrelevant to both conjectures, which make no predictions about these associations. For the same reason, the one-tailed significance levels for these two correlations (and for the three negative correlations in Table 2) should be doubled to give the more appropriate two-tailed values.

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Restriction of Sexual Activity as a Partial Function of Disease Avoidance: A Cultural Response to Sexually Transmitted Diseases

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Across cultures, sexual relations are expected between husbands and wives. This expectation is virtually a constant, a universal. On the other hand, sexual relations between two persons who are not married to each other is much more of a variable across cultures. It is argued that part of the differences among cultures in their treatment of extramarital sexual activity is a function of the presence or absence of sexually transmitted diseases (STDs). Because of the serious sequelae of STDs on fertility, multiple sexual partners in the presence of STDs threatens the ability of a community to replace itself. Hence, restrictions on the number of partners act to limit the adverse consequences of the STDs. In the absence of STDs in the breeding pool, no such restrictions are needed. Ethnographic data are provided in support of the thesis.

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The nearest primate homologues to humans are the great apes: the orangutan, the gorilla, the bonobo, and the chimpanzee. None of these primates has a mating strategy that would be predictive of human strategies. The adult orangutan is solitary and visits the other gender only for copulation. The gorilla has a harem system with one alpha male and several females. The bonobos and the chimpanzees have extensive sexual activity among plural females and plural males.

Across cultures, humans have overlaid a mating system with a marriage system. Sexual restrictions—for both males and females—often exist prior to marriage, and additional restrictions occur after marriage. This article attempts to partially explain some facets of those restrictions.

THE UBIQUITOUS DOUBLE STANDARD

A cross-cultural analysis of extramarital sexual norms does illustrate that men's behaviors tend to be less restricted and that women's behaviors tend to be more restricted (see Table 1).

One explanation that is often invoked to explain the basis of the asymmetry is that of "paternal certainty" (Kurland, 1979; Smuts, 1995). That is, for a man to maximize his certainty that he is indeed the father of his wife's child, his best strategy is to cloister his wife. The more complete is the cloistering, the more confidence the man has in his paternity. Enforced, coerced cloistering seems like a fairly good definition of "restricted sexual options." This explanation of the double standard is testable.

Some societies (roughly 12%) are "matrilineal" such that inheritance passes from mother to daughter. Note that "matriliny"—a system of inheritance—is not the same as "matriarchy"—a system of power. Although some societies are matrilineal, none are matriarchal. In a matriliny, a child, whether a son or a daughter, belongs to the woman's clan or lineage. The father's lineage includes his maternal aunts, his mother, his sisters and their children (his nieces and nephews), and his brothers. Accordingly, the father has no claim on nor kinship with his wife's children. They belong to a separate kin group than his own. Thus, paternal certainty has no social importance to the father. Because of the social meaning of the child belonging to the mother's kinship circles, it would thereby be expected that the double standard—if it is generated by a need to certify paternity—would not be needed nor be found in these

TABLE 1
Extramarital Sex Norms for Husbands and Wives: 216 Cultures

	Spouse		
	Husband	*Wife*	*Total*
Permissive norms	60	13	73
Restrictive norms	48	95	143
Total	108	108	216

SOURCE: Adapted from Broude (1980).
NOTE: $\chi^2 = 45.7$; $df = 1$; $p < .001$; $C = .42$.

TABLE 2
Frequencies of Adultery Norms for Women by Inheritance Type: 105 Cultures

	Adultery Norms for Women		
Lineage Type	*Permissive*	*Restrictive*	*Total*
Matrilineal	2	10	12
Patrilineal	6	41	47
Other	5	41	46
Total	13	92	105

SOURCE: Adapted from Broude (1980).
NOTE: Not all of the cells have a minimum expected value of 5, a number generally viewed as the minimum number for a valid test. However, the small expected frequency would tend to inflate the χ^2 value. Given the exceedingly small overall χ^2 value of 0.31, the test is presented with the caveat that there are cells with expected frequencies less than 5. $\chi^2 = 0.32$; $df = 2$; $p > .05$.

matrilineal societies. But such is not the case. As Table 2 clearly illustrates, the adultery norms are virtually identical in matrilineal societies as in patrilineal societies or as in alternative forms, such as bilineal.

