EXPOSURE VERSUS SUSCEPTIBILITY IN THE EPIDEMIOLOGY OF "EVERYDAY" BELIEFS

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Running head: THE EPIDEMIOLOGY OF BELIEF

Abstract

This paper examines whether exposure to information (as determined by physical and social access), or susceptibility to belief (a variety of cognitive biases underlying belief adoption) is more important in determining the distribution of food taboos in an oral society from the Democratic Republic of Congo. Matrix regression techniques are used on optimally scaled cultural similarity data to infer which social and psychological characteristics of individuals are correlated with a higher probability of taboo transmission between them. Results indicate that access to information in this population is nearly universal. Constraints on belief adoption rather than on information flow are much more important in determining the intra-cultural distribution of food taboos. I conclude from these results that the processes underlying the dissemination of both cultural traits and pathogens, considered as replicating units of information, appear close enough to justify using epidemiology as a common framework for investigating cultural and biological diffusion.

Introduction

Most definitions of culture distinguish between innate and learned information: individuals are assumed to be born naive to cultural knowledge. Becoming a mature member of a cultural group therefore requires the individual to acquire a variety of specialized knowledge and skills from already-adept members of their group. When viewed from a population perspective, this socialization process results in patterns of diffused information. The study of diffusion has traditionally been limited to novel information spreading from well-known points of origin, so that implicit social contacts can be tracked geographically and temporally (e.g., Rogers 1962; Rogers and Shoemaker 1971; Rogers and Kincaid 1981). However, most cultural knowledge consists of commonplace beliefs and values with long standing in a population. Here, I argue that epidemiology, an approach developed to study the social communication of biological information, can be generalized to deal with the social diffusion of "endemic" cultural information. In fact, the analogy between pathogens and cultural traits (so-called "memes," following Dawkins 1976) can be quite compelling.

Epidemiology is primarily interested in modeling the reproductive rate of an infectious agent, given the proportion of the population which is not already infected or resistant (due to previous infection), the probability of contact with such individuals, and the likelihood of infection, given contact (Anderson and May 1991). These probabilities can be complex. For example, in epidemiological models of "social diseases" such as HIV, the influence of distance on the probability of contact is defined in both social and physical terms (e.g., Anderson et al. 1992; Garnett and Anderson 1994; Morris 1993). Since most cultural beliefs have social purposes, models of their transmission should also reflect "social space," or the demographic and behavioral influences on interaction. Similarly, human "hosts" are usually not defenseless victims of infection by socially-transmitted information, some of which require them to sabotage their own well-being. The likelihood that a given belief or attitude will be adopted therefore depends not only on acquaintance, but on an individual's determination that such knowledge is true or valuable. This decision-making process can be glossed as "susceptibility to belief." Thus, in cultural epidemiology, social contact can produce exposure to a belief; if susceptibility is low compared to the virulence (or believability) of the belief, infection results. Only after infection can one expect the individual to exhibit the symptoms of belief (i.e., belief-directed behaviors and further transmission). Therefore, the rate at which cultural variants replicate in a population is determined by the relative strength of the barriers a receiver places on the transmission of messages (i.e., the degree of contact and susceptibility to belief) versus the force of transmission imparted to a message by its sender (i.e., the efficiency of replication and general believability of a trait).

The primary question I wish to address in this paper focuses on the reception end of the transmission equation: the relative importance of exposure and susceptibility in determining the probability of cultural infection.[1] In true epidemiological fashion, I will be concerned with the roles played by these factors in determining the endemicity (or degree of consensus) and social distribution of cultural knowledge.

Standard epidemiological models indicate that, if previous infection confers some resistance to reinfection, the answer to this question depends on the prevalence of susceptible as opposed to resistant individuals in the population (Anderson and May 1991). People are relatively unarmed in their fight against new pathogens, so that the epidemiology of "emerging diseases" is almost soley determined by the pathogen's own mode of transmission (e.g., sexual transmission or via some animal vector) (Morse 1993). For novel pathogens (e.g., brought in through migration of some individual infected elsewhere), progression through the population is typically one of epidemic diffusion because no one has prior acquaintance with, and hence has developed no defense against, the offending arrival. In effect, exposure determines the rate and pattern of spread. However, for "everyday" or endemic microbes, with a relatively long previous history in a group, the proportion of

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[1] This requires that I assume the "force" of transmission is roughly equal between all cultural traits considered, so that its influence on trait replication rates and distribution can be ignored. I believe the analysis below of the empirical models (which are specific to a certain class of traits) justifies this assumption in the case investigated here.

susceptible individuals is characteristically much lower, and the resulting pattern of diffusion more dependent on whether exposed individuals are susceptible than on the determinants of exposure (i.e., social and physical relationships between individuals) (Becker 1989:9).[2]

The adoption of novel cultural traits in a population tends to exhibit the same temporal pattern as infection with infectious biological novelties: a logistic curve (Valente 1995). There seems to be a threshhold beyond which further diffusion becomes inevitable. Where this point lies on the curve (i.e., the size of the critical mass) depends on the structure of social networks (Valente 1996, 1995). The question this paper seeks to answer is whether a similar parallel between the biological and social realms exists with respect to the epidemiology of "everyday" traits: Is their diffusion largely determined by susceptibility rather than exposure?

This is a difficult question to answer because in the case of diffusing innovations, there is a "wave front" to trace. One can merely watch the temporal sequence of who switches from a state of ignorance (susceptibility) to knowledge (infected). If the effective network of social contacts is known, the rate of adoption can be estimated. However, when the trait is endemic, the source of infection becomes much more difficult to locate. People are still switching states as a function of social contacts, but the already widespread pattern of infection obscures which contacts influence infection.

A further difficulty in answering this question derives from the possibility of mediated transmission. Pathogen transmission patterns depend on whether infection occurs as a direct result of action by the carrier (e.g., sneeze-born pathogens) or via some intermediate vector that carries the infection from one individual to another (e.g., insect-born pathogens) (Ewald 1993). So too does access to information depend on the nature of the conveyance mechanisms which mediate cultural interactions. However, if information transfers can occur at a distance, through mechanical vectors such as television, determining contact relationships becomes difficult. For example, many mediated transfers (e.g., through books) are only "quasi-interactions" because information consumers are unknown to the producers, and consumption can take place many years after the original production of the cultural vector (Thompson 1995). In effect, tracing exposure to particular sources of information throughout the lifetimes of all the members of some group in a "mass media" society becomes practically impossible.

In a face-to-face society, however, all information exchange requires inter-personal contact. Information diffusion is then a function of personal mobility, and histories of residential-based contact can provide reasonable data about a lifetime of access to information. In such societies, physical constraints on the distribution of information largely boil down to the effect of spatial distance on the likelihood of contact between individuals as they circulate in the environment. Similarly, social constraints devolve chiefly to role-based constraints on the likelihood of social interaction, the decision by knowledge-holders to transmit that information, given an interaction, and of course, the recipient's willingness to adopt that information as a personal belief once exposed to it. This last aspect is what makes social contacts effective transmission events.

I therefore pursue my cultural epidemiological study in one of the few remaining oral societies: among horticulturalists and foragers living in the Ituri Forest of the Democratic Republic of Congo (formerly Zaire). The cultural belief system concerns avoidances against the eating of various foods, otherwise readily available for consumption. Each person in the population has a unique concatenation of such avoidances which require recurrent decision-making about a biologically and socially important kind of behavior. I therefore consider this an "everyday" belief system.

I assume that the result of cultural transmission between individuals is increased similarity of belief. This allows me to use a non-parametric matrix regression technique to ascertain whether social roles and life history experiences (i.e., measures related to susceptibility, considered as kinds of psychological adoption biases) are more important than proximity (my measure of exposure) in determining the pattern of diffusion of beliefs, as expected from the biological parallel. Results indicate that the three classes of food avoidance

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[2] In fact, the long-term persistence of a pathogen depends on the rate at which susceptible individuals are replentished in the population, either through loss of immunity or cessation of infectivity (Becker 1989:9).

considered have quite distinct patterns of transmission, as well as functions. Indeed, one type of avoidance, which is not socially sanctioned, is not culturally transmitted at all, but rather arises through direct experiences with particular foods. Social contact also has a relatively trivial impact on transmission for the two kinds of taboo, or sanctioned avoidances, investigated. Taboos of one of these two types appear to be perceived as physical laws, such that acquaintance with the underlying idea (which comes through contact with others having the requisite knowledge) commits the individual to obeying the rule. Finally, the second class of food taboos are social norms, so acquaintance with the relevant information is not severely handicapped by physical distance, despite individuals' lack of mobility. Nor does social role-playing significantly influence the pattern of intra-cultural variation observed (perhaps because the number of roles is limited in this subsistence-level society). Rather, taboo replication in this case is due primarily to an indirect cognitive bias -- in particular, the adopting individual must recognize the sender as a socially sanctioned authority for the transmission of such information. It is probably also the case that knowledgeable individuals would not attempt to communicate these taboos unless confident of this authority.

Thus, the primary determinant of the distribution of sanctioned cultural knowledge in Ituri society is susceptibility. The expectation that infection with "everyday" cultural traits, based on biological epidemiology, would be largely independent of exposure is thus proven true. But "susceptibility" means quite different things for the two types of taboo. In one case, the magical thinking which underlies the taboo is a fundamental aspect of human cognition (Rozin and Nemeroff 1990), so susceptibility is intrinsically unconscious and automatic. In the other case, susceptibility is a characteristic of a transmission channel or dyad, and not a function of features of the cultural trait itself, nor the psychology of either the message sender or receiver. These novel results indicate that the application of the epidemiological analogy to culture requires care because susceptibility can have unique properties when it is psychological or social rather than physiological in nature. Nevertheless, this paper shows that cultural epidemiology, pursued in a principled fashion in an appropriate context, can indeed meaningfully increase the level of understanding of real cultural systems, and may be a productive route for other scholars to follow as well.

Background

The Ituri Forest is home to individuals from a variety of ethnicities, speaking languages from either the Sudanic or Bantu language groups, and practicing foraging or horticulture for a living. Horticulturalist villages are small, each house usually containing a nuclear family, with neighbors being families from the same clan. Clusters of villages tend to contain clans from the same phratry or super-clan (Grinker 1994), so the population is organized on the landscape in a hierarchical fashion according to kinship. Forager camps are somewhat smaller, and their membership more fluid, as post-marital residence tends to be less constrained. Camps tend to be quite close to the road along which horticulturalist villages are spread for much of the year, despite the foragers' need to capture wild animal and plant resources, due to social dependencies on horticulturalists (Bailey 1991).

