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SIGNALS IN STONE: EXPLORING THE ROLE OF SOCIAL INFORMATION EXCHANGE, CONSPICUOUS CONSUMPTION, AND COSTLY SIGNALING THEORY IN LITHIC ANALYSIS

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Stone tools are most often seen and studied as utilitarian objects. However, as with other types of material culture, lithics may have played an important role in the creation of identity and the negotiation of interpersonal relationships for people in the past. As a result, archaeologists interested in lithic technological organization should consider not just the function of stone tools to cut, scrape, or pierce; but also their social function. One evolutionary approach that links stone tool production, use, and discard with the potential social meaning and information that these tools have shared is costly signaling theory.

Originating in biology and human behavioral ecology, costly signaling theory is concerned with wasteful and "uneconomic" displays that impact reproductive fitness and has been used successfully by several researchers to explain behaviors in humans and nonhuman animals. However, some researchers have identified existing archaeological applications of costly signaling theory as "just-so-stories" (Codding and Jones 2007), a crutch for inexplicable phenomena or seemingly illogical behavior in the archaeological record. Although costly signaling theory is a fertile theoretical approach, it is important that archaeological applications of costly signaling theory are grounded in the theory as well as the archaeological data. To make costly signaling theory a sound scientific approach, we must build models, develop hypotheses, and test them using the archaeological record.

In this chapter I will not solve all the problems of applying costly signaling theory to lithic data sets, nor will I provide "the answer" for how to

identify costly signaling with lithics. I will, however, explore the theoretical foundations of costly signaling theory and social information exchange, illuminate the potentials and pitfalls of this theoretical perspective for those concerned with lithic analysis, provide a general framework to approach signaling in the archaeological record, highlight several lines of archaeological evidence that may be used to identify the presence of costly material displays in stone in the past, and examine a few existing archaeological examples that may be appropriate for applying signaling approaches in the future. Altogether, I will weigh the strengths and weaknesses of using signaling theory in archaeological contexts, explore ways in which it has been used by archaeologists in the past, and provide a potential roadmap for incorporating it into studies of lithic technological organization.

SOCIAL INFORMATION EXCHANGE, MATERIAL CULTURE, AND LITHIC TECHNOLOGICAL ORGANIZATION

Material culture items convey information and play an important role in the negotiation of social relationships in human societies (Earle 2004; Preston 2000; Robb 1998, 1999; Wobst 1977, 1999). Some of that information is actively displayed and received, some is passively conveyed and received, and some information is not received by peoples observing the material culture items (Sackett 1982, 1985; Wiessner 1983, 1985). Although lithics have not often been held up as a primary means of social information exchange (often that distinction is given primarily to adornment items, dress, and ceramics), researchers have viewed lithics (particularly diagnostics and tools) as conveying information about past peoples (e.g., Barton 1997; Bernstein 1984; Gero 1989; Holm 1994).

When examining lithic assemblages, archaeologists often first address issues of tool function, retouch patterns, and procurement strategies with an explicit focus on the utility of stone tools in important subsistence acquisition strategies. This is not a bad place to start, but it often leaves unanswered or unaddressed questions about the social implications of the use and discard of stone tools. Examining the role of lithics in "utilitarian" and functional contexts is a necessary task for archaeologists, and I do not intend to suggest otherwise. I do, on the other hand, think that lithics can and should be studied as other types of materials in the archaeological record are studied: with an eye toward their role in contexts of information exchange in the past.

There are reasons why stone may have been not only a good vehicle for social information exchange in the past, but also a valuable source of information on dynamic social processes for archaeologists. First, there are several characteristics about stone and stone tools (e.g., raw material availability, source type, and production costs) that make them good candidates as costly

signals. Second, as an artifact type that is often among the best preserved in the archaeological record, lithics provide a source of data that if properly situated within discussions of information exchange can prove valuable for testing models and hypotheses about social information exchange in the past.

THEORETICAL FOUNDATIONS OF COSTLY SIGNALING THEORY

Costly signaling theory combines concepts of costly behavior and public generosity (Fried 1967; Mauss 1924; Veblen 1994) as forms of social competition that provide a way to articulate the notion of intangible social benefits that can be gained through symbolic representations of self with more materialist notions of individuals as self-interested but socially embedded decision makers (Bliege Bird and Smith 2005; Quinn 2006). Others have defined costly signaling as something that increases the fitness of an individual by altering the behavior of recipients of the signal (Dawkins and Krebs 1978; Hasson 1994; Krebs and Dawkins 1984; Maynard Smith and Harper 1995). The signal must be beneficial for reproductive fitness in the given information exchange between individuals, yet costly in other contexts (Hasson 1994; Maynard Smith and Harper 1995). In addition, the signal must be an honest representation of an individual's underlying reproductive fitness predicated on the fact that the signal is so costly that it is impossible to possess without the characteristics or qualities being signaled.

