# Style, Function, and Cultural Evolutionary Processes

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## Introduction

When explaining human behavior, anthropologists frequently distinguish the things that people do of their own free will from the things they do because they have to. In much of anthropology, and most American archaeology, this is the difference between *style* and *function*. Functional behaviors are the things people are constrained to do; stylistic behaviors are the things people do when unconstrained. Where necessity stops and free choice begins is, of course, a classic problem of social science theory, but wherever the boundary is placed, it is generally implied that the domains thus divided are not of equal importance (Bettinger 1991:49-50). Few straddle this fence: Materialists emphasize function and downplay style; structuralists and postmodernists do the opposite. Recent attempts to apply neo-Darwinian concepts to the archaeological record predictably side with materialist tradition, repeating the premise that it is most important to explain functional behavior; stylistic behavior is interesting only for localizing social units in time and space.

Any attempt to create a rigid boundary between style and function will fail. For example, the attempt to use free will as a distinction founders on the fact that conforming to stylistic conventions of speech, dress and belief is frequently compulsory and almost always sanctioned. We may often have more opportunities for free choice of mundane utiliatrian objects. Style often has functions, and the most basic functions--eating, defacating, and having sex--are usually done in style.

In this paper we argue that materialists forfeit too much when they dismiss the importance of style for humans. Human stylistic behavior over the last forty thousand years is extraordinarily extensive and elaborate. This is critical because for neo-Darwinians complex, richly-structured forms always signal the operation of natural selection or *related evolutionary forces*. There are simply no known material processes except natural selection, and analogous evolutionary forces in the cultural realm, capable of accounting for phenomena that appear to be "designed" (see Dawkins [1986] for an excellent introductory summary of the adaptationist form of this argument). From this view, art objects, languages, and supernatural ideologies seem as much to be the product of evolutionary processes as subsistence technology and cannot be ignored.

With the advent of unambiguous stylistic features in the archeological record at the Upper Paleolithic Transition, subsistence strategies also improved and populations of humans jumped (
and Gamble, 1993). We argue that this coincidence is not accidental. Style has functions. The style-function dichotomy embraced by materialists and non-materialists alike obscures understanding of the fundamental processes that generate human behavior.

Treating style and function as a dichotomy arises from an oversimplified picture of evolutionary processes. In animals, “style” arises due to sexual selection and perhaps more generally to social selection (West-Eberhart, 1983). Evolutionary biologists since Darwin have engaged in a complex debate about the functionality of plant and animal style. However, this debate has hardly ever had the character dividing sexually selected traits off inconsequential. The modern debate has focussed on whether style counter-functional (the runaway hypothesis) or whether it is an index of the overall fitness of a potential mate (the handicap hypothesis). Too much time and effort go into style for it to be neutral!

Human cultural styles cannot be explained without understanding the cultural analogs of the sexual selection mechanism. The conventional style function dichotomy is a result of not taking account of the variety of these forces in cultural systems, and how the relate to the action of natural selection of adaptations. Human culture is influenced by a complex of evolutionary forces that ultimately derive from the operation of natural selection, but which have proximal properties that differ substantially from it (Campbell, 1965; Boyd and Richerson, 1985). Several of these involve the choices of cultural mates and parents and are like mate choice sexual selection. Others are perhaps more direct stand-ins for natural selection through psychological predispositions (Cosmides and Tooby, 1992). When such "related evolutionary forces" are taken into account the rigid distinction between style and function dissolves. Stylistic variation responds to a complex of random and directional evolutionary forces and can serve important functions precisely because it is arbitrary and symbolic. Explicit evolutionary models of stylistic variation clarify our understanding of style and its relation to function and culture history, and improves our understanding of the patterns style might leave in the archaeological record.

In the first part of this paper, we review recent debates on the implications of stylistic behavior for archaeology. Then we analyze the limitations inherent in assuming that evolutionary processes can be collapsed into selection acting on functional attributes and random effects acting on stylistic variation. Finally, we argue that recent advances in the theory of cultural evolution provide a reasonable account of the processes that affect the complex of stylistic and functional of culture.

## Style and Function in Neo-Evolutionary Perspective

### *Style versus function*

"Natural selection is the primary explanatory mechanism in {Bob, typo “social”?} ”scientific” evolution....Style and function are defined in terms of natural selection. Because of the distributional entailments of natural selection, each has a distinctive, wholly predictable distribution in the archaeological record." Dunnell 1980:49,88.

"Style denotes those forms that do not have detectable selective values. Function is manifest as those forms that directly affect the Darwinian fitness of the populations in which they occur...The dichotomy is mutually exclusive and exhaustive." Dunnell 1978:199.

"Stylistic variation is selectively neutral. Hence stylistic traits are sorted stochastically: by drift." Neiman 1993:1.

The position of Dunnell (1978, 1980), a prominent archaeological exponent of the rigid style-function dichtomy, serves as an excellent starting point for our counter-argument. He argues that the distinction between style and function in anthropology is essentially between behaviors that are subject to processual explanation and behaviors that are not. Because Dunnell advocates a neo-Darwinian view of process, for him *functional* refers to things explicable as adaptations due to natural selection and *style* means, effectively, afunctional or neutral--things without direct positive or negative selective value.

Dunnell argues that because they are free of selective constraint, stylistic traits will vary stochastically, much like adaptively neutral traits in biology. He notes that these properties make style especially appropriate as measures of time (e.g., in seriation), social interaction, and culture history (cf. Neiman 1993). As with other techniques that employ presumably neutral traits to measure descent relationships (e.g., non-coding DNA resemblances, lexicostatistics), shared features of style are taken to be homologous similarities reflecting common cultural heritage. Dunnell observes one complication in this simple style-function distinction: if a functional requirement admits alternative solutions, the same trait can be stylistic (neutral) and functional, depending on the level (scale) at which it is defined. Variants of a functional trait (e.g., Z-twist and S- twist cordage) may be neutral with respect to each other, even though all are utilitarian.

Dunnell's definition of style and function is widely accepted by those interested in applying evolutionary principles to the archaeological record. Most materialist archaeologists agree that functional features will be non-randomly patterned as a result of selection, and features of style will be merely stochastic. This is frequently read as meaning that the former are subject to processual explanation, the latter are not (e.g. Kirch 1980, Leonard and Jones 1987, O'Brien and Holland 1992; Neiman 1993).

In portraying art and style -- the things anthropologists have historically identified as distinctively "cultural" -- as beyond the reach of neo-Darwinian explanation, Dunnell articulates a traditional tenet of materialist anthropological inquiry, expressed first in modern form by Steward (1938), and subsequently in increasingly extreme form, by early cultural materialists (Harris 1968), neofunctionalists (Vayda and Rappoport 1967), New Archaeologists (e.g., Binford 1962; cf. White 1959), and, most recently, by human evolutionary ecologists (e.g. O'Connell, Jones, and Simms 1983). Dunnell simply operationalizes the traditional argument through the prediction that art and style always pattern randomly.

*Style as Style*

"Every style is necessarily prelimited...The range of its channeled skills will extend so far; beyond they fail. Then we say that the style has exhausted itself, its characteristic pattern has broken down...It is commonplace that all aesthetic styles, rise and fall and perish." Kroeber (1948: 329-330)

Many anthropologists, of course, dispute the materialist account of style and the nature of stylistic change. Kroeber (1948) was one of many for whom stylistic change was directed rather than random. Kroeber viewed styles as basic themes (analagous to styles in art or music) upon which cultures elaborated. Because it seemed inconceivable to him that such elaboration could continue beyond a climax in which the possibilities inherent in the style were exhausted, Kroeber believed that stylistic change followed a non-random historical trajectory, a position that Dunnel and others explicitly reject. Claims of this kind (Sahlins, 1976) are often presented as alternatives to the functional account style, but this is not necessary. Even among Krober's lengthy ruminations, one can find the kernel of an idea reconciling the view that style shapes and constrains cultural change with the functionalist view that culture is adaptive.