People in the Ituri (as elsewhere) believe that certain foods should not be consumed because a special relationship exists between them and the food. Violation of such beliefs (called here food avoidances) can lead to special kinds of illness. Food avoidances tend to concentrate on the forest fauna, of which there is a rich profusion.

There are two very different belief systems that result in food taboos in the Ituri. The first is a set of beliefs surrounding homeopathic transformation and the act of ingestion -- psychological predispositions that are universal, and which result in taboos surrounding pregnancy and other transitional stages of an individual's life history. I call these Homeopathic Taboos (following Meigs 1984). Since these taboos have an intrinsic believability, no social authority is required to back up their transmission. The rationale of the rule derives from some anomalous aspect or behavior of the animal which suggests something resembling that feature might become characteristic of the consumer -- or in the case of pregnant women, the fetus -- if eaten. An example is: "Eating a frog [when pregnant] would make my child's skin mottled."

The second kind of belief I call Ancestral Taboos. These are believed to arise when an ancestor died following consumption of a particular animal, or there is some other special relationship between the clan and this animal that began as a particular historical event (e.g., the animal is believed to have helped a lost ancestor in the forest, or not sharing some meat was the cause of jealousy between brothers, which led them to fight, so the animal is now refused). They result in very dangerous life-long taboos, such as the belief that consumption will cause instant death (by witches). The Sudanic horticulturalists have these in preponderance, while the other groups have very few because they do not believe in witchcraft, the mechanism of enforcement against rule violators.[3] A related normative belief suggests that these Ancestral Taboos should be learned from one's same-gender parent.

A third type of restriction against consumption of particular foods is not culturally sanctioned in the same way because no explicit social consequences follow violation. These Other Avoidances can be expressed as attitudinal rejections of, or general prohibitions against, food, or as a determination that the item simply is "not food." For example, the cattle egret's coloring resembles the white habit of the Catholic nuns in the area; no one can imagine eating a nun.

Food avoidances have a number of characteristics which make them ideal for a study of cultural transmission. First, a food avoidance is a discrete, definable, measurable and universal cultural trait that can be elicited with a fair degree of reliability in the field using formal interview procedures (Aunger 1994b). This means quantitative tests can be performed with relative impunity on such traits. Second, food avoidances exhibit considerable intra-cultural variability in the Ituri, so that statistical models can partition this variation to the effects of different influences. Third, it seems unlikely that genetic inheritance influences the food avoidance system: predispositions concerning the desirability or tastefulness of food items have generally been found insignificant (Krondl et al. 1983; Rozin, Fallon and Mandell 1984; Rozin and Millman 1987; cf., Pliner and Pelchat 1986). It also seems likely that the costs of independent experimentation in the selection of dietary items are higher (in terms of sickness/death and nutritional deficiency) than errors resulting from copying the dietary practices of others in the same social and ecological environment. Higher cost to independent experimentation compared to copying others in the acquisition of dietary practices should promote reliance on social learning (Boyd and Richerson 1985). Variation in intelligence may affect memorization and recall abilities, however, and cannot be excluded here. I can therefore reasonably assume that change in this belief system is unrelated to the genetic characteristics of the population, but is likely to be influenced by both psychological and socio-cultural factors.

Methods

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[3] Previous work (Aunger 1996) suggests that social authority systems underly the transmission of food taboos: if alternative systems of authority become available, people turn away from ancestor-based authority and the food taboo system collapses. On what is this authority based? Among the closely-related (Sudanic-speaking) Azande, witchcraft is inherited by "biological transmission from one parent to all children of the same sex" (Evans-Pritchard 1976:2). They also have a "vague belief. . .that man possesses two souls, a body-soul and a spirit-soul. At death. . .many people say that the body-soul of a man becomes the totem animal of his father's clan while the body-soul of a woman becomes the totem animal of her mother's clan" (Evans-Pritchard 1976:2-3). Thus, among the Azande, there is a clear tie from geneology to witchcraft and thence to totem animals. It is only a short step to food taboos against such animals being the ground for ancestral taboos. It is reasonable to expect the Ituri Sudanics make similar connections among these beliefs, since they have all the constituent beliefs -- about witchcraft, the tabooing of animal foods, and a similar belief in totemic animals (members of a clan turn into a specific animal at their death). So the mechanism for the enforcement of taboos, witchcraft, may also be conceptually tied to the transmission norm for these taboos as well -- constituting a culture complex.

My basic analytical problem is to infer a sequence of past transmission events given the pattern of present similarity in a population's cultural beliefs. These beliefs are therefore considered to be the sequelae of such events: cultural transmission leads to the sharing of information, and hence increased cultural similarity. Partitioning variation in belief to social influences, physical proximity or psychological traits will thus isolate the relative importance of exposure and susceptibility to belief on the distribution of cultural knowledge.

Optimal Scaling and Multiple Quadratic Assignment Regression

As justified earlier (Aunger n.d.a), I assume that food taboos are stored cognitively as simple rules which define: 1) the individual or group affected by the rule, 2) the animal referred to by the rule, 3) the circumstances covered by the rule, and 4) the consequence of violating the restriction on consumption. For example, "[1] Women don't eat [2] red antelope [3] during pregancy [4] because they will give birth with a lot of blood." A prior conclusion (Aunger n.d.a) indicates that individuals learn these rules over time from a variety of people (Aunger n.d.a). I therefore require a principled way to infer multiple cultural links between individuals. To maximize the likelihood of correctly gauging the likelihood of past transmission based on present cultural similarity, the measure of cultural similarity should retain as much information about the nature of differences in belief as possible while reducing the dimensionality of that variation to a manageable level. If there is a differential probability of certain types of taboo being clustered within particular animal groups, then information about the kind of animal involved in a taboo mismatch should be preserved. Proportional matching (i.e., the counting of differences) does not contain such "positional" information -- it does not reflect the *structure* of difference between informants.

However, optimal scaling does. Scaling is a data reduction technique that can be used to infer densities of ties between groups of actors (i.e., those closely grouped in space have more ties to each other). In this procedure, avoidance reports are first subjected to a nonlinear correlation analysis, which produces object scores for each informant.[4] This

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[4] The SPSS OVERALS routine was used on categorical responses to 140 questions, assuming multiple nominal measurement levels (i.e., linear relationships among variable states were assumed to be independent for each dimension of the resulting solution). Animal-specific beliefs are grouped into the same twenty sets as used in Aunger (n.d.a). Nine or ten different subtypes of food avoidance were allowed in each model.

OVERALS is a data reduction technique which uses an alternating least squares algorithm (i.e., correlation analysis alternating with optimal scaling), to quantify relationships between categorical values of a variable by finding approximately linear dependencies, assuming that the categories of a nominal variable correspond to values of a single underlying interval variable which can be represented in Euclidean space (SAS Institute 1990:42). The OVERALS procedure produces the nonlinear transformation which maximizes the total variance accounted for by a given number of eigenvalues of the transformed variable matrix. The relevant measures of fit for the resulting scores are reproduced in the table below. Eigenvalues add up to total fit, the maximum of which is 3 (the number of dimensions). Note that the coding scheme makes as much information as possible available for the scaling algorithm, so that the algorithm's ability to find relationships is relatively unconstrained. As a consequence, fit is relatively high, but the r^2 for the MQAR analysis is relatively low.

	EIGENVALUES			TOTAL
	1	2	3	FIT
POPULATION A				
Ancestral	.669	.596	.508	1.773
Homeopathic	.512	.425	.425	1.362
Other	.550	.466	.440	1.455
POPULATION B				
Ancestral	.575	.495	.449	1.519
Homeopathic	.443	.388	.383	1.214

scaling is performed on species-within-groups, which is a close approximation to the actual unit referred to in transmitted rules (Aunger n.d.a). Second, Euclidean distances are calculated between each pair of informants' object scores (in three dimensions); these are then reversed and rescaled (range 0 to 1) to produce dyadic similarity values.[5] A separate model can also be run for each general category of food avoidance, consistent with the earlier suggestions (Aunger n.d.b) that the pattern of transmission is unique to each category.

It is then necessary to determine what independent characteristics of these dyads are correlated with an inferred high probability of transmission between dyad members (as measured by their the scaled similarity). Since the transmission population is the population of interest, a nonparametric technique is preferable. I therefore use multiple quadratic assignment regression (MQAR; Hubert 1987) to determine the significant correlates of transmission. This is done by regressing the scaled measure of cultural similarity on a variety of characteristics the individuals participating in information transfer might share. More specifically, MQAR factors similarity matrices by randomly permuting the rows of the cultural similarity matrix for each possible dyadic pairing in the relevant Population and then regresses this permuted matrix on a set of independent variable matrices. These steps are performed repeatedly to generate an empirical distribution of regression coefficient values.[6] These values measure the probability that individuals sharing a particular characteristic will have exchanged cultural information of the type considered by that model.[7]

The Correlates of Transmission

A wide variety of possible correlates of transmission will be examined. These correlates can be grouped into several general categories, each of which is likely to have a significant influence on the social transfer of information (see Table 1). The first suite of variables concern exposure. In a society that depends on inter-personal contact for communication, the history of residential movement is a potentially important constraint on exposure to beliefs. Information about these histories can therefore be included in the model as proxies for probabilities of exposure, so that correlations between cultural similarity and past proximity can be used to infer cultural transmission events in the unobserved past. The residential variables (Household, Residential Proximity, "Time Shared," Childhood and Adolescent Village) are therefore meant to control for various non-preferential or base-rate transmission biases as a simple function of propinquity. The first of these, Household, is

Other	.485	.481	.450	1.416

[5] In each of the Ancestral and Homeopathic Taboos and Other Avoidance object score matrices, values for one or two dimensions of one or two outlying cases were changed to the second-most extreme values for that dimension in that matrix to reduce the range of Euclidean distances derived from these values.

[6] Analyses were performed using a SAS program written by Rebecca Brown. One thousand replications of each model were performed. Due to the sensitivity of the linear model to outliers produced by the scaling routine, the critical probability for a variable to remain in the model was set to 0.01.