Costly signaling theory has its roots in biology and the handicap principle. Zahavi (1975) originally explored costly signaling while attempting to understand why animals would engage in costly and extravagant displays. The handicap principle is the hypothesis that costly physical or behavioral characteristics will be inherently reliable signals of reproductive success. Males who possess these characteristics will be selected as mates by females who are trying to find mates with the best genotypes (Zahavi 1975). For example, the handicap principle explains the practical inefficiency of peacocks' tails. Peacocks require the necessary genetic ability to fight parasites and invest energy into the tail, which means that a large and healthy tail would signal to peahens that those individuals had good genes. Grafen (1990) reformulated the handicap principle into a series of models, including costly signaling, where individuals used visual displays at various costs to signal their quality as mates, and emphasized that signaling was an evolutionarily stable strategy. Anthropologists then took this concept and attempted to apply costly signaling theory to conspicuous consumption and "uneconomical" displays in ethnographic contexts (Hawkes 1990, 1991, 1993; Kaplan and Hill 1985; Veblen 1994).

Two conditions are required for the evolutionary stability of costly signaling (Grafen 1990; Zahavi 1975). First, signals must convey reliable information about variation in the underlying quality being advertised, involving such

aspects as resource control and competitive ability (Quinn 2006). Second, the signal must impose a cost on the signaler that is directly linked to the quality being advertised. The payoff to the signaler comes from being chosen as a mate or ally or deferred to as a dominant in mating, cooperative, or competitive contexts (Smith and Bliege Bird 2000). The payoff to the recipient comes from the usefulness of the information being signaled to evaluate the signaler's quality as a competitor, mate, or ally.

COSTLY SIGNALING AND HUMAN BEHAVIOR

Human cultural behavior often acts in ways not seen in biological systems. To go beyond qualitative metaphorical comparisons between the two, researchers must examine whether there is predictive substance in the implication that social systems satisfy similar principles and constraints as biological systems (Bettencourt et al. 2007). This has a profound effect on the use of evolutionary approaches, such as costly signaling theory, taken from biology. Archaeologists need to adequately explore the ways in which signaling in cultural contexts differs from biological contexts to appropriately use costly signaling theory to explain human behavior in the past.

Behaviors and material culture do not need be directly genetically linked to affect reproductive fitness. Instead, behaviors and material culture are often seen as part of the extended phenotype (the outward expression of the genotype) of an individual (Boone and Smith 1998; Dunnell 1980; Kantner 2003). There has been much debate about the concept of an extended phenotype and the role of natural selection operating on the phenotype (interactors) (Dunnell 1980; Lyman and O'Brien 1998, 2001) or on individuals (replicators) (Boone and Smith 1998; Kantner 2003; Smith and Winterhalder 1992). The selective process occurs on the individual, as selection of particular material culture items that make up an extended phenotype is governed by individual decision making and cultural transmission (Boone and Smith 1998; Boyd and Richerson 1985; Durham 1991; Kantner 2003; Kelly 2000; Smith 2000; Smith and Winterhalder 1992). Social information embedded within material culture is often associated with markers of reproductive fitness as well as the individual themselves. Just as there is genotypic plasticity that affects biological phenotypic expression (such as genes for height being affected by an individual's nutrition while young), I believe that phenotypic plasticity can be seen in material culture. Phenotypic variability is not generated randomly, even in biological contexts (Dawkins 1987; Rindos 1989; VanPool and VanPool 2003). For example, artifacts that represent reproductive fitness for an individual at one time in his or her life may not be reproductively fit at another time in his or her life. Fitness is, therefore, mutable and fluid. Although not genetically linked, material culture items associated with an individual often link to

attributes such as age, gender, status, wealth, access to resources, knowledge, and knowledge about access to up-to-date information, thereby becoming phenotypically expressed. Because phenotypes affect reproductive success, variability in behavior or material culture that causes an individual to have more, higher quality offspring than other individuals will be subject to selection processes similar to those guiding natural selection.

People who invest in costly signals will do so for a perceived benefit (i.e., reproductive fitness, increased social status, increasing quantity and quality of allies) that may or may not translate into actual benefits. There are several reasons that signaling based on perceived benefits would not result in actual benefits for those who invest in the costly signals. People are not always rational or able to adequately measure the costs and benefits of an activity. A decision based on perceived benefits may actually result in a low return, one that may have been higher if the individual had access to more accurate and up-to-date information about dynamic social, economic, and political conditions. Changes in these conditions will result in shifting ratios of costs and benefits that may not be taken into account by individuals or groups when they choose to invest in costly signals. In addition, there are unpredictability and unintended consequences in human action that limit the benefits associated with a particular signal. Although actual benefits may not always match perceived benefits, for costly signaling to be an evolutionary stable strategy it must confer actual benefit often enough to become a shared evolutionary strategy. For archaeologists, it is fortunate that signaling decisions are made based on perceived benefits. Because real costs and benefits will be highly fluid and dynamic (based on changing social, economic, and political milieus), it would be more difficult to identify constantly changing signaling strategies in the archaeological record. Perceived benefits, on the other hand, will likely produce more stable signaling strategies (due to a lag between the perceived and actual benefits) that will produce more identifiable archaeological signatures.