"...For things to be done well they must be done definitely, and definite results can be achieved only through some specific method, technique, manner, or plan of operations. Such a particular method or manner is called a style in all the arts....A style...may be said to be a way of achieving definiteness and effectiveness in human relations by choosing or evolving one line of procedure out of several possible ones and sticking to it" (Kroeber 1939: 329)

Sackett (1982, 1985) has more recently labeled such behavior *isochrestic*: patterned behavior reflecting essentially arbitrary choices between essentially functionally equivalent ways of doing things. This is Dunnell's scale effect -- specific variability in traits that equally satisfy the same adaptive function. Dunnell, Sackett, and Kroeber, then, all seem to agree that just how one skins a cat can be functionally less important than the fact that one skins it at all. They disagree fundamentally, however, in what this implies about the mechanisms driving the historical trajectories of alternate variants of cat-skinning.

For Kroeber (as exemplified by the latter quote) and Sackett isochrestic variation is mainly a product of the formalization and routinization of technique, which makes the transmission of the knowledge about how to make a complex object easy to imitate, remember, and execute. These benefits evidently resulted when simpler forms of individual and social learning were replaced by arbitrary conventions that streamlined acquisition by cultural transmission and coordinated complicated cultural behaviors. Once craftsmen become skilled at making and using a tool one way, they may rationally resist change because of learning costs. This is consistent with formal models suggesting it pays to retain a suboptimal tool when searching for the optimal alternative is costly or error prone (Simon 1959, Heiner 1983, Boyd and Richerson 1992a). At the same time, as Kroeber and Richardson's (1940) classic paper on dress style shows, there is nothing in the concept of isochrestic variation that denies the possibility of non-random historical trajectories of change.

Others working with style find isochrestic variation methodologically problematic and favor stylistic inquiries that emphasize iconic and symbolic variation. Binford (1989:52-53) sees the style-function dichotomy as an opposition between conscious, explicitly-rational, problem-solving behavior, on the one hand, and unconscious, rote-learned motor habits and socially or symbolically-motivated behavior, on the other. Within the latter, he evidently now follows Weissner (1985:162) in equating isochrestic variation with the unconscious or rote-learned motor habits (Binford 1989:56,58). Because it is always possible that what appear to be isochrestic variants connected with individuals or ethnic units actually have functional significance, Binford believes that when defining actors or actor-groups in the archaeological record it is safest to focus on the most obvious sorts non-functional variation related to social or ideological behavior. The closer a style is to purely symbolic, the less likely it is to be functional, i.e., patterned by rational choice. Backed and self bows are at some level functionally equivalent but this equivalence is not guaranteed so generally as would be the functional equivalence of alternative geometric designs painted on them.

Binford and Wiessner have discussed strategies for working with formal variation in material culture that consciously transmits information about social or personal identity. The emphasis here is on the use of the variation as emblems or icons of social or political groups (emblematic and iconological style) or expressions of individual identity within such groups (assertive style). In these cases, variation is said to be purely symbolic but serves a function (communication) and is surely not random. Weissner (1985:162; and evidently Binford 1989:54-55) argue that because social or ideological stylistic variation is manipulated to suit changing social and individual contexts, it should vary substantially through time and space, in contrast to isochrestic variants resulting from streamlined cultural decision-making, which are stable once established. As just noted, however, the isochrestic concept does not require this and, as Dunnell argues, isochrestic choices made by individuals can certainly give rise to behavioral change at both the individual and population levels.

In the main, Dunnell dismisses the relevance of these distinctions for the archaeological record. In contrast to Sackett, for whom cultural transmission streamlines (hence constrains) decision-making, for Dunnell cultural transmission is adaptive for the opposite reason: it broadens access to behavioral alternatives. It increases the amount of functionally significant variation from which individuals can choose and, thus, upon which selection can act. This increases the speed and range of adaptive responses relative to simple genetic transmission, where population variation is more finitely constrained by such things as generation length, mutation rates, and existing genetic variation (Dunnell 1978: 198). Selection sorts (hence patterns) the functional traits, leaving stylistic traits, symbolic and isochrestic, to drift randomly. If this is so, the methodological and ontological complexities of non-symbolic isochrestic variation that charge the theoretical debate between Sackett, Binford, and Weissner are empirically unimportant. Style and function are more cleanly distinct under this assumption, and non-stylistic variation is always functionally significant.

To summarize, if our review of the literature above is correct, archaeologists identify three types of artifact variation: (1) functional variation uncomplicated by stylistic features, (2) isochrestic variation in functional traits in which variants are qualitatively different but nearly equal in function, and (3) isochrestic variation in iconic and symbolic traits derived from arbitrary, functionless decorative elements. These three types seem to be viewed as points in a two dimensional space with one dimension representing function, ranging from completely functional to completely isochrestic, and the other dimension representing communication, ranging from  variation that is highly salient as expressive or emblematic communication to variation that communicates nothing and is socially irrelevant. Note that although there might be some tendency for specific traits to lie on a diagonal line in figure 1, nothing prevents the existence of off-diagonal cases, as Wiessner, Binford, and Sackett repeatedly note. The upper right of figure 1, for example, would accomodate the many known cases in which stylistic display is costly (e.g., Cohen, 1974) or in which functional differences are meaningful as expressive or emblematic symbols, as when pastoralists take pride in owning cattle and despise their livestock-poor farming neighbors. By contrast, the lower left of figure 1 would include cases where functionally neutral variation is completely ignored for communication, as Sackett supposes for variation in San projectile points.

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     high      ¦3                      functional variation
               ¦                       used communicatively,
               ¦                       costly symbol systems
               ¦
Communicative  ¦
importance     ¦               2
of variation   ¦
               ¦
               ¦functionally neutral
               ¦traits not used
               ¦communicatively                  1
     low       +-------------------------------------
                 low                            high

                   Functional importance of variation
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Figure 1. The three "types" described in the text may result from a tendency for actual variation to cluster along the diagonal as indicated by the numbers corresponding to the numbered items in the text. However, it is an empirical matter how thickly cases are scattered off the diagonal.

There is little agreement about what Figure 1 means for the patterns one might expect to find in the archaeological record. Many commentators, represented by Dunnell, would apparently be comfortable arguing that variation projecting on the function dimension will be controlled by selection, while that projecting on the communicative dimension by random processes. Structuralists, represented in our brief review by Kroeber, imagine non-random processes, but emphatically not selection, to be acting on variation with high communicative function, perhaps leaving only variation near the bottom left of figure 1 to random processes. In contrast, Wiessner (1985:162) and Binford (1989:54-55) argue variants in bottom left of figure 1 should be highly stable and not subject to random processes, a pattern Binford (1989:54) extends to many highly-adaptive, non-symbolic functional characters (i.e., variation in the lower left of fig. 1). Sackett (1986:630-631) seemingly rejects the notion that isochrestic variation will consistently conform to any specific pattern.