[7] Thus, I use a non-linear optimal scaling analysis, coupled with a non-parametric regression technique, to find the correlates of transmission, rather than direct estimation of the transmission pathways themselves (as with the earlier phylogenetic approach of Aunger n.d.a). Optimal scaling and MQAR do not constrain transformations of the basic similarity data beyond use of an objective function, and therefore are more "black box"-like than phylogenetic models, which admit specific constraints on trait transformation. But in so doing, multiple information pathways between individuals are allowed, and the assumption of a single cultural "parent" characteristic of phylogenetic models -- shown to be false in Aunger (n.d.a) -- is avoided.

both a kinship and residential variable; interpretation of this effect is therefore likely to be somewhat difficult.

A second suite of variables concern susceptibility to belief, and define various criteria which individuals might use to bias their learning of food taboos. Each of these factors may influence the likelihood of social interaction between, and the adoption of communicated information from, individuals who share such characteristics. They can also be interpreted as various markers of social identity (ethnicity, gender, age class). Whether social knowledge is distributed according to such role variation is an important question in social science. In a kin-based society such as the Ituri, kinship is expected to be an important locus of bias, so several indicators have been included in the model. These markers determine ever-more-specific social circles, leading inevitably to a certain amount of inter-correlation. There is an effectively one-to-one relationship between the earlier measure of residential proximity and several variables used here to measure susceptibility: in effect, those who share a village are members of the same clan; those who share a phratry are from physically-grouped clan-based villages, while ethnicity is again clustered on the landscape at a larger scale. We can therefore assume that the variation in belief partitioned to these explicit measures of social relatedness (Ethnicity, Phratry and Clan) take into account geographic distance, and therefore represent real learning biases.

I also include a third category of effects which I assume measure neither exposure nor susceptibility, but which might influence transmission indirectly, and hence serve as controls for the effects of primary interest. Life-historical events can influence not only what an individual knows, but also attitudes or beliefs that might impinge on decision-making about food avoidances. For example, both Education and Work History measure exposure to acculturating factors (schools or plantation-work, respectively). I have previously shown that acculturation influences attitudes toward the adoption and practice of these traditional beliefs (Aunger 1996). Reproductive History is designed to measure the effects that having children has on active learning about Homeopathic Taboos; individuals should be similarly ignorant if don't have children, similarly knowledgeable if both do, but different if only one has offspring. It may also signal attentiveness to the duty to pass on taboos, and hence inspire more careful relearning of other beliefs, since the transmission norm confers on individuals a responsibility to disseminate these beliefs to their offspring. Marital History, or similarity in the number of marriages, presumably measures the effects on continued belief (especially in women) of being socially dominated by members from various other clans.

Related to these psychological controls are a number of variables included in the model to account for a standard problem in social scientific research: the attempt to measure temporal processes using cross-sectional data. An individual's age confounds having been at a particular developmental stage when encountered with a particular suite of environmental conditions. As a result, effects correlated with age often conform with several inconsistent interpretations; sorting out which one is most likely typically depends on independent sources of information. To assist interpretation, I have included several variables which compare the ages of potential transmission pairs. Informant ages have been divided, following standards in demography, into generations of twenty-five years (i.e., 0-25, 26-50, and 50+ years).[8] Two cohort-specific variables, about the effects of sharing either the youngest or oldest generation categories, serve as proxies for the psychology of uncertainty among youths and of senility among the aged. However, these cohort effects might also reflect any changes between generations in the overall robusticity of the taboo system, so interpretation must again appeal to patterns in the results from the two different Populations. The baseline

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[8] Although somewhat shorter than the 28-year reproductive generation identified by Howell (1988) as characteristic of the similarly-situated !Kung (subsistence level population with relatively high rates of secondary sterility), this generation length properly identifies family structures (roughly twice as many opposite-gender sib pairs as for single-gender pairs in households; parent/offspring pair numbers to match -- see Aunger n.d.a), and coincides with break-points in the cultural sphere: ignorance of food taboos ends at around 25 years of age, with another break point in the spline at 50 years of age when brought to road (see below). This division therefore seems to be a natural one for the Ituri.

generation effect can be seen as an indicator of the strength of inter-generational transmission.

Finally, reported beliefs are notoriously sensitive to psychological (e.g., priming), inter-personal (e.g., gender of interviewer) and socio-cultural (e.g., socio-economic status) effects, as the sophisticated nature of contemporary social survey questionnaire design attests (e.g., Fowler 1995; Kish 1995; Rubenstein 1995).[9] Therefore, interviewer effects are introduced as a methodological check. All of the above variables are defined so that positive coefficients imply similarity effects, to simplify interpretation.

[9] Certainly, the phylogenetic results (Aunger n.d.a) suggested the presence of important biases in interviewer style that should be eliminated to clarify the transmission picture.

The Transmission Populations

Another important methodological task is to determine the bounded group within which cultural change is presumed to occur -- what I will here call a *transmission population*. Durham (1991:427) argues a transmission population (which he calls a "reference group") consists of individuals facing a roughly equivalent cultural and ecological environment (i.e., set of cultural and genetic selection pressures) with similar psychological predispositions. However, the sample of people for whom information about the cultural traits in question is available is typically smaller than the likely transmission population, which might encompass several thousand individuals -- as is the case here. My criteria for selection must therefore be rather more strict. In a face-to-face society, the possibility of cultural transmission is a function of interpersonal contact. When mechanical transportation of any sort is rare, as in the Ituri, such contact is largely due to use of one's own feet. Thus geographic propinquity should be a strong determinant of social networks, and is taken here as the dominant criterion for defining a candidate transmission population. A second type of criterion is methodological: that the group thus identified be intensively sampled, since if any individuals important in the diffusion of memes are missing from the analysis, results could be significantly biased.

Given these constraints, it is relatively easy to identify two transmission populations of roughly 100 individuals each, which I will call A (N = 112) and B (N = 107). They form the samples on which analyses in this paper are conducted.[10] These populations are arranged side-by-side along the major road through the eastern Ituri, and although in many respects similar, they exhibit three differences which may influence estimated transmission patterns within each. First, Population A is composed of a single large phratry, or confederation of related clans, while Population B contains five phratries (although one of these constitutes nearly half the sample; another constitutes a further twenty percent). Second, they also have somewhat different social contexts: Population B is subject to greater external influence, both from a larger ethnic mix of local residents, as well as outsiders coming down the road. This probably makes Population B somewhat richer monetarily as well, although no quantative measures are available. Population A is isolated from Population B by an often-broken bridge (which precludes all but bicycle and pedestrian traffic), and are surrounded only by other Sudanics. Third, Population B is significantly younger than Population A (see figures above). Such differences allow us to determine whether there is significant variation in the structure of transmission at this rather detailed geographic level -- due either to variation in the demographic structure or in the social situation of the respective populations.

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[10] These two populations together have a number of analytical virtues for serving as the basis for an analysis of cultural transmission. First, their members reside in geographically contingent villages. Second, they are naturally bounded by a multi-ethnic plantation on the north end, and a river on the south. Hence, they are somewhat isolated from other populations. Third, there is a single dominant ethnic group in the area (79.5/75.7% are Lese-Dese; 91.1/91.6% are Sudanic). The area from which both derive can thus be reasonably called "North Lese-Dese-land" (since another pocket of Lese-Dese live south of the study area). Fourth, the gender-ratios in both Populations are balanced (52.7/53.3% male). Fifth, their age structures are demographically characteristic (27.7/42.1% are under 26; 74.1/86.9% are under 51). Sixth, both populations have been intensively sampled (≈ 90% of individuals over age 10), so that in each case, the sampled individuals constitute effectively the *entire* population along a 3-mile stretch of road, although seperated by approximately 6 largely unpopulated miles. Seventh, individual life-histories are well-known. Eighth, most individuals speak the same language. Ninth, they have roughly the same mobility patterns. Tenth, they share approximately the same level of contact with Westerners, through schooling or plantation work (72.3/73.1% with less than four years of schooling; 82.1/87.9 have never worked for wages). Eleventh, they share the same "vocabulary" of taboos (described in detail below), facilitating comparison. Finally, on a methodological note, the author was interviewer in the majority of cases (81.3/81.3%), and a single Sudanic assistant from the local population was responsible for the other portion.

The Comparative Study

Estimates of the significance of the transmission correlates from the MQAR analyses are highly variable -- both for the different types of taboo and for Populations A and B (see Table 2 for basic results and Table 3 for estimated relative significance values for the variables[11]). Close attention must be paid to the composition and situation of each Population to interpret these results.[12] For example, since Population B is more cosmopolitan, its estimated models should be more highly variable than for Population A. Certainly, nearly all of the anomalous results are associated with Population B: in particular, negative interviewer, ethnicity, "Under25", and household effects.

In fact, all the models are significantly weaker (in r^2 terms) for Population B. This suggests that as the complexity of population structure increases, the ability of the models to detect patterning decreases, probably because countervailing transmission tendencies obscure the overall signal. This does not bode well for studies of transmission in societies which have more significant social structuring, unless they can constrain the analysis to a greater degree than was possible here, simply using similarity measures. In fact, since model results are based strictly on correlations and a variety of interpretations are often equally plausible, I must rely on a number of other information sources to establish which interpretation is most likely. These include the influence of differences in the demographic structure of the two sample Populations on the pattern of results, consistency with other statistical tests, and the history of the Ituri region.

R^2 values for the Ancestral Taboo models are higher than those of the other two kinds of avoidances, suggesting there is greater structure to the distribution of this type of belief.[13] Independent results concerning the practice of food taboos in the Ituri (Aunger n.d.c) suggest this is the type of taboo most influenced by normative expectations. On the other hand, Other Avoidances show the weakest general patterning, especially in Population B (even to the exclusion of a significant interviewer effect). Since these beliefs lack reference to any social consequences, Other Avoidances should be those least influenced by the transmission norm, being rather more idiosyncratic and personal in nature. I now pass to an investigation of particular categories of correlates to see if they confirm these general suspicions about transmission patterns.

Exposure Factors: Proximity

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[11] Since the MQAR results proved very similar to those from least-squares (parametric) regression, I have used OLS-based t-values as an approximate measure of significance.

[12] I conducted preliminary investigations with two-way interaction effects, hoping that such interactions would ease interpretation of the underlying patterns. Large models could be constructed, but r^2 did not significantly improve and the models became more idiosyncratic and hence difficult to interpret.