UNITS OF ANALYSIS

The models of costly signaling, like most models that come from evolutionary ecology and optimal foraging theory, have several significant characteristics that make uncritical adoption inappropriate. First, these models assume that the individual is the only relevant unit. In many non-Western contexts, other units of analysis, such as the household or the community, may be more important entities within the social system than individuals (Gintis 2000; Gintis et al. 2003; Wilk 1989, 1996). In these cases, it is quite possible that individuals defer decision making to household leaders and not act to optimize their reproductive fitness absent a consideration of the household. In addition, in certain contexts the success of a household can be more important than the success of

an individual (whose success is predicated on group membership and success of those groups). It is important to not overemphasize the autonomy of individuals in these contexts and therefore our models must be plastic enough to shift with the different units that are socially relevant.

In addition to the considerations of the role of the individual in past societies, archaeologists must deal with another problem when employing models from human behavioral ecology: the individual is almost always invisible in the archaeological record. For a theoretical approach designed around individuals, individual decision-making processes, and measuring reproductive success, direct correlates are often absent from the archaeological record. Even in most mortuary contexts, where we have an individual and an individual burial event, we must acknowledge that the individual was buried by others and the body treatment and artifacts in this context may or may not reflect the status or identity of the buried individual (Parker-Pearson 1999). The palimpsest of behavior that forms the archaeological record requires a refocus away from the individual, individual decision making, and ways of measuring reproductive fitness that are more available to biologists and ethnographers today.

Although there are pitfalls to employing costly signaling to the archaeological record, the archaeological record has the potential to inform our understanding of costly signaling in unique ways. First, in the archaeological record we can most easily identify activities and behaviors that are culturally shared and repeated (or are substantially durable). Costly signals must be recognized for their links to reproductive fitness, and as such, must be perceived by the group. In this way, idiosyncratic materials or behaviors may not be easily recognized by the potential audience as conveying information related to reproductive fitness (and therefore would not be a costly signal). This is not to say that no idiosyncratic behaviors or objects can be costly signals, just that as archaeologists we will be hard pressed to find evidence of these behaviors and objects and justify calling them costly signals. Second, the diachronic perspective offered by archaeological analyses can highlight ways in which material culture use changes through time at a scale not easily accessed to ethnographic or biological researchers. Long-term stability or instability of signaling strategies informs our understanding of the role of costly signaling within a particular cultural system as well as our understanding of how objects become and cease to be costly signals. While archaeologists cannot recognize all costly signaling in the past, the archaeological record provides enough evidence to identify some costly signaling behaviors and objects. More importantly, archaeologists can see patterning and changes in behaviors and material culture use through time and space that enlighten reconstructions of past lifeways.

To use costly signaling models within anthropological and archaeological contexts, we must acknowledge the diversity within human social systems by allowing for other units of analysis and other considerations beyond a

specific individual's own reproductive fitness. These views do not necessitate an avoidance of models that were initially developed to deal with fitness-optimizing individuals; instead, they require (1) a consideration of multiple identities and levels at which a human's reproductive fitness is impacted (such as households and communal membership); (2) linking the evidence of (a) the relevant unit of analysis, (b) the relevant reproductive fitness characteristics, and (c) the costly signals that link to those characteristics for the specific cultural context being investigated; and (3) an acknowledgment of the limitations of the archaeological record for seeing individuals, individual reproductive success, and individual actions in the past.

CONCEPT OF COSTLY SIGNALING IN ARCHAEOLOGY

The most common application of costly signaling theory in anthropology has been associated with identifying costly behaviors (e.g., Bliege Bird and Smith 2005; Bliege Bird et al. 2001, 2002; Gintis et al. 2001; Hawkes 1990, 1991; Hawkes and Bliege Bird 2002; Henrich 2007; Ohtsubo and Watanabe 2009; Smith 2004; Smith and Bliege Bird 2000; Sosis 2003). In archaeology, the focus on behaviors as costly signals has also received attention. McGuire and Hildebrandt have employed costly signaling theory to explain big game hunting as a prestige acquisition strategy among Great Basin hunter-gatherers (Hildebrandt and McGuire 2002, 2003; McGuire and Hildebrandt 2005; McGuire et al. 2007). Although not universally accepted (see Codding and Jones 2007), the work by McGuire and Hildebrandt has been among the most visible incorporation of costly signaling theory in the archaeological literature. The debate about archaeological evidence of big game hunting as a prestige acquisition strategy is plagued by limitations of the archaeological record to preserve evidence of these behaviors (Codding and Jones 2007), necessitating a greater emphasis on theoretical and methodological approaches for seeing costly signaling behavior in the archaeological record. Although the potential of studying costly behaviors in the archaeological record is far from conclusive or extensive, there is another aspect of costly signaling that is as useful, if not more, for archaeologists: studying costly signals in material culture.