## A Critique of the The Selectionist Program in Modern Archaeology

We believe that one cannot operationalize the models of style presented by Dunnell, Kroeber, Sackett, Binford, and Weissner, much less differentiate them with respect to pattern, because nowhere in their writings can one find an explicit model of the cultural transmission and "selection" processes that give rise to stylistic variation. Opler (1964) took Kroeber to task severely on this count but the others mentioned here are equally culpable. *Indeed, given the importance contemporary archaeology places on model-building it is remarkable these individuals have not been more severely criticized on this point by processualists* (post-processualists, of course, have not overlooked the problem, but their critique is beyond the scope of this discussion). The absence of criticism is symptomatic of a tendency of contemporary materialism to reduce cultural process to selection/adaptation, with the implication these are a clearly-understood, straight-forward processes. When this simple selectionist account fails, materialists are much too ready to abandon the inquiry (e.g., Binford and Weissner) or resort to explanation in terms of random factors (e.g., Dunnell).

The problem, in short, is that the belief that cultural variation is adaptive is not supplemented by a concern with the details of the processes through which adaptations actually arise. Despite references to the importance of cultural transmission (e.g., Dunnell 1978: 198), the adaptationists are suspicious of models of those processes. The groundwork was for this view was laid by White and subsequently explicated in detail by Binford and others in the New Archaeology movement. They exhorted archaeologists to abandon models of culture as a system of inheritance and replace them with a models of culture as adaptation.

"A normative theorist is one who sees as his field of study the ideational basis for varying ways of human life...For adherents of the normative school, the assumptions about units or natural "packages" in which culture occurs are dependent upon assumptions about the dynamics of ideational transmission...The normative view leaves the archaeologist in the position of considering himself a culture historian and/or paleopsychologist (for which most archaeologists are poorly trained)...[therefore] a new systematics, one based on a based on a different concept of culture, is needed to deal adequately with the explanation of culture process...[that being]...culture as man's extrasomatic means of adaptation [White 1959:8]." Binford 1965:203,204,205.

Dunnell, Sackett, and Binford (and of course many others) evidently believe that ignoring the details of cultural transmission is justified because selection favors faithful cultural reproduction.

"If we acknowledge that a cultural system is a system of extrasomatic transmission for behaviorally relevant information from one generation to the next, then a cultural tradition in its reproductive mode would be most effective if the transmission of information from one generation to the next is exact and unchanged in the process." Binford 1983: 222.

"I think it should be clear that discussing a cultural system in terms of...the dynamics of cultural reproduction...is not likely to help us understand the dynamics of descent with modification." Binford 1983:222 (but compare Binford 1983: 221).

For Binford (and most other adaptationists), White's definition of culture as an extrasomatic means of adaptation selectively favors exact or near-exact cultural transmission: the initial phase of each new cultural generation is a near-duplicate of the terminal adult phase of the preceding generation, differing only in minor and random ways, as Dunnell assumes. These authors believe that such faithful transmission renders transmission inconsequential. To predict human behavior in a particular environment, one needs only determine what behaviors are adaptive in that environment---

selection will sort things out so that explicit attention to the process of adaptation is unecessary.

Experience in evolutionary biology suggests that this view is almost certainly wrong. Adaptationist thinking has been extremely useful evolutionary biology, and adaptationists have offered many useful insights about the behavior of humans and other species. However, complete dependence on adaptionist thinking, particularly the simple version used by Dunnell, Binford and others, forfeits the most powerful elements of Darwinian thinking because, contrary to the view widespread in anthropology, there is more to *Darwinism than natural selection*. Selection is just one of several Darwinian processes, and "natural selection" itself is a heterogenous complex of processes, some which do not produce adapations in any intuitive sense.

More fundamentally, Darwinism is not a list of processes ordered by relative importance; it is a methodology guided by the central assumption that the key to understanding evolution is good bookkeeping. Even the simplest evolutionary forces interact at several levels in complex ways, and to understand these complexities requires concerted attention to accounting for how some inherited variation responds at the population level to forces like selection. It is the interaction of the forces, at various levels, that is of interest.

Sexual selection referred to already illustrates the importance of keeping careful accounts of the interaction of multiple processes. Darwin believed that exaggerated, presumably maladaptive, male characters like peacock tails arose because females preferred males with such characters. Darwin could not explain, however, why female prefer such males. This question is now being hotly debated by evolutionary biologists (Barton and Turelli, 1991; Eberhard 1986, Maynard Smith 1991, Kirkpatrick 199x [ARES review], Pomiankowski 1988). The run-away hypothesis, one of the competing positions in this debate, will illustrate our point. In this view female preference for showy males is a pathological consequence of female choice (e.g. Lande, 1981). Suppose there are cryptic males with practical camoflage tails and showy males with bright predator-attracting tails. If females who prefer males with showy tails are sufficiently common, their choices can increase the frequency of "showy-tail genes" even though such tails are otherwise disadvantageous. Such choices will also cause the genes that generate a preference for showy tails to co-occur with the genes that cause showy tails. As a result an increase in the frequency of "showy-tail" genes will also cause increase in the genes that cause females to prefer showy males. During the next generation, sexual selection will favor showy males even more strongly, which in turn will further increase the frequency of females who prefer showy males, further increasing the strength of sexual selection, and so on, until males become spectacularly elaborated. A key problem for the runaway hypothesis is the magnitude of the association between genes for tails and genes for female preferences, which in turn depends on the interaction between natural selection acting on both sets of genes, sexual selection, and the mechanics of linkage and recombination. It is simply impossible to understand this plausible evolutionary mechanism without detailed models that carefully track the net effects of this complex of interacting processes (Barton and Turelli, 1991). Nor is this a singular case, similar complexities are confronted in the sexual selection debate (e.g. Hamilton and Zuk, 1982; Ryan, et al. 1990), models of speciation, models of the evolution of sex, recombination, mating systems, the shifting balance theory, and  a number of other current problems in evolutionary biology.

The lesson is clear. The evolutionary interpretation of human behavior, contemporary and extinct, requires anthropologists to construct explicit models of cultural processes and calculate the implications of those models. Binford has relentlessly exposed the fallacies of interpretation that result when we try to intuit the meaning of archaeo-faunas without formal models that force us to keep track of various formation processes acting at various levels. Darwin's methods of "population thinking" encourage a similar attention to the details of how particular variants increase or fail to do so under the impact of specific environmental and social effects. It is quite clear that an evolutionary perspective of culture process requires models of cultural transmission that are analytically separate from models of other proceses that act on that form of variation, such as selection.

In this regard, contemporary adaptationists in archaeology tend to follow the interpretive tradition of anthropology, which emphasizes generalizations about consequences, rather than the more process-oriented tradition of evolutionary biology (Bettinger 1991). The data of a particular archaeological case are "explained" by means of empirical generalizations about the archaeological record and by arguments about the larger "meaning" of those records. For contemporary adaptationists, the archaeological record implies the overwhelming importance of natural selection. Thus adaptation, like progress for earlier scholars, is used as the interpretive tool to dissect and explain a case at hand.

In contrast, evolutionary biology devotes much of its effort to studying the actual processes of evolution. Genetics, population genetics, and population ecology are mostly about the processual inner mechanics of the inheritance of variation and its modification by the population-level impact of environment. The adaptive interpretation of the structure and behavior of particular organisms depends on the knowledge we have about these processes, gained from many kinds of studies of many kinds of species. Sometimes adaptive interpretations are fairly obvious and don't depend crucially on a close knowledge of process, but the opposite is quite often true. In the case of sexual selection, for example, the debate is tightly focused on the details of models of the sexual selection process and upon the interpretation of data (large scale surveys of bird coloration by Hamilton and Zuk, and of insect intromitent organs by Eberhardt). Rather than use the theory to interpret cases, cases are used to decide how the theoretical models apply. Only if this search leads to general conclusions do we obtain some warrant for a more general interpretive strategy.