In addition, even if a relationship had been found, there still would have been contraindicative cultures, for example, societies wherein sexual restrictions are lessened, if not minimal. Clearly, an additional social force over and beyond paternal certainty is in operation. Such an additional social force is proffered below: namely, cultural rules to avoid sexually transmitted diseases. Of course, to the extent that paternal certainty reflects not just a

social category but a more primordial jealousy response (i.e., the guarding of the exclusivity of a sexual partner), then the society's type of lineage would also be somewhat irrelevant.

THE THREAT OF SEXUALLY TRANSMITTED DISEASES

A part of the human condition is our ability to become ill. A number of parasites have specialized in exploiting humans as quite congenial, if unwilling, hosts. Several of these parasites are transmitted through sexual behavior: namely, sexually transmitted diseases (STDs). There are more than 50 sexually transmitted organisms and subsequent maladies recognized by the Division of STD/HIV Prevention (1990). Over and beyond the distress these organisms create for the affected individuals, one at a time, the threat to the community is at least as important.

Because host and parasite adjust and readjust to each other over long periods of time, it is impossible to document the level of lethality or impairment that current organisms caused in prior centuries. However, it is probably not unreasonable to suspect that in pre-antibiotic eras, STDs, in variant forms, were at least as debilitating as are their current counterparts. For example, earlier forms of syphilis were far more fatal than are the present cases (McNeil, 1976).

What then would be the threat to the commonwealth beyond the infected patient? There are four unique facets of STDs that expand their influence over human hosts and are relevant to this argument.

1. The best preventive for an STD epidemic in a community is complete abstinence. However, this "cure" would last only one generation. Complete abstinence would mean that there would be no further generations. The next best strategy would be a compromise and allow sexual contact but reduce the number of sexual partners (i.e., institute monogamy).
2. Although STDs occur in both males and females, there is an asymmetry between the genders in two important respects. Man-to-woman transmission of STDs is easier and more efficient than is woman-to-man transmission (Hook & Handsfield, 1990; Moore & Cates, 1990). In other words, an infected man can infect a (symptom-free) woman more easily than an infected woman can infect a (symptom-free) man. For example, in a single episode, an

TABLE 3
Reproductive History of Women Diagnosed With Abnormal or Normal Fallopian Tubes

	Patients (n = *1,732)*		*Controls* (n = *601)*		
Reproductive Events	n	%	n	%	Z
Avoided pregnancy	370	21.4	144	24.0	1.33 *ns*
Attempted pregnancy	1,309	75.6	451	75.0	0.29 *ns*
Became pregnant	1,100	84.0	439	97.3	7.34*
First pregnancy ectopic	100	9.1	6	1.4	5.38*
No pregnancy occurred	209	16.0	12	2.7	
Not pregnant for unknown reasons	53	3.0	6	1.0	
Totals	1,732	100.0	601	100.0	

SOURCE: Adapted from Weström, Riduan, Reynolds, Alula, and Thompson (1992).
*$p < .001$ (two-tailed).

uninfected man has a 20% chance of developing a urethral infection from an infected woman. In the reverse situation (man to woman), the chance is between 50% and 90%. Male-to-female infection of HIV is approximately 20 times more efficient than is female-to-male infection. Finally, the annual risk of passing the (genital) herpes virus is 20% from man to woman but approximately 5% for woman to man (Hook & Handsfield, 1990; Moore & Cates, 1990).

3. An infected woman is far more likely to be rendered infertile than is an infected man (Weström & Mårdh, 1990). Currently, pelvic inflammatory diseases (PIDs), such as salpingitis, are the primary sources of female infertility (Mosher & Aral, 1985). (See Table 3 for an example from Sweden.) It is rare that a male would be rendered infertile by an STD.
4. If a pregnant woman is infected by an STD, she increases the chances of infant mortality and infant morbidity, including prematurity, low birth weight, and spontaneous abortion (Brunham, Holmes, & Embree, 1990; Weström, 1991), as well as ophthalmia, conjunctivitis, pneumonia, and arthritis (Gutman & Wilfert, 1990; Schulz, Murphy, Patamasucon, & Meheus, 1990).

STDS AND REPRODUCTIVE SUCCESS

STDs are not benign occurrences. Current problems related to human fertility that stem from contemporary STDs involve a myriad of pathogenic agents. These organisms include bacteria,

viruses, ectoparasites, fungi, and protozoa. The pathologies caused by these organisms include, but are not limited to, infertility, chronic pelvic pain, copulatory pain, and ectopic pregnancy due to gonorrhea and chlamydia; anal, cervical, penile, and vulvar carcinoma due to human papillomavirus; acquired immunodeficiency due to HIV; hepatitis and hepatic cancer due to hepatitis-B virus; and life-threatening fetal, neonatal, and infant infections (i.e., syphilis, HIV, herpes simplex virus, hepatitis-B virus) (Aiken, 1992; Holmes, Mårdh, Sparling, & Wiesner, 1990; McDermott, Steketee, Larsen, & Wirima, 1993; McDermott, Steketee, & Wirima, 1996; Schulz, Cates, & O'Mara, 1987; Villa, 1997).