The perspective that material culture can be costly signals is not a new idea in archaeology, though often it has not been explicitly linked with costly signaling theory. Kohn and Mithen (1999) have argued that the production of large quantities of symmetrical Acheulean handaxes was a way for individuals to show off their skill and attract mates (through Zahavi's handicap principle) (see critique and reply: Hodgson 2009; Machin 2008; Mithen 2008). Neiman (1997) has argued for monument construction as a form of conspicuous consumption and wasteful advertising, which would produce distinctive material correlates as costly signals. Plourde (2008) has argued that prestige goods (such

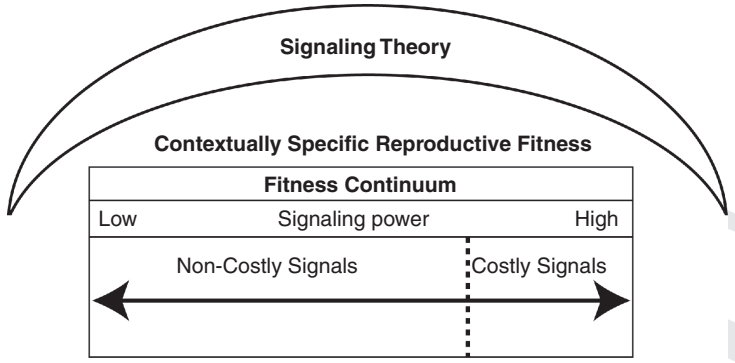
as objects of personal adornment and other costly objects) evolved as costly honest signals conveying the quality of an individual who manufactured or possessed these goods to others to gain advantages of prestige, increased access to resources, and deference in social relationships.

However, not all costly signals are materialized. For example, Smith and Bliege Bird (2000) have argued that the Meriam Islanders hunt turtles as a form of costly signaling. However, the successful turtle hunts and hunters do not have any material markers of their success. We can imagine that a turtle shell would be an easy material into which information about turtle hunting prowess can be embedded, but this is not the case, as turtle shells are discarded after processing. Thus, it is necessary to examine both where and when costly signals become materialized, as well as what information is actually being conveyed. In the preceding text I have laid out an initial roadmap for the identification of costly signals in lithics, but this is only a start, as more contextually specific sets of archaeological correlates must be developed and compared with real data sets.

There have been only a handful of studies that have explicitly linked costly signaling theory and lithic technological organization. Waguespack et al. (2009) have raised the possibility that all stone projectile technology may be costly signals. Based off of experimental studies, the researchers argue that wooden-tipped projectiles were functionally equivalent to stone-tipped projectiles. If stone points provide no functional advantage and impart a cost (access to raw materials, time and skill of production) that is greater than wooden points, then as Waguespack et al. suggest there may be a social benefit to the use of stone points for expressing identity and manipulating social relationships (Waguespack et al. 2009).

COMBINING COSTLY SIGNALING THEORY AND LITHIC ANALYSIS

Although signaling theory is an overarching theory of social information exchange through material culture, not all signals interact with reproductive fitness in the same way. Some signals are more directly related to reproductive fitness than others, while some signals may not impact reproductive fitness at all. The relationship between signals and reproductive fitness can be conceptualized as a continuum; on one end are signals that do not affect reproductive fitness and on the other are signals that play a significant role in not only broadcasting, but also enhancing, reproductive fitness (Figure 11.1). Links between the material signals and the continuum are fluid and dynamic based on the relationship between the variables that affect reproductive fitness. Costly signals contain information about reproductive fitness and affect the negotiation of interpersonal relationships by imposing an immediate cost (loss of resources) for a potential deferred benefit (increasing reproductive fitness).



11.1. Signaling theory, the fitness continuum, and the relationship between costly and non-costly signals.

Non-costly signals can still convey information, such as age, gender, and ethnicity; however, because they do not incur a significant cost borne by the signaler their costliness does not directly affect active negotiation of reproductive fitness. Most artifacts associated with lithic technology fall on the non-costly signal end of the signaling power continuum. They (1) do not convey information about one person to another and (2) do not pose a substantial cost to the individual or group who acquires them.