## Processes of Stylistic Evolution

The traditional definition of style requires that behavioral variants not be subject to natural selection. Stylistic variants must be neutral with respect to natural selection (and selection-derived, adaptation generating, decision-making effects such as Boyd and Richerson [1985] discuss under the headings of bias and guided variation). This definition  fails to do justice to stylistic variation in three major ways. First, many isochrestic variants of utilitarian artifacts may be subject to frequency dependent effects. When Qwerty keyboards are common, it is sensible to adopt them, even though rare keyboards (like Dvorak) are actually better. Selection itself can maintain sylistic heterogeneity. Second, purely symbolic characters will come to have fitness effects if they become the object of choice, as in sexual selection. Third, stylistic variation may be controlled by evolutionary forces that generate non-random patterns, even in the neutral case. (It is perhaps also worth mentioning that natural selection in a randomly varying environment will tend to impose that randomness on functional variation under its control and that chaotic dynamics might mimic random variation.)

We sketch below a taxonomy of the processes that might affect the evolution of stylistic features. This discussion leads to two conclusions: First, well-defined cultural evolutionary processes can result in detectable, non-random patterns in adaptively-neutral stylistic variation that will often be difficult to distinguish from the kinds of patterns that result from natural selection acting to produce adaptations. Second, some of the reasons for pattern in style have to do with *indirectly* functional features. The argument that there should be a simple distinction between random stylistic and adaptive functional patterning is supported neither methodologically nor onotologically.

*Pattern generated by non-selective random processes*

If individuals acquire stylistic traits by faithfully copying others, and then make innovations that are random with respect to adaptation, the resulting patterns may be random in the sense that there is no correlation between stylistic features and environmental variables affecting fitness. Only cultural variants in the bottom left extreme of of figure 1 (much of Sackett's isochrestic variation) will have such simple dynamics, but this case is of considerable interest here because the traditional style-function dichotomy holds that such dynamics should produce "random" patterns that are distinctively different from those characterizing variants at the bottom right of figure 1. Even this simple comparison contains enough complexities to support the argument that archaeologists must pay  closer attention to the details of process.

Imagine a very large, well mixed population with a stylistic repertoire of $n$ discrete elements, a transmission rule in which each individual acquires one of these variants at random, and a rule for innovation in which individuals (with some probability) switch to another variant with equal probability. A population using such rule will more or less rapidly converge to a state in which each variant is present in the population with equal frequency ($1/n$), no matter what the starting point.

Evolutionary systems with properties formally very similar to this kind of stylistic cultural variation have been extensively studied by population geneticists interested in what is called the *neutralism controversy.* The debate is briefly reviewed here because it contains important lessons for those interested in the evolution of stylistic cultural variation (Ridley, 1993; Kimura 1983; and Gillespie 1987, 1991, for reviews of this subject; see also Cavalli-Sforza and Feldman 1981 for theoretical applications to the special case of cultural variation). In the 1960s advances in molecular genetics demonstrated the existence of a huge amount of genetic variation in populations (Selander 1976). Individuals are heterozygous at ca 5-15% of loci and at the population level 15-60% of loci are detectably polymorphic (at least one rare allele with a frequency greater than 1%). Kimura (1968) argued that natural selection could not possibly maintain so many polymorphic loci because recombination would ensure that each individual had a suboptimal genotype at many loci. Even a small amount of selection against each suboptimal locus would cumulatively ensure a huge selective load on the population. Kimura argued that such a large amount of variation could be maintained only if most alleles were neutral with respect to natural selection. The ensuing debate is of interest since isochrestic cultural variants are so similar in concept to neutral alleles in genetics. The problem in both cases is to distinguish traits under natural selection from traits that are not.

Tests pitting Kimura's neutralist claim against the alternative that selection plays a role in maintaining variation proceeded by the construction of models to deduce the unique predictions of the neutralist and selectionist hypotheses. The first complication here is that even in the completely neutral (i.e., "stylistic") case, one must take into account that populations are not infinite. Patterns in time and space will arise in finite populations if one includes the effects of genetic drift (random effects at the population level). New genes will be introduced into the population by mutation (random effects at the individual level), and the chances of "sampling" during reproduction in finite populations will cause some genes increase and others to decrease by chance (random effects at the population level--genetic drift). For the mutation rates and population sizes thought to characterize animal populations, the theory predicts that many genetic loci should be monomorphic, but a fairly large proportion should have varying degrees of polymorphism. The data fit this prediction approximately, although there is considerable debate regarding the parameter values that must be assumed for mutation rates and population sizes. For example, for *Drosophila* population sizes have to be rather small to account for the low levels of variation observed. Ohta (1976) argued that the fit is better if one assumes most alleles are subject to slight negative selection. Gillespie (1987, 1991) concurs that the Ohta version is the most empirically reasonable version of the neutral theory (albeit also flawed). At least aspects of the neutral theory can be rescued with other assumptions, for example that populations were on average smaller in the Pleistocene. Regardless of the situation for genes, the theory may be quite appropriate for some kinds of cultural traits, especially isochrestic variants near the lower left of figure 1.

If we survey a population over time, the neutral hypothesis predicts that there will be a more or less rapid turnover of genes as drift "selects" for at first one and then another genetic variant by chance. Superficially similar replacements will occur, however, if the locus concerned is responding to selection due to environmental fluctuations or any other time-structured environmental factor. There is simply no warrant at this level for the archaeological assumption that random and selective effects will have qualitatively different patterns in time. Given error in sampling or random variation in the direction of selection, or some drift superimposed upon a trajectory of selection, the gross time trend of neutral and selective evolution can be very similar. The processes of selection and random evolution by mutation and drift are sufficiently complex that models of both contain enough "tunable" parameters to mimic each other closely. This is one reason why a seemingly trivial debate could vex population genetics for a generation.

For the analogous case of human stylistic variants, the whole debate over parameter values would have to be conducted anew, but perhaps some guesses will give an idea of how random evolution proceeds. Let us start with a population in which one variant of a stylistic trait is overwhelmingly common. Individuals acquire their variant by copying someone of the parental generation at random, but also, rather rarely, certain individuals at random innovate one of the many other stylistic variants that are possible. Suppose some individual in a population of N individuals invents a particular new stylistic variant. Assuming, for simplicity, that each individual uses only one variant what is the chance *p* that the new variant will eventually become in turn the overwhelmingly dominant variant in the population? It is simply,

$$p = \frac{1}{N} \qquad (1)$$

which is easiest to see if we notice that by chance drift (random variation in the role of specific individuals in transmission each generation) in the long run, some one of the current stylistic alternatives will become the only one used (supposing no more innovation). Since every existing person's style has an equal chance of being the one that "drifts to fixation" as the population geneticist says, any given new innovation has a chance of being that lucky variant equal to its frequency at the point it first appears, which is (1) in the absence of simultaneous innovation. Of course, on average it will take a fair length of time for some given variant to be replaced by another by chance, and it much more likely that any given innovation will be lost due to chance non-imitation of its originator or successors (1-*p*). If we suppose that there is a certain per-individual rate of innovation, *u*, we can ask what the rate of stylistic turnover in the population might be. In large populations there will be more innovations each generation, *Nu*, but according to (1) the rate at which they will become fixed is an inverse function of N. In this simple model the two exactly cancel, so that the time for one stylistic variant to replace another, *k*, is expected to be

$$\frac{1}{k} = Nu\frac{1}{N} = u \qquad (2).$$

That is, the turnover rate is just the reciprocal of the innovation rate.

If we imagine that societies are fairly conservative as regards stylistic innovation, say an innovation rate of a few tenths of a percent to a few percent per individual per generation, then the time to replace one style with another is a few hundred to a few tens of generations, independent of population size. That is, in a population in which a few tenths to a few percent of people innovate each generation, the turnover of stylistic features will occur on an archaeologically interesting time scale. A stylistic feature will drift in and out of a population over the course of hundreds or thousands of years, just like the standard battleship curves of stylistic seriation, as Neiman (1993) illustrates.