These contemporary STDs present a wide range of consequences that can lower both a woman's fertility and neonatal viability. Most important to this article, STDs would lower a community's ability to replace itself in proportion to the prevalence of the STDs within that community. For example, if syphilis is contracted by a woman, the chances for miscarriage, infant death, stillbirths, and premature births are all increased (Schulz et al., 1990; Waugh, 1990). Furthermore, if the mother is infected, then the chances are also substantial that the fetus will contract syphilis from the mother, which would decrease the child's life chances: life chances that would include a reproductive history. In addition, the proportions are not small. Untreated syphilis during pregnancy is passed to virtually 100% of the infants, with 50% resulting in prematurity or perinatal death (Schulz et al., 1990). In a 1917 (pre-antibiotic) study of 1,000 syphilitic pregnancies, 8% ended in stillbirths, 23% in infant death, and 21% of the infants had contracted syphilis. The corresponding numbers for the controls (n = 826) were 2%, 11%, and 0%, respectively (Schulz et al., 1990). Examples of sequelae following congenital syphilis to the neonate include deafness, dental defects, bony lesions, eye lesions, and nervous system lesions, including mental retardation, obstructive hydrocephalus, and seizure disorders. None of these conditions would seem to enhance an individual's reproductive history or desirability as a mate. Acquired immunodeficiency syndrome (AIDS), of course, is a fatal disease and is also associated with higher infant and children mortality (Taha et al., 1995). (See Barkow, 1989; Graves & Duvall, 1995; Haldane, 1949; Hamilton & Zuk, 1982; and Ridley, 1993, for complementary discussions and examples from nonhumans [cf. Sheldon, 1993].)

The current leading cause of infertility is pelvic inflammatory disease (PID) as caused by STDs (e.g., chlamydia, gonorrhea) (Aral,

TABLE 4
Chances of a Woman Becoming Sterile From Gonorrhea by Number of Infections

Number of Lifetime Infections	*Cumulative Percentage Who Become Sterile*	*Percentage Who Remain Fertile*	*Total Percentage*
1	14.1	85.9	100.0
2	25.9	74.1	100.0
3	36.4	63.6	100.0
4	45.4	54.6	100.0
5	52.9	47.1	100.0
6	59.2	40.8	100.0
7	65.5	34.5	100.0
8	68.3	31.7	100.0
9	77.5	22.5	100.0
10 or more	77.5	22.5	100.0

SOURCE: Adapted from McFalls and McFalls (1984).

Mosher, & Cates, 1991; Harrison & Alexander, 1990; Moore & Cates, 1990; Moore & Spadoni, 1984; Peterson, Galaid, & Cates, 1990; Weström, 1987; Weström & Mårdh, 1990; Wolner-Haussen, Kiviat, & Holmes, 1990). Basically, these STDs can infect (salpingitis) and scar the fallopian tubes, thereby impairing uterine conception. Consequently, such afflicted women can have impaired fertility or have a tubal (ectopic) pregnancy. Note that ectopic pregnancies represent the leading cause of maternal deaths during the first trimester in the United States (Herbertson & Storey, 1991; *Journal of the American Medical Association*, 1995). Prior to effective and sterile surgical procedures (e.g., 1880), the prognosis for an ectopic pregnancy was death, with survival rates between 10% and 28%. The current prognosis is more than 99% survival and less than 1% death (Lurie, 1992). A recent study in Sweden (Weström et al., 1992) indicated that occluded fallopian tubes significantly decreased the chances for a successful attempt at becoming pregnant and, if pregnancy did occur, also (significantly) increased the chances of an ectopic pregnancy by at least a factor of five (see Table 3). Moore and Cates (1990) estimated that after a single episode of PID, infertility resulted in 6% of the mild cases, 13% of the moderate cases, and 30% of the severe cases. Note that these figures arose even when effective treatment was available.