Reproductive fitness is contextually specific. Any given social, economic, political, or environmental setting will have differing individual attributes that enhance an individual's reproductive fitness. The characteristics that will be selected for by others in mating and alliance formation situations will be directly linked to the attributes that make an individual fit within that context. Hence, certain characteristics may be signaled in one context due to their desirability for mates or allies, while those characteristics may not be as important in the selection of mates or allies in a different cultural context. In addition, a given artifact may be an accurate signal of reproductive fitness in certain contexts while not a fitness signal in others based on that artifact's link to honest representations of highly desired fitness characteristics. Therefore, proxy markers of reproductive fitness are not universal. The fitness of individuals will be based on the cultural (including environmental) contexts, and individuals who signal attributes that are the most directly linked to reproductive fitness in those contexts will likely be selected as mates or allies over individuals who do not signal fitness within that cultural context. As archaeologists, therefore, we cannot simply classify particular items or artifact classes as "costly signals" or "non-costly signals." Instead, arguments for the past existence of costs and signaling power must be developed on a case-by-case basis to both predict expected signals in a given context as well as evaluate signaling power models. To this end, we need a framework for approaching information exchange and signaling in the past that can examine the signaling power of lithics in varying

cultural contexts by looking at individual artifacts, entire assemblages, and the way in which those objects were made, used, and discarded in the past.

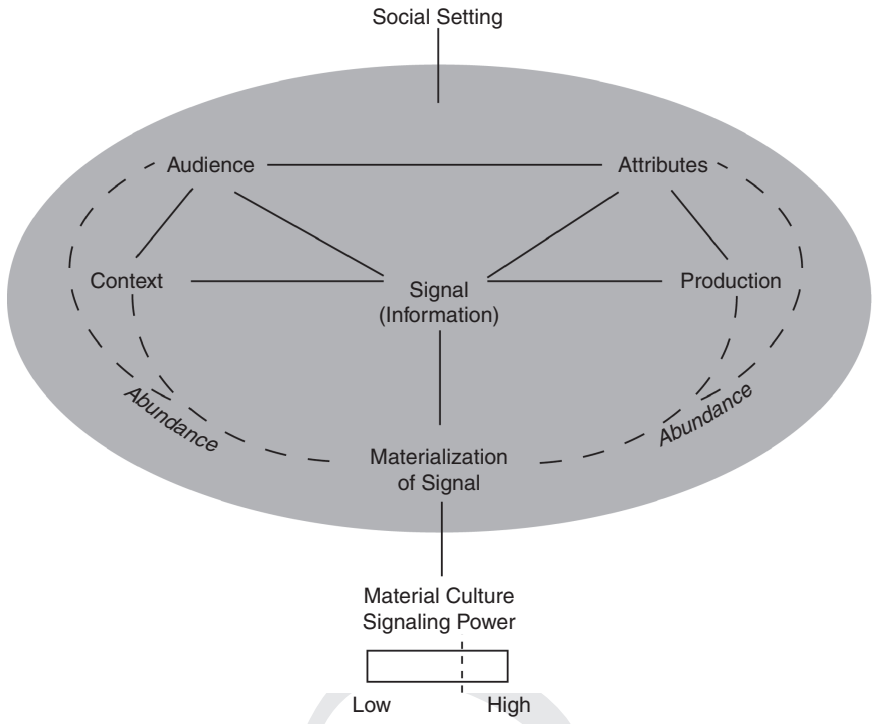
Although costly signaling theory has been previously introduced into archaeological and lithic analysis literature as a potential explanation for seemingly wasteful behavior, there still is much work to be done to link the theoretical approach to the archaeological record. In the next section, I provide a framework (specific to material culture signaling) for investigating costly signaling using objects made of stone in the archaeological record. This approach is meant to complement, not supplant, investigations into costly behaviors such as big game hunting. Instead, the framework will allow for rigorous evaluations of costly signaling as an explanation of material culture use in the past. It is in the operationalizing of costly signaling models that we can begin to take applications of costly signaling theory from "just-so-stories" (Codding and Jones 2007) to fully developed archaeological theory that is ripe with predictive and testable models.

COSTLY SIGNALING: A GENERAL FRAMEWORK

I present a multilevel and nested framework for assessing signaling power of lithics. In Figure 11.2, the first-order variables as well as their relationships with each other and their contributions to signaling power are displayed. All of the variables in Figure 11.2 are amalgamations of several lower order variables that contribute to the primary variables (Table 11.1). This framework has the benefit of providing a common set of variables that are potentially relevant to the design of data collection strategies, the collection of data, and the analysis of lithic objects and their signaling power. Similar frameworks have been proposed for the study of other multivariate, dynamic, and complex social systems (such as socioeconomic systems – Ostrom 2009) primarily because this approach allows for the recognition of complexity, the potential to quantify aspects of social systems, and the ability to generate and test hypotheses about human behavior.