The spatial patterns generated by random stylistic choice will be governed by sub-population size, innovation rates, and diffusion rates (see Neiman 199?). If population sizes are large and migration is high relative to innovation rates, chance effects alone will not be sufficient to cause populations to diverge. Of relevance here is the controversy in evolutionary biology as to whether genetic drift might be responsible for population differentiation and, in combination with group selection, play a role in moving populations across sub-optimal troughs in the adaptive landscape, a famous hypothesis of Sewall Wright. The conditions are fairly restrictive in the biological case, but then mutation rates of genes are assumed to be very small, on the order of $10^{-6}$ per locus per generation.

If the corresponding innovation rates are something like $10^{-2}$ in the case of culture, and stylistic diffusion rates are not too high, chance stylistic differentiation of local populations is easy to imagine. In general, if innovation rates are greater than diffusion rates, we would expect chance differentiation to be important where selection is negligible (Selection complicates the situation by retarding divergence between populations in which the same variants are favored, enhancing divergence between populations in which different variants are favored). The rate of differentiation will also depend upon population size (Neiman 199?). Raw population size, however, will be less important than the portion of the population that is active in transmission of genes or culture, the "effective" population size in the jargon of evolutionary biology.

Cultural transmission is likely to be sensitive to effective population size because it often takes the form of "one-to-many" transmission, in which some traits are transmitted by relatively few "teachers" to large numbers of others. In this case, the effective population size is much smaller than a simple headcount would indicate, which, *ceteris paribus*, strengthens the effect of drift (Cavalli-Sforza and Feldman, 1981).

Barth (1987) gives the example from New Guinea of the Mountain Ok, among whom the transmission of ritual knowledge is controlled by the handful of older males in each community who have succeeded in passing through a long series of ritual initiations. Because the transmission of this ritual knowledge is infrequent and subject to errors of memory, innovation rates are much higher than they would be in genetic transmission. As a consequence, the esoteric lore of the semi-isolated Ok ritual communities diverges very rapidly. Ok shamen individually attempt to remain faithful to tradition, and, when they occassionally visit initiation rites in other communities, are shocked by the alarmingly large deviations from what they take to be ancient, immutable Ok truths.

Scientific disciplines are a more familiar case. Most modern disciplines count their practitioners and teachers in the thousands but are sharply stratified with respect to influence so that textbook writers, successful innovators, and individuals with many students have disproportionate weight. In the relatively narrow subdisciplines where most change is generated, the "effective" number of influential investigators in any one generation can be very small, perhaps less than ten, so chance effects in the evolution of science are perhaps likewise alarmingly likely. (We are indebted to J.R. Griesemer for this last example.)

Returning to the style-function dichotomy, the trouble is that there are no simple qualitative rules to distinguish these drift-induced patterns from those produced by simple adaptive processes like selection, by other adaptationproducing and non-adaptive cultural processes (outlined below), or by the interaction of several of these processes. To take a simple example, favorable technical innovations tend to occur at irregular intervals, and each sweeps through the population once discovered. The history of improvement of a technology thus tends to be characterized by a succession of improved forms in time. For this reason particular technical forms can often be expected conform to battleship curves that are indistinguishable from those that provide the basis for stylistic seriation (e.g., Phillips, Ford, and Griffin 1951: Fig. 11.3). We defy the reader to distinguish with respect to pattern Mangelsdorf's seriation of changing corn frequencies in the Tehuacan Valley, Mexico (Mangelsdorf 1974: Fig. 15.23), which is presumably directed by selection, from Deetz and Dethlefsen's (1967: Fig. 1) seriation of changing New England gravestone designs, which is presumably not directed by an adaptive process at all. In detail, these processes make quite different predictions about behavior. For example, a given technical improvement can sweep rapidly through even very large populations, whereas fixation by drift is a slow process in large populations. However, until we make reasonable estimates of the main parameters of the processes, such as innovation rates, magnitudes of selective differences, and effective sizes of populations, we cannot take advantage of the knowledge that selection and drift will produce different effects.

*Pattern resulting ordinary adaptive forces*

The argument that stylistic variants must all have equal fitness, rests on the implicit assumption that all adaptive problems have *unique* solutions. Stylistic variation must be neutral, the argument runs, because only neutral variation can persist. If two stylistic variants differred significantly in function selection would rapidly eliminate the inferior variant. Persistent differences between groups in functional traits must then be the result of an environmental difference. This reasoning fails, however, if there are two or more *locally* stable traits. Natural selection is only a myopic optimizer---it causes a population to climb up the adaptive topography, eventually coming to rest at a local optimum. Most models of adaptive processes in cultural evolution suggest that they are similarly myopic (Cavalli-Sforza and Feldman 1981, Nelson and Winter (1982), Boyd and Richerson 1985, Durham 1991). If there is more than one local optimum, populations that begin from different positions may reach and maintain different equilibria even when some equilibria are better solutions than others. Clearly, environment alone cannot account for such differences.

There is substantial evidence that adaptive problems typically have many local optima. Engineers have shown that many design problems have this property. For example, Kirkpatrick et al. (1983) report that where the problem was to minimize the number of slow connections between chips in the IBM 370, there are about $10^{1503}$ possible arrangements, many of which are locally optimal. Local trial-and-error search cannot improve these local optima even though they tend to have about 4 times as many connections as the best arrangement the engineers discovered. Among the many local optima are a substantial number (≈ 70) of designs that are qualitatively different but essentially identical in function to the best arrangement found. Optimization texts (e.g. Wilde, 1978) suggest that virtually all real world design problems "from dams to refigerators" (p. xx??) have many equilibria. We see no reason to suppose that the design problems facing people in subsistence economies are any different (Bettinger 1980).

Economists believe that increasing returns to scale, particularly those resulting from what they call “network externalities,” often generate multiple evolutionary equilibria in modern economies (Arthur 1990). Network externalities arise when more widely availabe goods have an adavtage merely because they are widely available. If you use a common make of computer you have access to more software and more add-on hardware, more of your friends are able to help you learn to use it, and it is easier to collaborate with others. As a result, computer technologies with an initial numerical advantage may come to predominate even though they are inferior to alternative technologies. Similar phenomena likely occur in subsistence economies. It could be that the smaller !Kung arrow points really are better than the larger points made by the !Xo, but that !Xo who adopted smaller points would be worse off because they would be unfamiliar to exchange partners, harder to learn to make and use and so on (See Wiesner 1983).

Models suggest that many types of social interactions also lead to multiple evolutionary equilibria. The simplest examples are coordination games in which fitness is frequency-dependent but there is no conflict of interest among individuals Sugden, 1986). Driving on the left versus right side of the road is an example. It does not matter which side we use, but it is critical that we agree on one side or the other. Reciprocity provides a good example. Such models (Boyd 1992b) suggest that there are a large number of different strategies that can capture at least some of the potential benefits of long run cooperation. In order to persist when common, reciprocating strategies must retaliate against individuals who do not cooperate when cooperation is appropriate. When such a strategy is rare, it will interact mostly with other strategies which cooperate and expect cooperation in a different set of circumstances. Inevitably, a rare strategy will retaliate or suffer retaliation and cooperation will collapse. Thus, a common reciprocating strategy has an advantage relative to rare reciprocating strategies, even if the rare strategy would lead to greater long run benefit were it to become common. Interactions of this kind are omnipresent in social life. Different social systems may often lead to variation in artifacts available in the archaeological record (e.g. Bettinger and Baumhoff, 1982 and below). Systems with conical clan political organization will tend to have a minority of graves with rich furnishings whereas systems with segmentary lineages will tend toward a more egalitarian distribution of grave goods.