TABLE 5
Normative Sequelae to Conceptions of Syphilitic Mothers as a Function of Number of Pregnancies

Pregnancy Number	*Expected Result*
1	Miscarriage at 5th month
2	Stillbirth at 8th month
3	Live birth but death from syphilis soon after birth
4	Live birth but infant shows signs of syphilis weeks or months after birth
5	Initially a healthy child who shows signs of syphilis after a few years
6	A healthy child until the teen years when signs of syphilis appear
7	A healthy child who never shows signs of syphilis

SOURCE: Kunitz (1972).

Each successive bout of PID acts to double the chances of infertility (Weström & Mårdh, 1990). (See Table 4 for an example.) An analogous sequence occurs with successive pregnancies in a woman who has contracted syphilis.[1] (See Table 5.)

It should be reiterated that these statistics arise in a time and a society with readily available medical information, medical technology, and inexpensive antibiotics. In the pre-antibiotic era, after being infected with gonorrhea, up to 70% of the women had tubal obstruction (Moore & Cates, 1990). In his 1930 study, Holtz estimated that 1.3% of the PIDs were lethal (as cited in Weström & Mårdh, 1990). Mosher and Aral (1985) calculated that PID accounted for one third to one half of recent increases in infertility. Similar sequelae result from infections of herpes simplex virus (Stagno & Whitley, 1990). Again, these statistics are from a time and a place where modern medical techniques were utilized.

Although these pathologies, inter alia, are not necessarily lethal to the nubile woman, the symptoms of these pathologies would tend to decrease the afflicted individual's level of competitiveness in attracting desirable mates. To the extent that these infections affect skin texture, body odors, genital secretions, general activity level, and romantic tendencies (see Buss, 1989, 1994; Buss & Schmitt, 1993; Cashdan, 1993), the chances for a successful impregnation are similarly decreased.

It is important to note that the number of sexual partners is the best current predictor on the chances of having a sexually transmitted disease (Allen et al., 1991; Aral et al., 1991; Brunham &

Plummer, 1990; Hunter, Baker, Japheth, Tukeik, & Mbugua, 1994; Laumann, Masi, & Zuckerman, 1997; Moore & Cates, 1990; Newell et al., 1993; Thrall, Antonovics, & Bever, 1997; Weström & Mårdh, 1990): the greater the number of partners, the greater the chance for an infection. As noted earlier, there is an asymmetry in the rate of transmission between the sexes. The rate of transmission from male to female is greater than the rate from female to male. Although the males are relatively less likely to become infected, once infected they are contagious and able to infect additional partners. Current STDs rarely render the infected male sterile, but once the male passes on the infection, the woman's fertility (e.g., blocked fallopian tubes, ectopic pregnancy) is threatened, as is the success of the pregnancy (e.g., stillbirths, etc.) (Hook & Handsfield, 1990; Howards, 1995; Joesoef, Weström, Reynolds, Marchbanks, & Cates, 1991). Thus, the male's fertility becomes effectively impaired in relation to and in proportion to the sterility of his partners.

It should also be noted that, unlike some other diseases, such as measles, STDs are not dependent on a large, dense population to remain within the host population. STDs are more dependent on the numbers of sexual partnerships and the frequency of matings for their persistence rather than on the numbers that compose the population (Garnett & Antia, 1994; Thrall & Antonovics, 1997; Thrall, Antonovics, & Wilson, 1998; see Ewald, 1993, for an overview on the evolution of virulence [cf. Krause, 1992; Long, 1996; and Zinzer, 1963].) Thus, STDs can exist and be maintained over generations within a small population. The consensual view is that early Homo was a hunting and gathering primate that lived in small mobile bands or tribes. Accordingly, such demographics would not preclude STDs from chronically affecting the social and behavioral dynamics of the tribes. (See Pennington & Harpending, 1991, for an example of a proposed relationship between a low population level [of the Herero in Botswana] and STDs.)

The thesis that humans have been vulnerable to STDs for a long time can be inferred from the specificity of the pathogens: whether the pathogen is a virus, a bacteria, or a metazoan. For example, herpes simplex virus type 2 (HSV-2) is transferred sexually and has specialized in the genital area. The time depth of HSV-2 in humans is fairly deep. Sakaoka et al. (1994) suggest that the split between herpes simplex virus type 1, usually transmitted nonvenereally, and HSV-2, usually transmitted venereally, had occurred several million years ago. (See Sakaoka et al., 1995, for a

similar argument; see Nahmias, 1992; and Nahmias & Dowdle, 1968, for an overview.) Thus, the split would have occurred during the tenure either of the latter australopithecines or in archaic Homo.