[13] r^2 values themselves are quite low. However, Krackhardt (1996; see also Krackhardt 1992) has argued that, at least for MQAR, the theoretical upper bound of r^2 is often considerably less than one. For example, when the dependent variable is binary and the independent variable is interval-measured, even when the independent variable explains 100 percent of the data, the observed r^2 can be as low as .05. It is therefore difficult to interpret the significance of the overall model using this standard indicator. Also problematic is the use of a linear regression method on dependent variables which are not distributed as bivariate normal. Here, the nonlinearly scaled dependent variables tend to follow sickle-shaped distributions. However, the interpretability of the resulting models suggest the analysis is meaningful.

There is a striking lack of significance of present or past contact on cultural similarity in the MQAR models. Two of the five variables in this category show no significant relationship to learning any kind of avoidance. One of these variables is a measure of life-long contact (through overlapping residence in the same village), while the other is a "critical period" learning measure. The former result is particularly surprising since it suggests that length of interaction, and the development of personal relationships likely to be fostered by long co-residence, has no influence on transmission of these cultural beliefs. Opportunities to communicate, or sharing experiences with animals that may be relatively rare, do not produce the transmission of food-related beliefs.

For example, despite being the center of social life, the household is surprisingly absent from the MQAR results. How can this be? As I remarked earlier, household is actually a complex category, since membership conflates coresidence with kinship -- and also includes individuals of both sexes and often two or more generations. The general lack of significance suggests that these varying factors have countervailing but equally strong influences on cultural similarity, so that any patterning is washed out altogether. We should therefore interpret any significant outcome as the result of a particularly strong influence in one direction from among these possible sources of variation. I would argue that the negative effect of household in the Ancestral Taboo model reflects the strong division by gender discussed below. For Ancestral Taboos, the gender difference dominates the generational differences in the breakdown of kinship (because all the men and young girls in a household share a single clan, while the mother alone has some other identity). This does not arise in Population B because kinship is more varied within households (spouses can even be from different ethnic groups), so the significant variation by gender is balanced by greater variation in kinship. By the same logic, the positive household effect (in Population B) for Homeopathic Taboos must indicate spousal transmission--that is, transfer of knowledge across gender lines among those in the knowledgeable generation.

As another indicator of the insignificance of contact, the closeness of two individuals' villages to each other has no influence on transmission for either type of taboo. Only in the case of the presumably more idiosyncratic Other Avoidances, does residential proximity lead to transmission. In the case of Population B, the relationship is negative: those living in neighboring villages are less likely to communicate these beliefs to each other. Since Population B is the more ethnically diverse one, this suggests that even Other Avoidances are particular to clans, as indicated by the positive significance of clan for this type of belief (discussed below).

A different interpretation of the same results is possible. Alternatively, the significance of contact may be obscured by gender differences in residential life history. For most men and younger women, natal clan is coincident with residence village. Women are likely to share the same village with natal kin for a portion of their life, but then move to another village through marriage and spend another part of their life with affines. Thus the length of contact with specific individuals should be significantly lower for women, but their numbers of relatively long-term contacts (and hence types of influences) higher. For older women who have married, the smaller-scale ethnic affiliations of those with whom they live are no longer their own. If they learn the type of taboo being studied early in life and do not change their values, their taboos will be different from those with whom they currently live -- including their husband and children, if the transmission norm is correct. I expect this is a good explanation for the general lack of significance of Household as a variable.

However, I suggest this is unlikely to be a *general* explanation of the proximity results because there are clear and highly interpretable results suggesting the importance of contact. In particular, although both the MQAR models and the cross-sectional analysis (Figure 1d -- see below) indicate that individuals do not learn food taboos in the Ituri during early childhood, there is a significant tendency for these beliefs to be learned during adolescence. Indeed, this constitutes the primary exception to the general lack of significance to proximity. This effect is always positive, indicating that sharing a village when one of the dyad's members is between 10 and 20 years of age leads to significantly increased cultural similarity between those individuals. This does not necessarily indicate that the older dyad member actively ensured that some learning took place by the younger one, but does suggest that someone in the shared village is responsible.

Susceptibility Measures: Social Identity

The second class of variables correlated with the likelihood of cultural transmission measures various aspects of social identity. The presumption here is that individuals seek to be similar to those with whom they share social roles, and effectively bias their adoption of beliefs in favor of the cultural alternatives promulgated by such sources. The primary social roles in Ituri society are demographic or kinship-based markers. Of course, an especially restrictive case of social identity bias is following the transmission norm, which specifies that one should only adopt food taboos from one's same-sex parent. As we will see, individuals seem to significantly bias their belief adoption in favor of those with a similar place in society, and -- at least for Ancestral Taboos -- in relative alignment with the transmission norm as well.

Kinship is insignificant for Ancestral Taboos in Population A because kinship is so homogenous in that group (most of the Population is a single phratry); where kinship is more diverse (in Population B), there is a degree of specificity at all three levels.[14] The effect is negative at the clan level, and increasingly positive as kinship becomes more inclusive. Since Bantu horticulturalists and foragers tend not to exhibit these beliefs at all, this probably reflects the real difference between ethnicities in Ancestral Taboos (these groups are almost entirely absent from the Population A sample). Given this difference in the ethnic composition of the two Population samples, the pattern of variation by kinship seems to indicate a general clustering of belief around the phratry level. But note the significant gender bias in transmission, which appears only with respect to Ancestral Taboos. This probably indicates that individuals follow the transmission norm, which specifies same-gender parent-offspring inheritance. While this norm implies that men from the same clan should share Ancestral Taboos, it also suggests that women who share clan membership should vary in their taboos, since their mothers derive from different clans (thanks to clan exogamy). Since clan-based effects measure over both men and women, the similarities and dissimilarities by gender should roughly wash out if the transmission norm holds. I therefore conclude that these results suggest a quite strong impact of the transmission norm on individual learning of these taboos, and that significant variation exists between gender-specific cultural lineages, which among men is associated with clan membership.

Given that Population A is more homogeneous with respect to kinship, but that there is not the same division between ethnic groups for the other two kinds of belief (see Aunger 1994a), similarity in both Homeopathic Taboos and Other Avoidances also seems to cluster somewhere between the clan and phratry levels.[15] However, the patterning is not as strong as in the case of Ancestral Taboos, being particularly weak for Homeopathic Taboos. Further, such clustering is probably unrelated to the operation of the transmission norm (Aunger n.d.a); in particular, there is no structuring along the lines of gender.

It is noteworthy that Homeopathic Taboos are not significantly different between ethnicities in Population B, where individuals from other groups appear. In fact, the variation within Sudanics is greater than that between ethnic groups for both Homeopathic Taboos and

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[14] Social identity is generally more significant in Population B, probably because of the greater variation in kinship in this more cosmopolitan group.

[15] For Homeopathic Taboos, kinship is positive at the phratry level for Population B, negative for ethnicity in Population A. Both indicate the same kind of effect -- some clustering of these beliefs within ethnicities at the phratry level (Population A simply doesn't have significant variation at this level). Similarity in Other Avoidances occurs at a somewhat smaller social scale, with cultural similarity in these beliefs arising at the lowest measured level of kinship, focussing on the clan, with the effects at higher levels of social organization being negative, due to differentiation as larger groups are encompassed. This picture is consistent for both Populations, but stronger in the more homogenous Population A (clan is only significant at $p = .025$ in Population B, and so is not included in the [weakest] final model).

Other Avoidances, suggesting these are quite universal cultural traits, at least in the Ituri, and do not particularly respect such boundaries to transmission.

Note also that there is a positive effect of proximity between clans/villages in Population A for Other Avoidances, due to the tendency for clans from the same phratry to form villages proximate to each other. In Population B, however, there is a greater mixing of ethnicities both within and between villages. Thus, in Population B, where the average degree of kinship more rapidly declines with a given distance, the proximity effect is negative. So, when coupled with the negative ethnicity result, this suggests that the difference in kinship results between Populations A and B is due to the nature of the neighbors: proximity is positive when they are same-phratry but negative when they might be different-ethnicity. The residential proximity effect (only significant here) is thus merely another manifestation of the observed low-level kinship clustering effect.

Susceptibility-Related Factors: Life History

The life historical variables have two possible interpretations: either as a direct effect on the acquisition or loss of food avoidances through contact with people deriving from particular kinds of life historical experience (i.e., an exposure effect), or as experiences which make individuals aware of other ways of organizing their cultural beliefs concerning foods (i.e., an indirect effect which influences decisions about the acquisition or loss of food avoidances). The pattern of results between avoidance types and Populations will be used to assist in interpreting the results.

First, I included Reproductive History largely because I expected individuals who had children to show increased sensitivity to the need to protect their children from dangerous foods indicated by Homeopathic Taboos. As expected, only the Homeopathic model allocated any importance to this effect: those in Population B who share the status of having children are more similar in their knowledge of these taboos. However, the opposite is true in Population A.[16] I expect this reflects a gender bias which is more pronounced in this more traditional Population: males in this Population do not view the observance of pregnancy-related taboos as their proper role, so that when women seek greater protection of their potential children by acquiring new Homeopathic Taboos as they come to reproductive age, their spouses do not follow this practice.

For Ancestral Taboos, Marital History is more significant than expected, and negative in the older Population A, positive in the younger one. This age difference suggests a difference in the average "marriedness" of the two Populations. In fact, such a difference is highly significant (two-tailed t-test for groups with unequal variances: $t = 3.82$; $p < .001$; $df = 198$). What this indicates is that most adults in Population B have been married at most once, while the majority of adults in Population A have experienced sequential marriages.[17] The model results show that remaining unmarried or with only a single marriage is associated with increased cultural similarity (in Population B) for both kinds of food avoidance which mark social identity: Ancestral Taboos and Other Avoidances. This suggests the existence of inter-spousal transmission of such beliefs. Given the nature of gender politics in the Ituri, this is almost certainly uni-directional transmission from socially dominant men to their wives of Ancestral Taboos, coupled with the imitation of local practice with respect to Other Avoidances by women marrying into a new social group. However, it also appears that the consequences for women of being socially dominated by men from a variety of different clans (during marriage) leads increasingly to the adoption of a suite of taboos, both Ancestral and Homeopathic, which becomes more and more at variance with the taboos of other

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[16] There is no difference in the proportion of the two Populations with children (two-tailed t-test for groups with unequal variances: $t = 0.85$; $p = .396$; $df = 216$).