*Pattern resulting from novel adaptive forces of cultural evolution*

Culturally transmitted determinants of behavior are potentially subject to a number of evolutionary processes that Campbell (1965) terms "vicarious forces." These result from natural selection acting in the long run to produce decision rules that in turn vicareously select cultural variants. That is, individual choices about what traits to adopt and innovate will guide cultural evolution rather than selection acting directly on cultural variation, although the direct effects of selection are not necessarily negligible. There is not space here to give even a cursory review of the complexities that these forces engender (see Durham 1991 and Boyd and Richerson 1985). In principle, however, these forces have effects that are distinctively different from each other, from direct selection, and from those in systems affected only by random variation and drift.

Consider as an example the force Boyd and Richerson call "conformist transmission." This is a version frequency-dependent biased cultural transmission (Boyd and Richerson, 1985: Ch. 7; Lumsden and Wilson, 1980). "When is Rome, do as the Romans do" is a familiar example of a conformist or "positive" frequency dependent rule. Conformist transmission causes people to discriminate against rare types, and is a potent suppressor of variation within societies. This can quite adaptive in a spatially heterogeneous environment because it causes people to discriminate against migrants, who more than locals, are prone to carry traits better adapted to other environments. On the other hand, it thwarts introduction of new variation, and so may impede adaptive tracking of environmental change over time. Such a simple decision rule may be most adaptive when it is applied without much judgement, as a kind of rule-of-thumb, to save on decision-making costs. Accordingly, conformist rules could be be applied to wholly neutral traits as a biproduct of their advantages with regard to adaptive traits, causing neutral and adaptive traits to pattern similarly.

The complexities introduced by such processes can be glimpsed in attempts to explain the observed spatial distribution of house forms in Africa. There, the ground plan of houses (rectangular, round, elliptical, etc.) is highly variable from place to place but relatively uniform within individual societies. There is considerable spatial autocorrelation so that societies with similar house form tend to co-occur geographically. Cavalli-Sforza and Feldman (1981:209ff) argue this pattern is perfectly consistent with drift-like effects in which: 1) the low variation within societies is due to the one- to-many drift-enhancement effect; 2) the spatial autocorrelation is due to migration between closely adjacent groups; and 3) the differentiation of distant societies is due to isolation.

It is easy, however, to produce a counter-scenario that couples a different form of transmission with adaptation/selection. Imagine that house builders use a "biased sampling" rule for acquiring cultural traits in which they survey a number of cultural models and imitate the house form most common among those models. As Africans adopted agriculture and began to build houses a few thousand years ago, subtly different house types may have been advantageous in different places, perhaps because of differences in raw materials from place to place. Such early accidents could have been frozen by conformist transmission, and distributed about the landscape by migration or by the tendency of non-house builders to acquire houses from nearest neighbors. Alternatively, adaptive considerations such micro-climate or availability of building materials may have tended to determine the standard house form in particular locations and thereafter conformity acted to suppress variation around that standard. Both hypotheses differ from that of Cavalli- Sforza and Feldman in that house form is determined initially by adaptation and subsequently by conformist transmission, i.e., by a mixture of adaptation and transmission.

Non-conformist transmission rules and more complex forms of "trend-watching" are quite conceivable (Lumsden and Wilson, 1980). The non-conformist version of frequency dependent transmission will protect variants from loss within societies by drift, tending to preserve variation arising by individual invention. This process will mimic a situation with high innovation and migration rates plus drift. Again and again the point emerges that empirical patterns, even the most rigidly-structured ones, are often consistent with a variety of different processual hypotheses. It is unrealistic to expect to be able at a glance to segregate them unambiguously as resulting from either selection or neutral transmission.

*Patterning as the result of correlations among characters*

One possible way to distinguish adaptive from stylistic-neutral patterns of variation is by the presence of plausible selective factors capable of explaining the observed pattern. In the genetic case, patterns related to selective factors (e.g., climate) are often found (e.g.Clegg and Allard, 1972; Watt, 1977). However, as proponents of the neutral theory countered, *linkage* of adaptive and neutral genes could easily give rise to patterns of neutral alleles that indistinguishable from those of adaptive variants. A neutral allele at one locus can "hitch-hike" to high frequency if it is statistically associated (linked) to an adaptive variant at another locus. In the case of genes, the statistical association is generally assumed to result from physicial proximity on the chromosome, so that if a gene for hair color is located on the same chromosome and very near the gene for cold-tolerance, the pattern of hair color (neutral) might end up being closely associated with patterns of climate due to selection on a linked gene influencing limb length or some other direct adaptation to cold.

Important technical innovations that produce waves of population expansion could easily drag a host of neutral or near neutral genetic and cultural traits to high frequency because of a chance high frequency in the the population which first acquires the adaptive trait. Physical linkage analogous to genetic linkage may be involved. For example, in a complex tool whose parts are made together may be learned as a more or less inseparable block, so that its individual components seldom "recombine." An adaptive innovation in one part of a tool may cause the hitch-hiking of non-adaptive variation and stylistic features with regard to other parts.

Hitch-hiking, however, does not necessarily require any linkage in the physical sense, only an initial statistical association. Because of this, genes can easily hitch-hike with cultural innovations or vise versa. Thus Ammerman and Cavalli-Sforza (1985) explain the gradient of certain human gene frequencies in Europe as a result of the genes hitch-hiking on the wave-like spread of agriculture from the Middle East westnorthwestwards beginning about 9,000 BP. It is a difficult to distinguish their hypothesis from the selective explanation that these gradients are largely adaptations to climatic gradients, since measures of climate (e.g., isotherms) largely parallel the isolines for the dates of the agricultural wave. The hitch-hiking hypothesis has been frequently invoked in various forms to explain the spread of languages, especially Indo-European (Renfrew, 1987; Mallory, 1989). Renfrew's hypothesis is that Indo-European hitch-hiked from an original focus in Anatolia, like Ammerman and Cavalli-Sforza's genes, with spread of agriculture. Mallory discusses the more traditional hypotheses that link Indo-European to later improvements in the use of horses in warfare. Given that language variation is prototypically stylistic, with no functional difference between alternative words, etc., the patterning of language in time and space is a powerful confirmation of the importance of the hitch-hiking effect. Such cultural hitch-hiking, of course, is the source of what is known as "Galton's problem," in which correlation produced by adaptive forces cannot be distinguished from correlations produced by shared history. Deetz and Dethlefsen (1967) have archaeologically documented a form of hitch-hiking in New England gravestone styles that is evidently related to shifting trade networks.

*Patterning as the Result of Signaling*

As we noted in reference to Wiessner's (1983) work, anthropologists and archaeologists commonly attribute commmuicative functions to stylistic variation, and at least the more symbolic cases of style in artifacts do commonly appear to function as expressive or emblematic communication. What is less well appreciated is that the processes that affect the evolution of communicative elements of style go well beyond simple random innovation and statistical drift. Rather, several different directional evolutionary forces will affect stylistic variables.

The issue is not a simple one. Consider the protoypical symbolic communication system, human language. All human languages are functionally equivalent (variations in technical vocabulary aside). It doesn't matter which one we speak, but it is important for purposes of efficient communication that we follow local conventions of semantics and syntax. Thus, to preserve function, we might expect forces that act to limit individual-level innovation (e.g., the conformist transmission bias) to dominate the evolution of language. If so, we would expect language evolution to be quite conservative when, in fact, it is fairly rapid. Mutually unintelligible dialects arise in separate populations in a few hundred years (Ruhlen, 1994). At first glance, this rapid tower-of-babel evolution seems to be in defiance of the communication function of language. Why don't human communication systems behave in a much more conservative fashion? For that matter, why isn't language a hard-wired human universal? The highly conserved basic structure of our genetic code behaves as expected, but our language does not.