Another example would be the human papillomavirus (HPV). There are more than 70 known types of HPVs (Ong, Nee, Rambaut, Barnard, & Harvey, 1996). Some HPVs can be passed venereally and can cause disease. For example, HPV types 16 and 18 are passed venereally and are causal agents in the development of cervical and vulvar cancer (zur Hausen, 1996). Ong et al. (1993) suggest that the diversity between HPV types evolved over several million years. (See Chan et al., 1992, for a similar argument and conclusion.) Of additional interest, Bernard, Chan, and Delius (1994) argue that HPV type 13, which exclusively infects the oral cavity, separated from its closest relative—the pygmy chimpanzee papillomavirus—approximately 5 million years ago.

Gonorrhea is caused by the bacteria *Neisseria gonorrhoeae*. McGee, Gregg, Johnson, Kalter, and Taylor-Robinson (1990) infected both female baboons and female chimpanzees with *N. gonorrhoeae*. The gonococci attached to, damaged, and invaded the oviduct mucosa (fallopian tube) of the chimpanzees but not the oviduct mucosa of the baboons, both in vivo and in vitro. The pattern of gonococcal infection in chimpanzees was identical to that in humans, whereas the pattern in baboons was like that in other mammals (in which the gonococci do not cause genital infections). Lucas, Chandler, Martin, and Schmale (1971) were able to infect male genitals of chimpanzees in vivo, whereas DiGiacomo, Gale, Holmes, and Buchanan (1977) were unsuccessful in infecting the genital tract of baboons in vivo. Thus, gonococcal infection was possible in chimpanzees, as it is in humans, but gonococcal infection was not able to be demonstrated in baboons. McGee et al. suggest that these data indicate that hominoid susceptibility to gonococcal infection began during the evolutionary interval between the baboons and the chimpanzees. Simply put, the susceptibility arose after the monkey-pongid split but before the hominid-chimpanzee split. Hence, genital infection from gonorrhea was possible among the australopithecines as well as among early Homo, and it was certainly plausible among Homo sapiens.

Because STDs have not been reported in feral chimpanzees or gorillas (Kraus, Brown, & Arko, 1975; Lockhart, Thrall, & Antonovics, 1996; Phillips-Conroy, Jolly, Petros, Alan, & Destrosiers, 1994; cf. Heldstab, Ruedi, Sonnabend, & Deinhardt,

1981), it is reasonable to infer that humans' unique and ongoing vulnerability to STDs occurred after the pongid-hominid split.

Lice are metazoan. Pubic lice (*Phthirus pubis*), head lice (*Pediculus humanus capitis*), and body lice (*Pediculus humanus humanus*) each specializes in a segment of the human body and are not interchangeable (Billstein, 1990). Again, this specificity suggests an extended time frame back to their common ancestor.

SOCIETAL RESPONSES TO STDS

At whatever level of consciousness that the connection was made between multiple sexual partners and sterile mothers and sickly infants, it is suggested that this connection was made across the world's community of societies. There was a systematic restriction of sexual partners. If a family or tribe wished to minimize STDs and still have children for the next generation, then the best course would be to institute and to maintain strict monogamy. The next best route would be to institute polygyny: plural wives allowed for men and one husband (monogamy) for women. Nearly 99% of the known cultures of the world either mandate monogamy (15%) or allow polygyny (84%). Less than 1% of the cultures entertain polyandry: one wife and plural husbands (Divale & Harris, 1976). The more vulnerable, more susceptible gender (in this instance, the female) would be more cloistered than the less vulnerable, less susceptible gender (the male). As with any other strong emotion, the social benefits would be maximized if the behaviors in question were to be placed under a moral rubric. Across the world, sexual promiscuity is generally considered improper behavior, more so for the woman and less so for the man. This two-pronged strategy—avoid polyandry and cloister the women more so than the men—is consonant with the solution of procreating the next generation with minimal dangers from STDs. However, the linkage between images/moral admonitions and the consequences of acting in concert with those images/moral admonitions is neither immediately apparent nor formally instructed.

HYPOTHESIS

Even if all of the above is accepted, there is still the problem of those cultures with loosened or minimal sexual restrictions. Why

TABLE 6
Adultery Allowed per Culture by Gender of Spouse

Adultery Allowed	*Husband (1)*	*Wife (2)*	*Both Husband and Wife (3)*	*Total for Husband (1 + 3)*	*Total for Wife (2 + 3)*
Absent	0	18	20	20	38
Present	12	0	17	29	17
Total				49	55

SOURCE: Adapted from Schlegel (1972).