[17] In Population B, 38% of individuals have not yet been married, while 70% of individuals have had only one or no marriages (negative exponential distribution with average of 1.00 marriages; with a maximum of four). In Population A, less than one-quarter of the population has never been married; fifty percent has had more than two marriages (normal curve with average of 1.64 and maximum of seven marriages).

individuals with similar experiences (both men and women). Remember that I suggested earlier that in the more traditional Population, women are more likely to adopt Homeopathic Taboos than their spouses; this is again indicated here. This cumulative process of change in avoidances, however, obliterates the distinctive nature of these womens' Other Avoidances, apparently because earlier-adopted ones tend to be retained (as shown also by the continuing influence of exposure during adolescence).

An Education-related effect is positive for the two taboo categories in Population A. This Population is less subject to outside influences than Population B, and less differentiated. Although those with educational experience tend to know more avoidances, they also tend to practice fewer of them, due to an increase in the disparagement of these beliefs associated with schooling (Aunger 1996). This acculturation aspect -- a distancing of self from the more traditional aspects of natal culture -- explains the similarity among the educated with respect to the two taboo categories: the Westernized attitudes feed back on the explicitly normative beliefs. Other Avoidances, although also tied to identity, are not taboos, and so not subject to the same attitudes about "culture." Thus, here, Other Avoidances appear to be personal in nature.

Work History is quite a significant determinant of cultural similarity.[18] It largely measures whether an individual has done wage labor. This tends to involve residential movement by entire families to the sites of such labor, since wage-earning opportunities in the Ituri are literally few and far between (largely in coffee plantations). Thus, the exposure aspects of Work History should be common to those who share household, albeit in this case being due to the shared contact with ethnically diverse people drawn from considerable distances by the lure of money. However, the pattern of results suggest that the reaction to this exposure varies. In particular, Work History is negative in the case of Ancestral Taboos, while positive for Homeopathic Taboos and Other Avoidances. The Ancestral Taboo result again probably reflects a differentiation among household members following gender lines after contact with the more cosmopolitan social circles at work sites. Men probably lose some Ancestral Taboos; women, on the other hand, can never consider themselves far from the watchful eyes of natal kin or in-laws (Aunger n.d.c), and so keep a strong hold on these taboos. In contrast, the positive effect for Homeopathic Taboos is probably due simply to contact with those knowing beliefs novel to those arriving to work from other areas. In the case of Other Avoidances, this again appears to indicate some imitation of those with whom one has come into contact through residential moves.

In conclusion, these susceptibility-related factors are quite important determinants of belief adoption. Although I have not directly measured the way in which these experiences influence decision-making concerning food taboos, they seem to influence changes in general attitudes toward traditional components of cultural life such as food taboos. This suspicion is certainly consistent with the tendency for these factors to be more significant in the more traditional Population.[19] In particular, Reproductive History reflects an interest in acquiring

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[18] It is only missing from the weakest model -- Other Avoidances in Population B, where it is significant at around $p = .03$. There is no difference in the work experience of the two Populations (Wilcoxon Rank Sum Test: $W = 11140$; $Z = -1.4359$; $p = .151$).

[19] Finally, interviewer effects were sizeable, but also varied between the two Populations. The consistent negative interviewer effect in Population B suggests that the overlap between interviewers was greater than seen within the set of interviews one of the interviewers conducted (i.e, he had more variable responses than the other). If, as I believe, my assistant interviewer was committed to the universality of Homeopathic Taboos (and within clans, of Ancestral Taboos), then this interviewer, who was from Population A, could use his bias to channel responses from informants in that Population, but like the author (the other interviewer), was unable to pre-judge responses in Population B. Thus, the difference probably derives from an interviewer bias effective in Population A which made our interviews significantly different in style for that Population. Variation naturally occurs with respect to non-taboos, or Other Avoidances, so a bias based on expected responses is irrelevant for these beliefs. Variation in what interviewers reported tended to be largest where the most dangerous beliefs were being reported, a result also seen in a more extensive investigation of such effects (Aunger 1994b).

the appropriate taboos among those with children to protect, but also gender differences in the need to observe such taboos (it is only the mother who has direct contact with the fetus, and provides milk to the infant). Marital History also operates differently in each gender: there appears to be some acquisition of new taboos, and perhaps some loss of Other Avoidances, among women who have gone through a number of marriages (and hence subjection to the social dominance of a variety of male clans). Men's beliefs, meanwhile, remain relatively unaffected by marital experiences. It is clear that Education essentially makes individuals more acculturated: it undermines the traditional authority which supports Ancestral Taboos while also making the magical thinking underlying Homeopathic Taboos seem more preposterous to those in the more traditional population. Finally, Work History generally brings people into contact with others of a sort they might not otherwise meet. But since Ancestral Taboos are only properly learned from kin, this contact does not lead to the acquisition of new Ancestral Taboos, but instead the loss of ancestral authority among men (but not women), living far from kin. In both genders, changes in Homeopathic Taboos takes place when people move to new work places, and in the more traditional Population, the prevalence of Other Avoidances is also changed by this involvement with more cosmopolitan people (perhaps more things become disgusting as "taste" is developed). Whether these changes are produced by a direct effect on the acquisition of novel food avoidances, or make individuals aware of other ways of organizing cultural beliefs concerning foods which undermines their resolve to uphold costly natal taboos, remains somewhat unclear -- although the Ancestral Taboo result suggests that some acculturation of attitudes is associated with this more Western mode of living.

And what can we conclude regarding the transmission of the various types of food avoidance? Infection with Ancestral Taboos follows normative chains of gender-specific transmission. This tends to differentiate cultural lineages which are associated with kin-groups among males. Homeopathic Taboos, on the other hand, are relatively unperturbed by social barriers to transmission, being picked up by individuals largely in response to life historical experiences, particularly those related to reproduction (such taboos are primarily effective during pregnancy and child-birth). Other Avoidances seem to mark local group membership. But why should Other Avoidances systematically vary by residence and kinship if they are unsanctioned, personal beliefs (i.e., attitudinal or generalized rejections of food)? Since residence and clan membership are closely tied for males but not females (because village placement largely recognizes patrilineal clan and super-clan distinctions), residential effects -- seen only with respect to Other Avoidances -- must represent a consistent pattern of observational learning from neighbors, especially by women. Which foods are rejected for these reasons therefore change with the "local culture" surrounding an individual. These suppositions are checked in the next section, which more directly investigates the issue of transmission patterns.

Age/History

I now move to consideration of the age-related influences. Untangling the possible causes of temporal trends from a single time-slice of data is notoriously difficult; the present case is no different. This is particularly distressing because it is the combination of kinship with generation which define a transmission pattern. For example, dissimilarity within generations coupled with similarity within clans (the case observed for Other Avoidances) implies vertical transmission.

The interpretational problem is that similarity within generations does not necessarily mean horizontal cultural transmission has occured. Unfortunately, patterns of similarity among generations may result from three forces which cannot be distinguished *a priori* but which have different implications for cultural dynamics: (1) cultural transmission within or between generations, (2) psychological characteristics specific to a cohort (e.g., senility among the old), or (3) a secular trend in the robusticity of such beliefs in the relevant group (e.g., a decline of interest in taboos due to recent acculturation). To infer that cultural similarity is due to cultural transmission, it is necessary to eliminate the latter two

possibilities.[20] One reason two Populations have been examined using equivalent methods and data is to assist in this task of interpretation.

For Ancestral Taboos, few generational effects are in evidence, but those indicators which are present suggest intra-generational transmission, resulting in greater similarity among those sharing an age cohort than pairs from different generations. This is opposite of the expectation from the transmission norm. For Homeopathic Taboos in both Populations, the generational effects are strong and clear: inter-generation transmission coupled with strong intra-generational similarity for the very young and very old. For Other Avoidances, generational effects are weaker, mixed and contradictory between the two Populations. Thus, on the face of it, Ancestral Taboos, which should be the category that is transmitted inter-generationally within families, appears to be largely horizontally transmitted, while those beliefs unaffected by the transmission norm -- especially Homeopathic Taboos, which should be contagious (if my argument that such rules are intrinsically believable, once heard, is to be believed) -- are apparently vertically transmitted. This invites more detailed investigation.

In attempting to resolve these unexpected indications concerning transmission patterns, I take a simple-minded approach, and examine the relationship between the number of avoidances reported by informants of different ages (see Figure 1). It appears that the division of informants into 25-year generations for the MQAR analysis coincides with changes in the rate at which informants in these age categories learn new taboos, as indicated by inflection points in a polynomial regression through the proportion of taboos reported by the Sudanic Population. The first slope (between ages 10 and 25) seen for all three types of avoidance undoubtedly represents the learning of new taboos, because the proportion of uncertain responses by informants declines in exact parallel with this rise (see Figure 1d). As suggested by MQAR, avoidance lists are not transmitted as a unit during a short period early in life. Those avoidances not affecting the child at an early stage of life are presented later on, closer to the time when the avoidance becomes relevant. For instance, some young men interviewed in adolescence had recently been told that they had to give up eating a particular food because continued consumption might interfere with their success at finding a mate. Likewise, some unmarried women were not yet sure what food items were forbidden to them during pregnancy. Some taboos are thus probably only transmitted to individuals when it becomes necessary for them to abide by them.

But note also that for both Ancestral Taboos and Other Avoidances, there is a second, if shallower, shift to a higher proportion of taboos among the elderly. This could also be due to some psychological anomaly of this group, or a secular trend in the robusticity of the food avoidance system in this population -- i.e., a decline in the richness of the belief system at present.

There is some evidence that older Sudanic informants make more mistaken reports in repeat interviews (that is, report one kind of avoidance on one occasion, but another during their second interview) (Aunger 1994b). However, this effect is ameliorated if the interviewer is more experienced and if the interviewer was not a Westerner.[21] There was no effect of age on the tendency for informants to “forget” to report an earlier avoidance on their second interview. So there is little evidence that the elderly are psychologically different from their younger compatriots. In addition, the most likely psychological effect (senility) would result in a decrease, not increase, in the number of reported taboos among older informants.

Rather, this second slope probably indicates a generational difference in the robusticity of the taboo system itself. This correlates temporally with a number of drastic social changes which took place in the 1940s and ‘50s, when the oldest generation was

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[20] Earlier results from phylogenetic analysis (Aunger n.d.a), while strongly indicating that there are multiple links between individuals, do not specify whether those links are to others of the same or different generations (i.e., whether transmission is inter- or intra-generational), and so cannot help us here.