The most plausible current hypothesis to explain the rapid evolution of human symbolic systems is that their main function is to communicate emblematic information about group membership and about appropriate group behavior in cases where individuals are frequently exposed to social interaction with members of another group.

Detailed microevolutionary studies of dialect change by sociolinguists (Labov, 1980) support this idea. In many areas of the contemporary world, microdialect change is rapid enough to be detected between generations. Dialect change seems to be set in motion by sociological processes, for example, competition between ethnic groups. In one of Labov's cases, the White dialect of Philadelphia appears to have arisen in response to the influx of Southern Blacks during and after WWII. In another case, on Martha's Vineyard, the evolution of Islander dialect appears to be driven by Islander desire to emphasize an identity separate from mainland tourists toward whom economic necessity compels an uncomfortable level of deference. Cohen (1974) developed a very similar hypothesis to explain the evolution of ideological and ceremonial systems, such as the adoption of Freemasonry by Sierra Leone Creoles in the face of political competition from traditionally disenfranchised groups.

By preserving ethnic identity this sort of process does foster social solidarity but need not be viewed in purely structural-functional terms because the symbolic behaviors that identify group membership may often be associated behaviors that are functionally adaptive. Boyd and Richerson (1985:Ch. 8, 1987; Richerson and Boyd, 1989) have examined this possibility with models of the evolution symbolic cultural traits inspired by data such as Labov's and Cohen's. In the simplest systems they have studied, populations are characterized by a symbolic trait, such as dialect, which is selectively neutral, and an ordinary adaptive character, such as a subsistence technique. Both traits were modeled as quantitative characters. They suppose that children acquire the symbolic variant when young by unbiased imitation of a local adult. In a second episode of imitation as "teen-agers," individuals acquire their subsistence trait by observing and imitating a wider range of individuals. They bias this second decision about whom to imitate in favor of individuals bearing a symbolic variant similar to theirs. After a period of experimentation, these "teen-agers" compare the success of different behavioral combinations (symbolic plus adaptive) and reject less successful combinations in favor of more successful ones. The criterion of "success" is arbitrary in the model, but can certainly be interpreted as adaptive success.

According to this model, in a spatially variable world in which optimal subsistence behavior is very different in different environments, a correlation can build up between the subsistence trait and a symbolic marker, so long as the rate of migration of people in the first symbolic episode of cultural transmission is less than in the second episode where subsistence traits are also transmitted. Once a correlation accumulates between a symbolic trait and a favored subsistence trait, there is a substantial advantage to using the symbolic marker as a guide for whom to imitate. Figure 2 illustrates that two populations using the symbolic rule can will diverge with regard to the indicator character until until the mean values of the adaptive character are optimal, whereas the adaptation to a variable environment by non-symbolic populations is adversely affected by migration and leads to less successful adaptations. Boyd and Richerson argue that such models are consistent with the hypothesis of a widespread advantage for the use of affect-laden emblematic symbol systems to regulate cultural transmission.

What Wiessner calls *assertive style* may result from the buildup of correlations between sylistic and functional variables. Several careful studies of contemporary populations (Irons, 1979; Borgerhoff Mulder, in press) have shown a strong correlation between prestige, as defined by the local ideological system, and wealth and reproductive success. This correlation also suggests that the use of symbolically defined status as a guide to whom to imitate would be functional, as Flinn and Alexander (1982) argued. Boyd and Richerson (1985: Ch. 8) review several other lines of evidence for the important role of using marker traits in choosing from whom to acquire cultural variants. Empirical microevolutionary studies of expressive art styles in the modern West have been conducted by Martindale (1975, 1990). He gives an interesting account of how psychological processes might drive the trends and cycles he discovers in his data.

The processes that build correlations between arbitrary stylistic features and adaptive characters might be termed "active hitch-hiking." Again, it would not be easy to distinguish the patterns generated by this process from simpler ones, especially from the effects of "passive" hitch-hiking. The potential for confounding is even more serious here since those aspects of the symbol system that are most subject to drift tend to make the best adaptive markers. This is because the active hitch-hiking effect is very weak when the symbolic difference between populations is small. The biased imitation effect works on the correlation between marker and adaptive characters (Boyd and Richerson, 1987). Accordingly, if the initial variation between populations is small, the correlation between symbolic and adaptive characters built up by migration between them will also necessarily be small. When there is a substantial correlation between symbolic marker and adaptive character in a given environment, individuals who have the common symbolic value associated with an advantageous variant of the adaptive character are doubly advantaged in cultural transmission relative to other types. Contariwise, before some variation in the symbolic character arises, the tendency to build further correlation will be very weak. For example, if an ancestral population divides and becomes segregated in different habitats, the bias process can build up a symbolic difference between them only very slowly. If random, drift-like processes are strong in  some characters, they will provide the first perceptible differences between the descendant populations. The active hitch-hiking effect is then liable to seize just these traits and build a correlation between them and adaptive characters. It is under such conditions, for example, that chance local variation in the frequency of functionally equivalent technical alternatives might become the basis for symbolic variation between groups.

The assertive use of style by individuals, particularly by prestigous individuals, seems to be the cause of rapid evolution of potential marker traits. Labov’s account of dialect evolution and Martindale’s account of artistic evolution both depend upon a certain, limited, taste for the novel which drives lingustic and artistic evolution in spite of the forces of conformity that are required to keep such systems functioning as media of communication. Language cannot change much in any one generation without disrupting communication between individuals, but the small innovations made by the leaders of linguistic change lead to rather dramatic changes in a relatively few generations. We hypothesize that the assertive use of style is the motor that builds up variation between semi-isolated groups, which can in turn then serve as badges of group membership. The evolutionary origins of the modern human sense of style might well lie in the the advantage of using stylistic variation as an indicator of differences in adaptive characters.

*Patterning as a result of runaway effects*

The process of using a marker trait to chose whom to imitate has potentially explosive unstable dynamic properties (Boyd and Richerson, 1985: ch. 8; Richerson and Boyd, 1989). In the abstract it is easy to see that a dramatically exaggerated prestige system can be protected against natural selection or selection-derived rational choice if success in the prestige system offsets losses due to the maladaptive consequences of the exaggeration. Once enough people use a specific marker to choose whom to imitate, anyone failing to display that indicator will be effectively be ignored in the the process of cultural transmission. Where social systems are based on an element of coercion, the possibility of maintaining arbitrary, non-functional behaviors is increased still further (Boyd and Richerson, 1992). The key question is how such a set of preference rules favoring imitation of people displaying costly prestige symbols, or a willingness to punish deviants, can arise in the first place. As with the analogous case of mate-choice sexual selection, theoretical models show that a system of coupled preference characters and display characters can run away to exaggerated extremes (Lande, 1981). The male-biased display characters of many animals, such as the feathers of peacocks and the elaborate constructions of bowerbirds, are often attributed to the runaway effect. We regard the similarity between the plumes of birds and the finery displayed by prestigious humans as more than coincidental. In this respect, the runaway hypothesis provides a way of turning Sahlins's (1976) notion of "cultural reason" into a cogent formal argument.