NOTE: $n = 55$ cultures coded for wives' adultery and then for husbands' adultery, $n = 49$ (6 cultures had data only for wives).

would STD avoidance behaviors be found in some but not all cultures?

One avenue to address this apparent anomaly is to examine the geographical loci of those cultures that have been designated to have fairly loosened sexual restrictions.

PROCEDURE AND RESULTS

In her seminal cross-cultural survey of matrilineal societies, Schlegel (1972) analyzed the category "adultery allowed for wife." She found 17 cultures within her sample of 55 matrilineal cultures wherein adultery was allowed for the wife (see Table 6). Note that there were 12 cultures wherein husbands were allowed adultery, but wives were not. In addition, there were 18 cultures wherein adultery was not allowed for wives, but the same sanctions did not apply to husbands. The asymmetrical relationship of restrictions on Adultery × Gender was significant, $\chi^2 = 30.0; df = 1; p < .001$. (See Table 6.)

Of the 17 cultures, 6 were from islands in the Pacific, 2 were from Arctic America, 1 was from Australia, 3 were from Sub-Saharan Africa, 2 were from North America, 2 were from South America, and 1 was from India. Note that none were from the circum-Mediterranean or Middle East regions.[2] (See Table 7.)

Broude (1980) surveyed sexual attitudes across cultures. With regard to extramarital sex, she used three categories: wife sharing (extramarital sex allowed for women), universal for women (almost all women engage in it), and universal for men and women (both genders allowed). For the category "wife sharing," Broude

TABLE 7
Geographical Loci of Cultures Wherein Adultery is "Allowed" for Wives

Number		*Location (Culture)*
1	American Plains	(Crow Indian)
1	Southwest America	(Hopi Indian)
2	Arctic America	(Kutchin, Tanaina)
1	Nigerian plateau	(Gure)
2	Sudan	(Darfar, Mesakin)
6	Pacific Island	(Lesu, Majuro, Ponape, Nauru, Plateau Tonga, Truk)
1	Australia	(Dieri Aborigine)
1	India	(Nayar)
1	Interior Amazonia	(Siriono)
1	Eastern Brazil	(Timbira)

SOURCE: Adapted from Schlegel (1972).
NOTE: n = 17; sample = 55.

TABLE 8
Geographical Loci of the Subsample of Cultures for the Category "Wife Sharing"

Number		*Location (culture)*
1	Himalayas	(Lepcha)
1	New Guinea/New Ireland Island	(Lesu)
1	Guiana	(Bush Negroes/Saramacca)
1	Eastern Brazil	(Aweikoma)

SOURCE: Adapted from Broude (1980).
NOTE: In this category, extramarital sex of any kind is allowed for women. n = 4; sample = 110.

found 4 examples (from a sample of 110). One culture was from the Himalayas, 1 was from an island near New Guinea, 1 from Guiana, and 1 from Brazil (see Table 8) (cf. Martin and Voorhies, 1975, surveyed female premarital [only] sexual activity in agricultural and horticultural societies whereby matrilineal and patrilineal cultures tended to have different profiles, i.e., matrilineal societies were less restrictive of the unmarried female).

For the category "universal for women," Broude found 7 cases (from a sample of 56). The 7 cases included 1 from an Australian

TABLE 9
Geographical Loci of the Subsample of Cultures for the Category "Universal for Women"

Number		*Location (culture)*
1	Australian Island	(Tiwi)
3	New Guinea	(Kwoma, Lesu, Wogeo)
1	Eastern Brazil	(Aweikoma)
1	Guiana	(Saramacca/Bush Negroes)
1	Arctic Asia	(Gilyak)

SOURCE: Adapted from Broude (1980).
NOTE: In this category, almost all women engage in extramarital sex. $n = 7$; sample = 56.

TABLE 10
Geographical Loci of the Subsample of Cultures for the Category "Universal for Men and Women"

Number		*Location (culture)*
4	Sub-Saharan Africa	(Hottentots, Hadza, Mende, Masai)
1	India	(Toda)
1	Central Asia	(Kazak)
1	Himalayas	(Lepcha)
1	Indian Ocean	(Andamanese)
1	New Guinea Island/New Ireland Island	(Lesu)
1	East Asia	(Manchu)
1	Arctic Asia	(Chukchee)
1	North America	(Huron Indian)
1	South America	(Aweikoma Indian)

SOURCE: Adapted from Broude (1980).
NOTE: In this category, both men and women are allowed to engage in extramarital sex. $n = 13$; sample = 116.

island, 3 from New Guinea, 1 from Brazil, 1 from Guiana, and 1 from Arctic Asia (see Table 9).