[21] Thus, this effect is probably due to the fact that older women were afraid of talking to anthropologist, especially in Swahili, which they tend not to know as well as men.

growing up: the Sudanics were moved from traditional villages widely scattered in the forest to more cramped locations along a single major road by Belgian colonial administrators. This brought them into closer contact with each other, which apparently led to a suppression of the earlier practice of inter-phratry raiding for garden produce and women. Contact with horticulturalists from other ethnic groups such as the Bantu-speaking Budu also increased significantly, while some relationships with Efe were lost, either because the Efe stayed in the forest or moved into relationships with Budu on the western side of the Ituri. Schools and dispensaries were instituted by Catholic missionaries, and there was active participation in cash cropping, primarily coffee (Grinker 1994:46-50 -- see also Wilkie and Curran 1993). Obviously, many of these social changes could be associated with changing transmission patterns, as well as the influx of new ideas into the taboo system. So this second age shift is likely to be due to general social rather than psychological factors -- in particular, the fact that those under about fifty years of age have had greater access to school. This constitutes a secular change in the food taboo system itself -- the effect of acculturation in the Ituri since the 1940s.

The pattern seen with respect to Homeopathic Taboos is rather different, however, and quite startling. There is a prominent increase in the number of such taboos reported by individuals during just that time when they should be most concerned with pregnancy: between ages twenty and fourty-five. Acculturation would suggest that the elderly exhibit more such taboos, not considerably fewer, than those a generation younger. Clearly, here is a case where a belief, no longer relevant to an individual, is simply discarded from the cultural repertoire -- it is not senility-based "forgetfulness" because the frequency of other types of avoidance is not reduced among the oldest informants. The elderly were probably just as responsible during their own reproductive years in protecting their children from the dangerous effects of homeopathically tabooed foods, but now, for them, such a threat no longer exists. Thus, we are seeing what happens during the course of an individual's lifespan: as new avoidances are acquired, uncertainty decreases, while after reproduction has ceased being a possibility, there is little interest in holding onto onerous beliefs.

In light of these results, we have to reinterpret our earlier suppositions. For example, the strongest age effects are seen in Population A for Homeopathic Taboos: strong negative Generational differences coupled with strong positive cohort effects. However, the cohort-specific similarity of the young and old is due to ignorance and dismissal, respectively, with only those individuals in middle-age reporting homeopathic beliefs, as seen in Figure 1. The Generation result in Population B is of reduced significance because the younger generation in that Population is less homogeneous. The negative Generation result for Homeopathic Taboos could also reflect a gender bias: only women of reproductive age pick up these beliefs, making them very different from their same-Generation spouses. All of this implies that even the strongest indicator of inter-generational transmission does not in fact reflect older individuals passing their knowledge to the young. Similar reassessments are suggested for the other two types of food avoidance.

In conclusion, Ancestral Taboos show some evidence of a secular trend, so the intergenerational difference in the MQAR results does not indicate transmission but differences in the robusticity of the taboo system between age cohorts. Other Avoidances show a similar, but weaker version of the Ancestral pattern (although it may just be that old people are crotchety, and not really a secular trend--however, the elderly are actually dependent on acquiring meat from others, and may have little choice about what to reject for personal reasons). Homeopathic Taboos are simply forgotten after their utility has ended.

If this interpretation is correct, then the Generation results from MQAR confound two different phenomena, neither of which has anything to do with cultural transmission: first, those under 25 are similar in their relative lack of acquaintance with the taboo system, while those in later adulthood are similar in knowing a more robust system, or in disregarding homeopathic beliefs that have no further use to them. Although this analysis leaves the pattern of transmission question open, it does indicate that individuals exercise considerable

choice concerning what to believe and when -- further evidence of the importance of susceptibility as opposed to exposure in the epidemiology of belief in the Ituri.[22]

Conclusion

In this paper, I employed optimal scaling and multiple quadratic assignment regression to infer the relative importance of physical access versus cognitive adoption biases on how information (concerning the edibility of foods) is exchanged in a population living in the Ituri Forest of the Democratic Republic of Congo. I argued this can be viewed as a question of exposure versus susceptibility to information, respectively, in an epidemiological approach to belief diffusion. This investigation showed that the likelihood of cultural transmission between individuals varies in a complex fashion by type of belief, kinship, generation, gender, social status and contact history, as well as the temporal frame of the analysis. However, the statistical models indicate a general, rather remarkable *in*significance of social contact on transmission. In particular, the transmission of these normative beliefs is largely unrelated to possible differences in exposure (i.e., propinquity or interaction frequency). Instead, cognitive biases (or susceptibility to belief in cultural epidemiological terms) largely determine the observed intra-cultural variation in belief: individuals rely on a number of learning predispositions to assess the value of information with which they have become acquainted. These predilections vary by type of food avoidance, influenced by the likely function of the relevant belief. For example, for one category of taboo, which serves as a social norm, transmission is influenced by who can legitimize their role as a teacher of such beliefs. So, in great part, it is not the lack of access to important cultural information that causes the highly complex distribution of food avoidances in the Ituri. Interpersonal association can be long and intimate without an avoidance being transferred. The relevant information is kept circulating in the social environment by constant chatter, creating gossip chains that reach nearly everyone, even though mechanized transportation is limited and technologies for information transfer nonexistant. Accidents of interaction do not significantly determine access to information.[23]

Rather than physical or geographic barriers to contact, it is either personal decision-making or social authority systems -- particularly the need to acquire beliefs legitimated by normative channels of transmission -- which underly the persistence of variation in these beliefs. The presence of heavy filters to adoption on the receivers' end of the transmission line results in highly favored selection of some cultural alternatives. These biases are evidenced particularly by the significant clustering of belief among those sharing kinship, gender and age cohorts -- the primary markers of social identity in the Ituri. Individuals are very choosy about which avoidances to call their own, and primarily seem to want to be like those with whom they share important social roles. In this case, the primary constraint on

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[22] Since determining the relative importance of susceptibility and exposure does not depend on whether there is more inter- or intra-generational transmission of food taboos, we defer the answer to this question to another paper (Aunger n.d.b).

[23] It might appear that, if there have been subsequent changes in belief, the measures of past contact will underestimate the probability of transmission between individuals who shared close residence because the traces of that exchange will be obscured by later overwriting of those communications. Still, it is interesting that those measures which did prove significant were confirmed by independent analyses: Adolescent Village was significant across the board; Childhood Village not at all. This is fairly precise placement of the effect temporally, consistent with an obvious surge in knowledge through those years.

In fact, since the models are based on entire Populations, with representative demographic profiles, the results here concerning the relative importance of vertical and horizontal transmission should be unbiased. Even though some earlier events may be obscured by later ones involving the same individuals, the age structure of the sample, if characteristic of that of the population, will reflect the proportion of events of each vector type in the proportions relevant to long-term dynamics.

belief replication is largely a social one: individuals need to be convinced that adoption of these costly beliefs is necessary to achieve cultural competence and hence social status.

A variety of specialized experiences such as schooling, work and marriage also significantly influence cultural similarity, and therefore the likely transmission of belief among dyads sharing such experiences. However, the effect is complicated because it is indirect: these factors (such as acculturation) influence attitudes and values associated with the social authority system or the tendency to mimic others which underpins avoidance transmission, not susceptibility to belief in avoidances themselves. In fact, factors quite unrelated to food avoidances per se can have a significant influence on the way in which these beliefs are distributed in the group. The adoption of cultural beliefs cannot be studied in isolation from acculturation, or attitudes toward society (in particular, authority structures). Culture, society and psychology are intimately related.

But if replication is almost entirely due to selection processes rather than availability problems per se, why have I argued for the importance of an epidemiological approach? In fact, it appears that transmission can be effectively ignored and even draws attention away from more relevant concerns (such as evaluation mechanisms). However, individuals do not make these complex rules up for themselves, so that cultural rule content is necessarily dependent on social learning. What is in an individual mind is highly influenced by the vocabulary of belief evolved by the group. Further, the evaluation of such information is constrained by the fact they have learned it socially rather than through personal experience. For example, information acquired through listening to the speech of others is often logically deficient due to only relevant aspects of the communication being enunciated (Sperber 1985; Sperber and Wilson 1986/1995). This influences the "believability" of such rules compared to those generated by internal reflection because inference based on socially-learned information is more constrained. For example, one cannot generate as complete a mental profile of a person known only through report as for a personal friend. Thus, knowing how and with what fidelity information is replicated by transmission-related processes remains important in determining the epidemiological characteristics of belief systems over the long term.

In particular, it is the intrinsically social nature of susceptibility in this case which makes the transmission process look chaotic when viewed from the perspective of individual people. This paper has shown that food taboos in the Ituri are, in essence, like the common cold: nearly everyone is frequently exposed but seldom infected, due to wide-spread resistance built up over a long history of interaction between the host population and these everyday "mind viruses" (Dawkins 1993). This long coevolution between beliefs and hosts places considerable importance on the social structure of contact: the prevalence of susceptible individuals is low compared to those who have developed cultural resistance (immunity being derived not from previous infection, but through innoculation by the transmission norm). The resulting pattern is one of endemic rather than epidemic transmission (Aunger n.d.a). As a result, the virulence of individual taboos is low: they have a relatively low nutritional cost on their hosts (Aunger 1994a). It is only when particular combinations of individuals communicate, or new variants are introduced to which immunity has not been developed, that individuals become infected by these cultural beliefs. This conclusion is consistent with the finding from social network studies that the adoption of innovations is not strictly a function of exposure (the proportion of prior adopters in an individual's personal network) because individuals have varying threshholds at which they will adopt new beliefs or practices (Marsden and Podolny 1990; Valente 1996).

Thus, the processes underlying the dissemination of both cultural traits and pathogens, considered as replicating units of information, appear close enough to justify using evolutionary epidemiology as a common framework for investigating cultural and biological phenomena. In fact, memes and pathogens both use individuals as hosts, so their fates are intertwined. It therefore seems not only fruitful but necessary to consider cultural and biological replicators as parts of a larger, interacting system.

Finally, why haven't I attempted to estimate the pattern of transmission quantitatively? In this and other publications (e.g., Aunger n.d.b), I have argued that most available methods for studying cultural evolution have proven impossible or unreliable for everyday or endemic culture. However, the remaining method, indirect observation or inference, used here and in Aunger (n.d.b), appears to have low powers of resolution. This

pessimistic note is confirmed by recent modeling efforts. Lowen and Dunbar (1997) conclude from a simulation exercise that although qualitative comparisons of cultural change rates are possible based on unstructured models (i.e., random social mixing in an effectively infinite population), *quantitative* estimates of cultural evolution requires knowledge of population structure. In effect, estimated rates of change in the prevalence of cultural traits are sensitive to stochastic fluctuations in the availability of persons to occupy particular roles. Here, the equivalent finding has been found true of a real population.