This general framework to signaling with lithics builds on previous work with costly signaling theory, lithic technological organization, and social information exchange, and identifies several primary variables that contribute to the signaling power of an object. This important step in approaching costly signaling in lithics is the recognition of (1) the constellation of variables that contribute to the signaling power of an object, (2) the fact that the variables are interrelated, and (3) the dynamic nature of the connections among the variables and signaling power based on the abundances of the materialized signals in circulation.

The four first-order variables are (1) the audience of the signal, (2) the contexts of use and deposition of the object, (3) the physical attributes of



11.2. A general framework for studying costly signaling behavior with material culture. The reproductive fitness characteristics in a particular social setting influence, and are influenced by, the variables that contribute to the costs and benefits of materializing signals. The more abundant the materialized signals are in circulation, the lower the signaling power of that signal. There is a dynamic and complex relationship among these variables, the fitness information, and material culture that requires a holistic approach to material culture information exchange to identify and explain costly signaling in the past.

TABLE 11.1. *Variables that archaeologists can study within the generalized framework to identify and explain material culture based costly signaling behavior in the past*

First-order variables	Variables that contribute to the cost and benefit of signals
Social organization	Units of analysis
	Cultural context
Artifact attributes	Size
	Color
	Sheen
	Raw material (distance to source; distribution/access)
Production	Skill level required
	Time to manufacture
	Producer/consumer relationship
	Cost of maintenance
Audience	Relationship between signaler and recipient
	Population size/density
	Artifact attributes
Context	Use context (daily life; ritual/event)
	Deposition context (caches, graves, votive offerings; loss; discard)

the object itself, and (4) the structure and organization of production and acquisition of an object. The relationships of these first-order variables to the signal, the materialization of the signal, signaling power, and each other can be seen in Figure 11.2. The signaling power of an object is diminished by the increasing abundance of objects of that type in circulation as the potential for cheating and dishonest signals increases (which also affects all of the first-order variables). Each of the first-order variables are affected by several other second-order variables (seen in Table 11.1), which are variables that can potentially be evaluated qualitatively or quantitatively using archaeological data. When combined, the connections between the second-order and first-order variables can be incorporated into an analysis of signaling power as a means of evaluating whether a given object is a costly signal or not.

When attempting to identify archaeological correlates of costly signals, we must recognize that there is no single variable that can mark an item as a costly signal, and therefore no single archaeological correlate of an item's use as a costly signal. There is a complex suite of relationships among these variables and the archaeological record. This complexity results in a nebulous conceptualization of signaling power, materiality, and costly signaling behaviors where all variables contribute and are affected by social, demographic, and technological organization. As a result, there is no easy set of boxes to check or trait list to examine to determine whether or not an object or artifact type was used as a costly signal. My discussion of the interrelatedness and interconnectivity of variables and their archaeological correlates will be inadequate to capture the entirety of the system, but it does provide a starting point for researchers interested in these issues.

The framework begins with an assessment of the social setting. Next, the characteristics that are associated with success and fitness in that context become the central focus of signaling. In the process of materializing a signal, attributes of the artifact and elements of the production system impose costs on the signaler while the benefits are amplified by the object attributes, the production system, the audience, and the use context of the object. These materialized signals are either costly signals (if they are directly related to fitness enhancing variables for the individual or group) or non-costly signals (if they do not directly impact fitness). This evaluation, however, is not stable. The circulation of objects that are materialized costly signals is necessarily restricted to the people who can incur the costs of acquisition or production. However, with more and more objects entering circulation, the signaling power of all of those objects will be diminished owing to lower acquisition costs and decreased recognition of uniqueness. This feedback loop between the abundance of materialized signals and the variables that contribute to signaling power impacts the diachronic stability of a system and can move objects that were once costly signals lower on the signaling power continuum to the point where they are non-costly signals (and vice versa).

ASSESSING COSTLY SIGNALING IN LITHIC TECHNOLOGY

Utilizing the general framework, we can begin to evaluate the utility of costly signaling theory in studies of lithic technological organization. The social context in which fitness relationships are negotiated is an extremely important factor in the presence or absence and type of costly signaling. The social organization of the group in which the information exchanges take place impacts the majority of primary variables that contribute to signaling power (such as audience size and structure, production organization, and the contexts of interaction). The materialization of signals in egalitarian hunter-gatherer groups will differ significantly from that in more complex stratified societies. In hunter-gatherer communities the needs of mobility limit the size of lithics that can be transported (potentially resulting in less ostentatious signals).