For the category, "universal for men and women," she found 13 cultures (from a sample of 116). This included 4 from Sub-Saharan Africa, 1 from India, 1 from Central Asia, 1 from the Himalayas, 1 from an Indian Ocean island, 1 from an island off New Guinea, 1

from East Asia, 1 from Arctic Asia, 1 from North America, and 1 from South America (see Table 10).

Again, the circum-Mediterranean and Middle East regions are not represented in the cultures adjudged to have lessened or reduced sexual restrictions.

DISCUSSION

Three points are germane here. First, humans are not promiscuous; cultural restraints are universal. Second, the central tendency across cultures is that women's sexual behavior is more restricted than is men's. Third, there are cultures wherein women's sexual options are less constrained than in alternative cultures. It is argued here that less-constrained areas are those that would have a reasonable opportunity to be free of STDs (at least at the time when they were surveyed). The argument takes the following form.

STDs within a community are highly deleterious to the community's fertility. Sustained deficiencies of fertility within a community threaten the very existence of the community, either through depopulation or through conquests by a more healthy competing culture. The best and simplest method of preventing or controlling STDs is to minimize the number of sexual partners (i.e., restrict sexual options).

On the other hand, if a culture had virtually no STDs within the breeding community—either through a founder's effect or through prior restrictions on mating partnerships—then restricting the number of partnerships would have no advantage. Hence, an STD-free breeding population would pay no penalty, in terms of community health, for more unrestricted sexual activity.

The geographical loci of those surveyed cultures with less restrictions on sexual partnerships are consonant with the model being presented. Cultures that are isolated—either by climate, elevation, or bodies of water—tend to be overrepresented in the examples of more unrestricted sexual partnerships.

Cultures within the circum-Mediterranean and Middle East regions have long been in continuous contact with each other. These regions are not represented in the subsample of more unrestrained cultures. STDs are clearly possible in these regions and sexual restriction is high. (See Hobhouse, Wheeler, & Ginsburg, 1915; Maxwell, 1967; Murdock, 1964; Prescott, 1975; and

Stephens, 1972, for complementary discussions on sexual restrictions and cultural complexity.[3])

An illustration of the suggested dynamics would be the Maori of New Zealand. The Maori population had been isolated from most of the world and all of Europe for a very long time. Early English writers on the Maori noted a fairly unrestricted sexuality on the part of their women (Buck, 1962; Crosby, 1986). Early English sailors were probably a good deal less restricted. Venereal disease from the English sailors spread rapidly within the Maori population. In the 1850s, Francis D. Fenton gathered data on 444 Maori wives while conducting a census of the Maori population. Of the 444, only 221 had any living children and 155 were completely barren. A colonial surgeon in the area noted that in a sample of 230 Maori women, 124 either had no children or had no living children (Crosby, 1986). Crosby (1986) noted that there were many possible explanations for the Maori barrenness, such as infanticide, "but the worst villain in the tragedy was surely venereal disease. It kills parents, kills fertility, kills fetuses, kills children, and erases the desire for children" (p. 257). The notes from an early clinic in New Zealand (1837) recorded that 3.8% of the Maori were diagnosed with a venereal disease (Crosby, 1986).

A similar process occurred in Siberia. Small pox and venereal diseases were introduced into the local groups: namely, the Ostyak, Tungus, Yakut, and Samoyed (Crosby, 1986; Donner, 1954; cf. Bogoras, 1901). Some of these groups, such as the Tungus, practiced sexual hospitality with strangers: "A woman is not food—she does not decrease" (Shirokogoroff, 1979, p. 72). The two diseases decimated the local populations.

CURRENT STDS AND CULTURAL RESPONSES

Two recent developments offer an opportunity to witness how the dynamics of biocultural evolution may operate. The two developments are (a) the (publicity of) increasing rates of sexually transmitted diseases in the United States, where, for example, nearly one fifth of American adults test positive for genital herpes (Division of STD Prevention, 1999); and (b) the very high rates of HIV infection in Sub-Saharan Africa. As presented earlier, STDs in general and HIV in particular have the potential to worsen the reproductive health of a group or community.