Even multiple time-slices of information will not necessarily help estimate transmission pathways unless social interaction patterns can be observed. Otherwise, determining which of the life experiences ocurring between observation periods are relevant to the observed changes in cultural traits can be difficult. Accurate information about the aspects of social relationships relevant to the transmission of particular kinds of beliefs and practices is vital. But since reliable social network data is itself difficult to obtain -- and is added to an already long list of information about the cultural values and life historical experience of each individual in a sample -- I believe it will often be truly arduous to collect the data requisite for quantitative conclusions concerning intra-cultural evolution. Models which combine social structural parameters with temporal data -- in particular, heterogenous diffusion models (Greve et al. 1995), and loglinear epidemiological/network models (Morris 1993) -- appear to be powerful, although largely untested as yet. Simulation does suggest, however, that even these models can become confused when social ties are dense and multiplex (Greve et al. 1995:417).

Further, even if the pattern of transmission can be reliably estimated for some period in a given population, this "truth" is not likely to hold for long. Such patterns are often quite ephemeral, given the transient nature of population structures and the limitation of estimates to narrowly-defined cultural domains (e.g., Ancestral Taboos). The estimated pattern may therefore not be one with a great deal of stability -- so even its application to the same suite of beliefs in the same population at a later time is questionable. Presumably this is especially the case if there is any change in technologies affecting information transfer, to which individuals may also have differential access.

At any rate, quantitative estimates are subject to a high degree of uncertainty, and so do not provide solid grounds for comparison. Thus, analytic models are sufficient to ascertain the direction of change in cultural systems, but numeric models, validated by empirical results, are required to estimate rates of cultural change. However, even the estimation of statistical models which include non-random levels of interaction have proven unable to generate stable quantitative predictions concerning the likelihood of transmission between individuals.

This is not necessarily the disheartening conclusion about the everyday workings of culture that it may appear. In effect, it merely suggests that the particular features of a transmission pattern cannot be of ultimate interest. But then, no one really cares to know that older women who have never married are more likely to acquire this or that taboo in some obscure population in Africa. Rather, we should investigate whether general principles of cultural change, or theoretically derived expectations about the nature of cultural belief, can be tested. Qualitative conclusions are often all that is required to answer theoretically interesting questions. For example, the ability of the results in the present paper to indicate the transmission norm actually exerts considerable influence on the maintenance of Ancestral Taboos in this population converts an imputed influence into an established result. So the study of cultural epidemiology *can* progress, even without quantitative findings. Whether it will do so depends on others taking up the challenge.

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Table 1: MQAR Model Variables

Variable	Effect	Definition
Proximity	*exposure*	
Household	intimate present contact	same household = 1
Residential Proximity	present contact	negative distance (in miles) between dyad members' present villages
"Time-Shared"	past contact	proportion of lifespan of younger dyad member spent in same village as other member
Childhood Village	critical period contact	= 1 if older dyad member lived in same village when younger member was child (< 10)
Adolescent Village	critical period contact	= 1 if older dyad member lived in same village when younger member was an adolescent (> 10 and < 20)*
Social Identity	*susceptibility*	
Ethnicity	learning bias	same ethnicity = 1
Phratry	learning bias	same phratry = 1
Clan	learning bias	same clan = 1
Gender	learning bias	same gender = 1
Life History Experiences	*susceptibility-related cognitive biases*	
Reproductive History	parenthood/ transmission obligation	= 0 if only one of dyad members has children; = 1 if neither or both do
Marital History	spousal transmission bias	negative absolute value of difference in number of marriages
Education	acculturation through Western schooling	negative absolute value of difference in number of years attended school
Work History	acculturation through contact with Western bosses	negative absolute value of difference in scaled work types (none, daily wage, or salaried employment)
Age/History	*other biases*	
Generation	learning bias/ secular trend in belief system/ vertical transmission	negative absolute value of generation difference (generation = 25 years)
"50-Plus"	senility/ secular trend/ horizontal transmission	= 1 if both dyad members ≥ 50 years of age
"Under-25"	uncertainty/ secular trend/ horizontal transmission	= 1 if both dyad members ≤ 25 years of age
Methodological	*elicitation bias*	
Interviewer	interview-style	same interviewer = 1

* Four percent of the sample have missing values for this variable because one dyad member had yet to reach adolescence.

Table 2: MQAR Model Results: Population A/Population B*

	Ancestral Taboos		Homeopathic Taboos		Other Avoidanc
	b-coefficients	p values#	b-coefficients	p values#	b-coefficients	p va
Intercept	0.75378	0.001	0.86595	0.001	0.88024	0.
	0.88443	0.001	*0.89403*	0.001	*0.95125*	0.
Proximity						
Household	-0.04658	0.001	-----	-----	-----	--
	-----	-----	*0.05849*	0.001	-----	--
Residential Proximity	-----	-----	-----	-----	0.00476	0.
	-----	-----	-----	-----	*-0.00552*	0.
"Time-Shared"	-----	-----	-----	-----	-----	--
	-----	-----	-----	-----	-----	--
Childhood Village	-----	-----	-----	-----	-----	--
	-----	-----	-----	-----	-----	--
Adolescent Village	0.02974	0.001	0.03821	0.001	-----	-
	0.04267	0.001	-----	-----	*0.02279*	0.
Social Identity						
Ethnicity	-----	-----	-0.01535	0.001	-0.03283	0.
	0.0.484	0.001	-----	-----	*-0.01828*	0.
Phratry	-----	-----	-----	-----	-----	--
	0.02678	0.001	*0.02301*	0.001	-----	--
Clan	-----	-----	-----	-----	0.02396	0.
	-0.03305	0.005	-----	-----	-----	-
Gender	0.01988	0.001	-----	-----	-----	--
	0.01415	0.001	-----	-----	-----	--
Life History Experiences						
Reproductive History	-----	-----	-0.00833	0.004	-----	--
	-----	-----	*0.01609*	0.001	-----	--
Marital History	-0.01368	0.001	-0.00687	0.001	-----	-
	0.02537	0.001	-----	-----	*0.01878*	0.
Education	0.00270	-----	0.00205	0.001	-----	--
	-----	-----	-----	-----	-----	--
Work History	-0.01539	0.001	0.01533	0.001	0.00890	0.
	-0.02717	0.001	*0.01419*	0.001	-----	--
Age/History						
Generation	-----	-----	-0.03924	0.001	-----	-
	0.01764	0.002	*-0.02150*	0.001	*-0.01214*	0.
"50 Plus"	0.01565	0.008	0.07558	0.001	-----	-
	-----	-----	*0.06755*	0.001	*0.03267*	0.
"Under 25"	0.09266	0.001	0.10264	0.001	0.02007	0.
	-----	-----	*-0.01604*	0.004	*-0.02433*	0.
Methodological						
Interviewer	0.09120	0.001	0.01303	0.001	0.04033	0.
	-0.02107	0.001	*-0.04093*	0.001	-----	-
r^2	.1111		.0867		.0408	
	.0606		*.0382*		*.0329*	

* the second, italicized value in each cell refers to Population B

from 1000 replications of MQAR

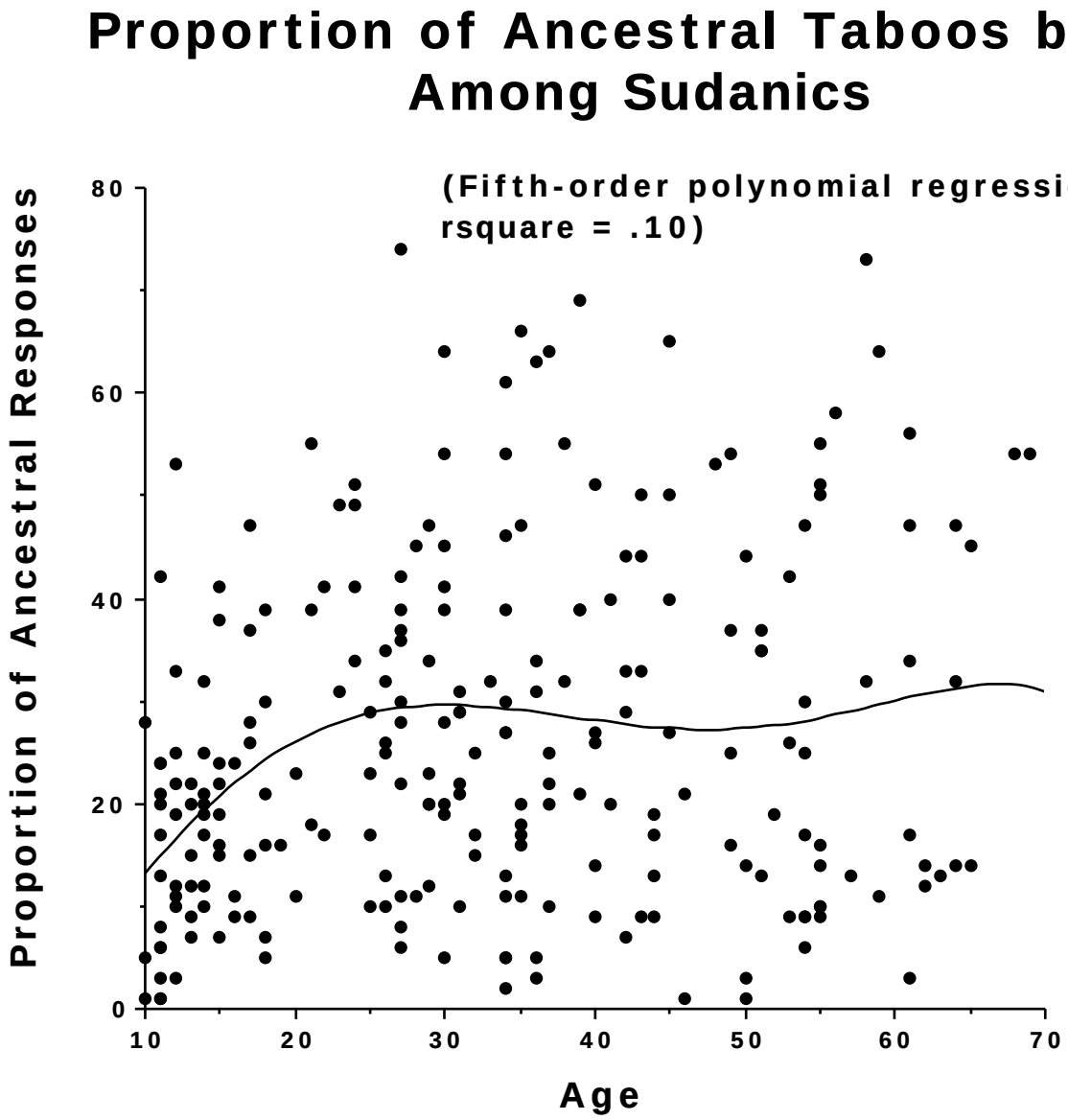
Table 3: Estimated Relative Significance of Variables: Population A/Population B*