One of the benefits of information exchanges using material culture is the quick nonverbal conveyance of information to people who would otherwise be unable to know, including information about reproductive fitness. With smaller group sizes and fewer social roles (when compared with more complex societies) this can limit the payoff of costly signals in band level societies. On the other hand, periodic aggregations of normally distant groups provides a unique opportunity for signaling, mate acquisition, and alliance formation. In addition, the important role of lithics in the material culture assemblage as well as the economic lifeways of most hunter-gatherer groups throughout prehistory may have made it an important vehicle for social information exchange. In more complex societies, the number of social roles and identities that can be conveyed through material culture can be large. The payoff of a signal in these contexts can be higher owing to larger audience sizes and the more active use of material culture items (and their collection) to convey information about fitness to others. However, the diminishing role of lithics as a result of technological innovations (such as metallurgy) can also impact their signaling power.

In different social settings there are different emphases on certain identities that may change the locus of information exchange. An individual's reproductive success may be directly related to his or her own ability to signal or it may be the household that is the relevant unit of identity; and the success of the household may be placed over the success of an individual (though it is expected that the individual will receive a real or perceived benefit from association with the household). In these cases, it is likely that signals that are associated with lineage membership and increase the status of the household will be emphasized. The differences among different levels of social organization are expected to be reflected in the form of different materializations of costly signals as well as the majority of variables that contribute to their signaling power. For this reason, it is necessary to evaluate any potential signaling within the specific social and cultural context in which the objects were used.

The structure and organization of stone tool production also affect the signaling power of lithics. Formalized tools are more likely than expedient tools to contain social information. In addition, any restrictions in access to raw materials and in the role of producers could have significant ramifications for the utility of lithics as costly signals. With higher degrees of specialization comes the ability for individuals to control production as well as the byproducts of production. Other restrictions on the production of particular stone tools arise from the difficulty of working the material, the skill required to make a tool, and time investment in production. The more bounded, restricted, and costly production of stone tools is, the more likely the tools are to carry information that can impact reproductive fitness. Archaeologically, the presence of production areas, raw material caches, and stores of finished items may indicate that there are restrictions on who has access to raw materials and finished products that can turn the artifacts into honest markers of this potentially fitness enhancing characteristic.

Characteristics of artifacts can impact the visibility of a signal – the larger and more visible the artifact (perhaps based on size, color, or sheen), the higher the payoff in terms of numbers of people who receive the information. Lithic raw material sources that are spatially discrete or distant are easier for individuals or small groups of individuals to create control over. Exotic raw materials that are difficult to acquire may be more associated with differential access that may also be linked with other useful characteristics (i.e., alliances, wealth, status). Raw materials that are costly to work (i.e., require high degrees of skill, difficult to knap) also may have high signaling power. Exotic materials and rare items are more likely to be used as costly signals than local and abundant resources. Spatially distinct sources or trade routes may produce assemblages that show differential access to raw materials, such as significant differences in exotics or different raw material types in different houses across a site.

The audience to which a signal is displayed is affected by multiple variables. The overall audience size (potentially measured as population size or population density) will impact the signaling power of a signal (the larger the audience, the higher the signaling power). In different cultural contexts, there may be different audiences of a signal. For example, hunter-gatherer bands may have lower audience sizes in daily contexts but also may have important audiences during times of aggregation or interaction with neighboring communities. In addition, in more populous social settings (such as sedentary villages), there may be more people who will see a signal, which will increase the benefit to the signaler when compared with signalers in contexts of low population density (even with the same cost). The audience of a signal is dependent on the visibility of the signal (the more visible the lithic object, the more people will see it) and the context in which it is displayed (the more people who are around when a lithic object is used/displayed, the more people will see it). Lithics used

in a common daily activity will be seen by a more restricted (and likely highly related) audience while lithics used in highly visible ritual events (such as feasts and funerary events) will have a larger and more diverse audience.

Factors in assessing the use of an item as a costly signal in the archaeological record are its use and depositional context. The same object found in different contexts may have had very different roles in social exchange of reproductive fitness information. One way in which context matters is if there is evidence that the object is used in different ways that are not explained as functional. Costly signals would likely have had different patterns of use-wear and retouch than non-costly lithics. Objects used in ritual or ceremonial performances may have been stored in locations associated with other paraphernalia. Similarly, iconography or other evidence that may hint at the role of lithics within ritual, feasting, or other highly attended and visible events can help determine whether or not lithics were used as costly signals.

Another way in which context matters is the way in which an artifact is deposited. Caching and hoarding behavior may be associated with conspicuous consumption and destruction of artifacts that may be interpreted as a costly behavior. Mortuary contexts are also an area where the destruction of wealth, rare items, and signs of status may indicate costly signaling, though it is important to recognize that a variety of other information (from group membership to individual identity) can be encoded in grave goods. With both the use and discard of an artifact, it is not where it was found or how much use-wear that matters; it is the deviation from the expected – evidence of active decisions by people in the past to use the artifact as a vehicle for information exchange – particularly as a fitness enhancing signal that makes it a costly signal.