Ceteris paribus, those families or clans within a group that reduce or preclude STD infections from occurring among their mating partners would have a clear advantage vis-à-vis within-group competition in terms of reproductive health and proportions of productive members. Similarly, those cultures that minimize or preclude STDs from occurring would have a clear advantage over alternative cultures that were pandemically infected with STDs (i.e., between-group competition). STD-free communities would have a similar advantage when compared to heavily infected communities (i.e., within-group competition).[4]

OPTIONS TO RESPOND TO ENDEMIC STDS

There are three cultural options by which a community can successfully counter an STD infestation.

1. The community can do nothing substantive and let the coevolution of the parasite and the host allow a mutual adaptation. If successful, the mutual adaptation would entail surviving hosts whose fertility is minimally reduced and surviving parasites that are not lethal to the hosts.
2. The community could institute mores and folkways—and appropriate sanctions—that minimize multiple partners and thereby minimize STD contagion. Such a reduction would tend to eventuate in some version of the nuclear family.
3. The community could cultivate and rely on sophisticated prophylactic and medical technologies either to prevent or to ameliorate dangers from STD infections.

Currently, Sub-Saharan Africa seems to be relying more on options 1 and 2. Western Europe and its extensions, including the United States, have increasingly shifted emphases from option 2 toward option 3. Other communities (e.g., cultures that incorporate fundamentalist religions) rely more on option 2 to cloister females and to prescribe female monogamy. Such cloistering and prescriptions minimize multiple sexual partnerships and thereby attenuate the spread of any STDs that may be harbored in the breeding population.

An interesting question becomes: Is there any one of the three strategies that is more effective across generations than its competitors? Or, stated differently: Is there an interaction effect such that different types of social structures are better preadapted to

one strategy rather than alternatives, and thereby distinct mosaics of Society × Strategy are equally effective but for different reasons?

Either by tautology or by definition, the winners will be those cultural groups that have a higher proportion of the world's Homo sapiens than their competitors in subsequent generations. The interface of cultural theory and demographic data emanating from populations experiencing STD epidemics should prove both informative and challenging.

Notes

1. The age of the woman is also relevant in terms of the infection's impact. Among those women who were seeking to achieve a pregnancy but had experienced one episode of acute PID, 12.6% in the age group of 15 to 24 years and 25% in the age group of 25 to 34 years were either infertile from their infection or had an ectopic pregnancy (Weström & Mårdh, 1990).

2. de Munck and Korotayev (1999) utilized a similar (overlapping) sample. In their survey, they analyzed 14 cultures wherein adultery was allowed for both genders: The de Munck & Korotayev sample of 14 included 1 from an Indian Ocean island (Andamanese), 1 from Arctic Asia, 1 from the Himalayas (Lepcha), 6 from Sub-Saharan Africa (Fang, Ila, Lovedu, Mende, Mongo, Nuer), 1 from South India (Toda), 1 from southeast Asia (Thai), 1 from a New Guinea island (Wogeo), 1 from Micronesia (Woleaian), and 1 from North America (Ojibwa). Note that no circum-Mediterranean or Middle East culture is represented. This omission parallels the Schlegel sample.

3. For an expanded discussion on the relationship between STDs and cultural evolution, see Immerman and Mackey (1997, 1999).

4. "Survival of the group" should in no way be construed as a variation on the theme of "group selection" as a replicator for Darwinian evolution. From this presentation's perspective, the gene—not the individual, not the population, not the meme—is the replicator that survives generation to generation. However, as both past and current events clearly and starkly illustrate, people do identify with their own cultural group and, sadly, do tend to eradicate alternative groups if given the chance. Examples include genocide in Cambodia and Rwanda, the Holocaust, pogroms, Stalin's vengeance on the Ukrainians, influenza in Amazonia, the extermination of the Tasmanians, "ethnic cleansing" in Bosnia, ad infinitum. But, an individual's tribal totems may identify that person to those who would eradicate that individual—and his or her genes. If all of the members of a

particular totem have been eliminated, whether by parasites, floods, colonial imperialism, blitzkrieg, or drought, then the group that is referenced by that totem is, by definition, gone. The unique genes or alleles shared by members of the obliterated group may live on in alternative individuals (e.g., captured war brides), but the cultural entity whose members have been obliterated is no more. To the extent that a cultural entity invents or adopts customs, mores, or habits that prevent the replication of its own members' genes, that cultural entity can either extinguish itself or reduce its population enough to be easily overwhelmed by more prolific and predatory cultural/genetic competitors.

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