	Ancestral Taboos	Homeopathic Taboos	Other Avoidances
Intercept	167.202	204.610	212.335
	210.138	*207.358*	*296.444*
Proximity			
Household	-4.573	-----	-----
	-----	*6.931*	-----
Residential Proximity	-----	-----	4.128
	-----	-----	*-4.239*
"Time-Shared"	-----	-----	-----
	-----	-----	-----
Childhood Village	-----	-----	-----
	-----	-----	-----
Adolescent Village	5.640	8.739	-----
	8.270	-----	*5.757*
Social Identity			
Ethnicity	-----	-5.025	-10.847
	10.351	-----	*-6.799*
Phratry	-----	-----	-----
	3.730	*4.082*	-----
Clan	-----	-----	3.764
	-2.946	-----	-----
Gender	5.650	-----	-----
	4.429	-----	-----
Life History Experiences			
Reproductive History	-----	-2.835	-----
	-----	*4.459*	-----
Marital History	-10.379	-6.299	-----
	11.915	-----	*11.562*
Education	4.864	4.508	-----
	-----	-----	-----
Work History	-6.200	7.525	4.500
	-10.252	*5.394*	-----
Age/History			
Generation	-----	-12.245	-----
	4.681	*-6.058*	*-3.893*
"50 Plus"	2.400	14.010	-----
	-----	*5.530*	*3.541*
"Under 25"	12.940	17.332	3.732
	-----	*-3.263*	*-6.115*
Methodological			
Interviewer	24.104	4.212	13.326
	-6.194	*-11.554*	-----

* values are t-values from ordinary least squares regression; the second, italicized value in each cell refers to Population B

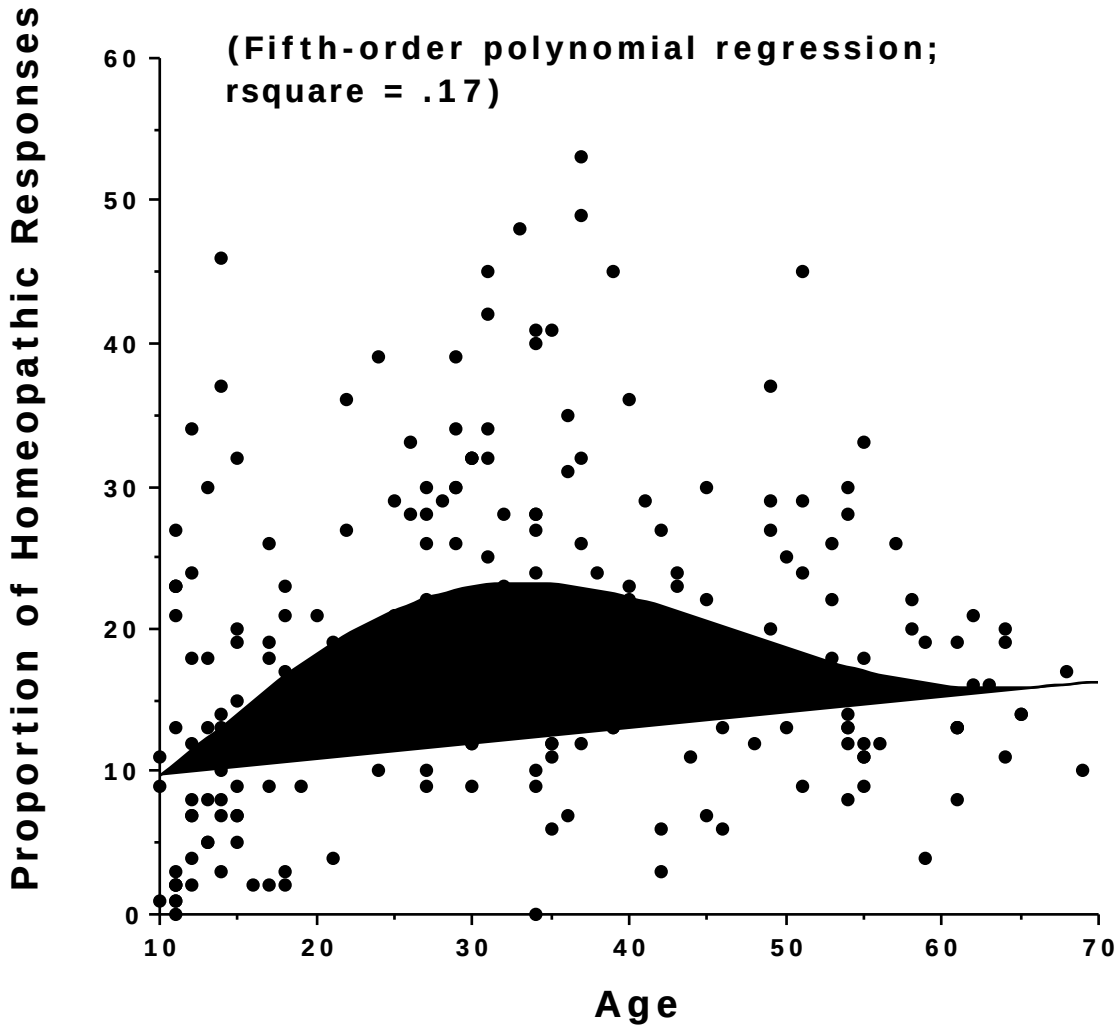
FIGURE 1

A.

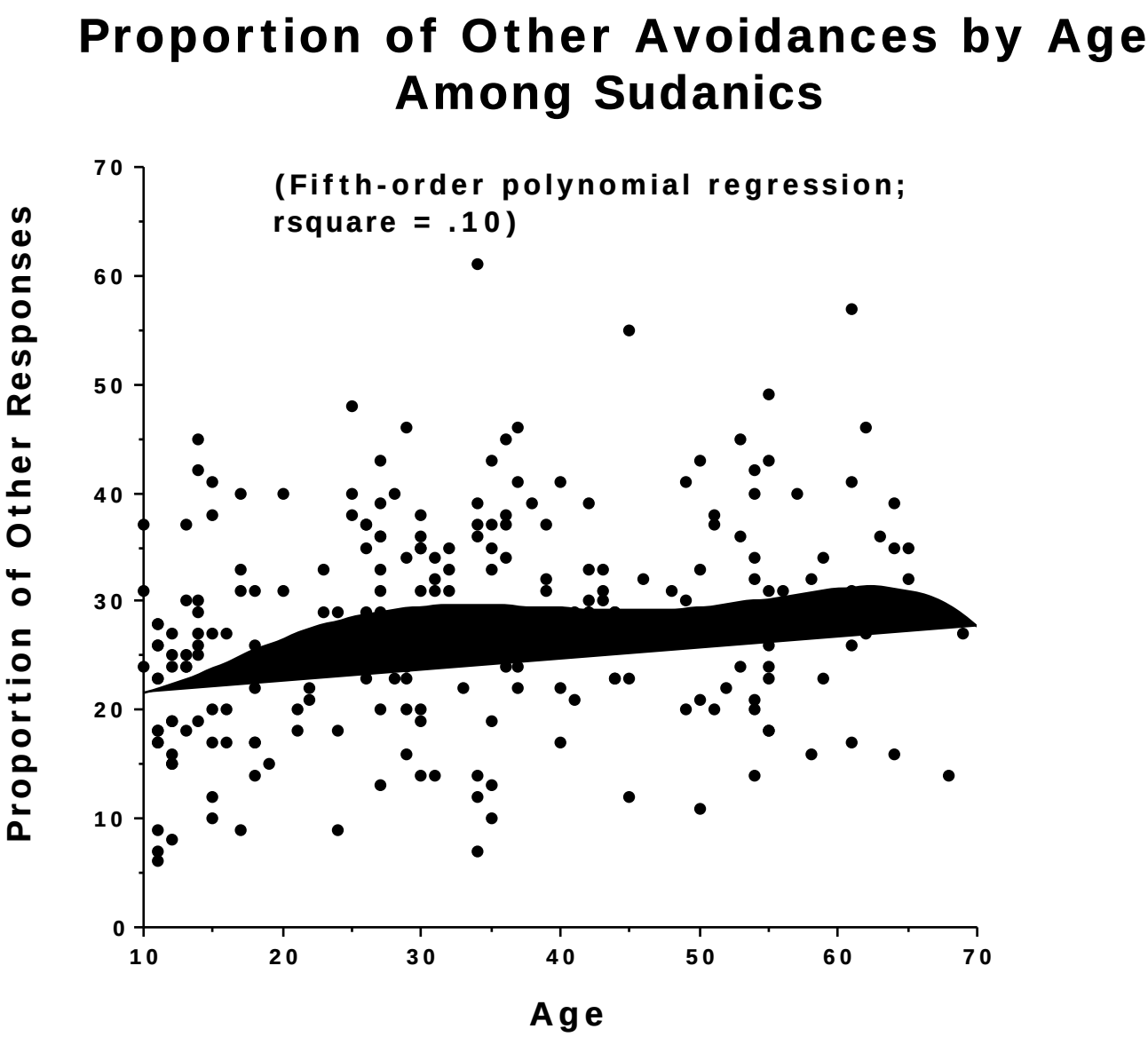

Proportion of Ancestral Taboos by Age Among Sudanics
(Fifth-order polynomial regression; rsquare = .10)
Proportion of Ancestral Responses
0
20
40
60
80
10
20
30
40
50
60
70
Age

B.

Proportion of Homeopathic Taboos by Ag
Among Sudanics



C.


Proportion of Other Avoidances by Age
Among Sudanics
(Fifth-order polynomial regression;
rsquare = .10)
Proportion of Other Responses
0
10
20
30
40
50
60
70
10
20
30
40
50
60
70
Age

D.

Proportion of Uncertain Responses by Among Sudanics