The importance and mechanics of the runaway effect are hotly debated by evolutionary biologists (see e.g. Barton and Turelli, 1990; Kirkpatrick, et al., 1990). Barton and Turelli's theoretical investigations suggest that the pure runaway effect is weak because the forces maintaining the correlation between the symbolic display and preference traits are inherently weak. What will encourage the exaggeration process is some independent adaptive advantage accruing to the selection of individuals with elaborate markers. For example, if economic success generates the wherewithal to display status more effectively (buy the fanciest car, pay the bride-price for the youngest and most beautiful woman), there will remain a correlation between ordinary adaptive success and the degree of exaggeration of display. Then it pays in both the ordinary adaptive and prestige games to chose mates or mentors with the most exaggerated system of prestige. In the limit, all the gains accruing from ordinary adaptive adavantages are dissipated in support of the most elaborate possible status displays, a sort of perverse inversion of the ordinary hitchiking effect. In such cases, it may be said justifiably that the culturally driven symbolic system has captured the mundane economic system, much as Sahlins claims.

Clearly, the gross patterns predicted by the runaway and signaling hypotheses are rather similar. Boyd and Richerson (1985: Ch. 8) argue that the ordinary adaptive advantages of choosing mentors by means of indicator characters will maintain this sort of choice mechanism by natural selection, even though the system misfires occasionally and gets caught-up in the runaway process. They further suppose that the traits most subject to exaggeration are will generally be one historically connected with adaptation. The growing of giant yams on Ponapae as a part of prestige contests is a possible example. It seems plausible that when the custom originated, good farmers did grow larger yams, and that large yams were a good index of yam-growing talent. If Turelli's hypothesis applies in the cultural case, the growers of giant yams may still be the best horticulturalists; the adaptive and runaway hypotheses are really wonderfully entangled in this case.

## Conclusion

The main attraction of the style-function dichotomy is that it apparently reduces the task of archaeological explanation to a manageable subset of phenomena that can be addressed by simple causal models. Some will undoubtedly read our rejection of the dichotomy as complicating the problem of archaeological interpretation to the point of impossibility. Because we reject the dichotomy and even cite the works of such authors as Sahlins with (qualified) approval, still others will read us as advocating a form of post-structuralist archaeology. Neither reading is warranted. We are enthusiastic advocates of causal and materialist explanation of social phenomena. We are also advocates of simple models of complex phenomena (Levins, 1966). Treating patterned variation in artifacts and behaviors as though it were purely functional and adaptive and assuming that stylistic variation is noisy and irrelevant may often be an acceptable simplification. Surely, human groups cannot exist as going economic concerns unless a large fraction of patterned variation is adaptive. Likewise, assuming that style behaves as if it were subject only to random innovation and drift provides an important theoretical warrant for seriation that can be highly useful even when patterns depart somewhat from the ideal. Within this context, our argument boils down to these three simple points.

First, there is good reason to think that the style-function dichotomy is frequently an unacceptable simplification. It is well worth thinking about this possibility and what it implies about how we should do archaeology. As Wimsatt (1980) notes in his defense of the use of simple models, failure to recognize the specific limitations of widely-adopted simplifying assumptions can lead to dangerous overconfidence in the robustness of our models and their results. As part of this, we must squarely face the difficulties involved in solving what physical scientists call the inverse problem (more familiar to archaeologists as the problem of "equifinality"). It may be hard, sometimes perhaps impossible, to infer the micro-scale processes that gave rise to a particular macroscale pattern. Many different evolutionary processes, for instance, can cause the familiar battleship (lenticular) pattern of increase and decrease. The problems this raises cannot be ignored. It is difficult to distinguish isochrestic from functional variation, as nearly everyone agrees. However, if the argument we have presented is correct, assuming that function and style can be separted into discrete categories with very different evolutionary properties is not possible. The processes of evolution are just more complex than that. What is called for is a methodologically rigorous program of study  patterned in the mold of contemporary middle range studies that use tightly controlled ethnoarchaeological and taphonomic investigation to distinguish the signatures of different processes that tend to produce outwardly similar archaeological consequences. In some cases the data will be insufficient to decide between competing alternative hypotheses but there is no reason to think that this will be true generally. The inverse problem is cause for despair only if it can be solved so infrequently that there is no hope of building a satisfactory picture of the relative power of different general hypotheses. Otherwise, it is merely a challenge to our imagination and initiative.

Second, style is too important and too interesting to leave to structuralists and post-modernists. A number of important archaeological phenomena make much more sense if we assume that stylistic variation is  functionally important. Why was the Upper Paleolithic transition a stylistic as well as economic revolution? Why does state formation so frequently involve the elaboration of religious institutions, ideology, and the arts? How costly are symbolic institutions, and how much do they distort or foster adaptation (however that might be operationalized)?

Third, Darwinian theory will eventually offer a processual account of cultural evolution that is as powerful as the one it now offers for genetic evolution. The problem presently is that we have limited knowledge of the operation of these processes in the cultural realm and are handicapped in our ability to use them in interpreting past behavior. On the other hand, this situation should be attractive to those of us who continue to share the processual goals that inspired the New Archaeology. There are a large number of essentially unstudied processes begging the kind of critical experimental and observation program advocated then and since by Binford and others.

Archaeologists, who are sometimes driven to do the work that should more properly fall to ethnographers (ethnoarchaeology), should appreciate that archaeology must play a distinctively critical role in understanding the processes of cultural evolution. The synchronic study of symbol systems and their evolution on the micro time scale is surely critical, but archaeologists, historians, and paleoanthropologists have a monopoly on data from the longer time scales over which the evolutionary processes generally work themselves out. The models of the adaptive role of symbolic marking of ethnic groups reviewed above, for example, are necessarily silent about just what sorts of adaptive differences between groups might be protected by this mechanism. That depends on how easily correlations between various kinds of traits can be built up in the face of migration. It is unlikely that short-term studies will be as convincing in this regard as the actual long-run data.

A bit of our own work illustrates the kind of process related information available from long records. Bettinger and Baumhoff (1982) have examined the case of the spread of Numic speakers across the Great Basin of the Western US from about 700 to 200 years ago. In this case the evidence supports the idea that the ethnic boundary between Numic peoples and their pre-Numic predecessors must have limited the spread of a social-organizational variable, not a direct technological variable. The record indicates that the same technology and tool types were everywhere available, yet the spread of stylistic elements associated with Numic-speakers, including at language and ideology, is associated with higher densities, differences in location of settlements, and quantitative variation in frequencies of the various tool types. Since the more plant-intensive Numic strategy required a larger role for plant storage and women's labor, it is plausible that the key to Numic success was a normative complex that condoned the hoarding of plant resources, gave women a greater role in decision-making, and reduced the autonomy of hunters.

The utilitarian consequences of mundane technology (e.g., seed-beaters) are generally rather obvious, and hence move easily across boundaries. Social norms have more complex and far-reaching effects that are often difficult for actors to understand and more closely tied to affect-laden ideological systems. Perhaps only an ethnic isolate is likely to take unusual steps away from obligate sharing and toward gender egalitarianism. Once the ethnic advance begins, an ethnic boundary can explain why the losing group persists in retaining its behavior despite the obvious disadavantages.

The Numic case may or may not be correctly interpreted, and even if correctly interpreted, it may not be representative. It does have the virtue of suggesting testable hypotheses: (1) That ethnic or other style-marked boundaries are important in the origin and spread of certain types of innovations, and (2) that technical innovations per se are likely to spread irrespective of style-marked boundaries, whereas more subtle aspects of adaptation (as judged by ability to support higher population densities for example) are likely to require boundaries to originate, and are then likely to spread associated styles by active hitch-hiking. It is archaeologists who are in a position probe the long-term patterns of correlation between different kinds of traits, and hence to make an essential contribution to the very basic social science problem of understanding just what is the significance of modern humans' massive preoccupation with style, and how it is that we came to replace populations with an (apparently) more utilitarian outlook.

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