When combined, the assessments of costliness and payoffs from signaling displays for each of these variables can inform our understanding of whether or not a signal is a costly signal or a non-costly signal. However, this assessment is dynamic and mutable depending on artifact abundance, stability in the social setting, and the changes in the relationship of the variables through time.

POTENTIAL APPLICATIONS OF COSTLY SIGNALING IN LITHIC TECHNOLOGY

As previously mentioned, Kohn and Mithen (1999) and Waguespack et al. (2009) have attempted to link social information exchange and lithics in the context of sexual selection and costly signaling theory. Although these researchers have not systematically considered all of the variables that impact signaling power, their work highlights existing attempts to utilize costly signaling theory to explain some phenomena observed in the archaeological record. Acheulean handaxe production and the use of stone as a projectile are not the only contexts (if they are contexts for this at all) where we anticipate seeing evidence

of costly signaling strategies. In this section I would like to provide a brief and broad survey of archaeological contexts and examples where costly signaling may be applied. This is not meant to argue that all of these cases are evidence of costly signals in lithics, only that these are the kinds of attributes in artifacts, assemblages, and contexts that are more likely than others to be venues for wasteful display and conspicuous consumption involving lithics.

Paleoindian Caches: Objects and Deposition

Clovis points, with their distinct basal fluting, were likely more costly to manufacture than other point forms. However, given their widespread distribution, it may not be appropriate to consider all fluted points as costly signals. In some cases, however, there does appear to be a distinct social function based on their attributes, production, and depositional context. In 1987, a cache of fluted Clovis points from an undisturbed context were discovered in East Wenatchee, Washington (the Richey-Roberts Clovis Cache; Mehringer and Foit 1990). These points were distinctly larger in size than most Clovis points, were made of very high quality raw materials, showed little evidence of retouch, were found in a high quantity and density that is extremely rare, and were found in association with ochre (Mehringer and Foit 1990). Together, these suggest that these artifacts may have been used to communicate social information rather than as utilitarian implements. Other cases of ritual fragmentation and deposition of pristine Paleoindian bifaces in the Great Lakes region has been argued to represent ritual activity (Ellis 2009). The link between ritual performance and lithic technologies suggests that stone objects may have been embedded with important individual or communal information that was negotiated through the use of material culture. Individuals or groups that controlled access to these objects or to the ritual performance may have benefited from these instances of conspicuous consumption. Larger considerations of stone point artifacts, their relationship to other Paleoindian lithic technologies around North America, the social setting of Paleoindian communities, and reproductive fitness characteristics for the people making and using these points must be undertaken before they are interpreted as costly signals.

Biface Caches: Mound 72 at Cahokia

During excavations at Cahokia's Mound 72, a series of hafted biface caches were recovered (Fowler et al. 1999). Two caches (caches 1550 and 1551) were in direct association with burials while a third (cache 1970) appeared to be deposited later than the other caches without being associated with a burial (Ahler 1999:102–103). The caches were made of several hundred bifaces, many of which were not heavily curated and numerous ones that were made of

exotic raw materials. Previous work has documented a significant amount of typological, depositional, raw material, morphological, and contextual variability among the different caches (Ahler 1999). This variability has been interpreted to imply that the different caches represented different social functions for their deposition (Ahler 1999:112). The diversity, use of exotic materials, limited retouch, and association with funerary performance, especially in the 1550 and 1551 caches, is suggested to represent larger audience sizes, representations of larger exchange networks, nonutilitarian uses of the lithics, and costly investment in acquiring and depositing points made of exotic raw materials. The performance of deposition of these points was likely part of a series of large-scale public events that would have brought together many communities, suggesting that there would have been large audience sizes (Brown 2006; Pauketat and Alt 2004). Given the abundance of lithics in the mortuary events and other ritual activities at Mound 72, it may be possible that they were utilized in conspicuous consumption events. Similar hafted biface caches have been reported from other Mississippian sites, such as the Spiro site (Ahler 1999), which may suggest a larger regional pattern of signaling with stone points. Given the variability among caches and the deposition of points in non-cache contexts during the Mississippian period, it is likely inappropriate to discuss point use in a general sense as an exhibition of costly signals. Instead, contextually specific examinations of artifact attributes, contexts, production organization, and audiences may elucidate where and when hafted bifaces were used as costly signals during the Mississippian period.

Kimberly Projectile Points: Display and Fitness

In pre- and postcolonial contact periods in northwest Australia, Aboriginal communities manufactured Kimberley points (Harrison 2002). Kimberley points possess a distinctive pressure-flaked margin that results in denticulate or serrate margins (Harrison 2002). These points have been argued to play important roles in functional resource extraction (Akerman 2008), demonstrating masculinity (Harrison 2002), displaying social identities (Harrison 2002), and negotiating colonial interactions (Harrison 2006). The utilization of these objects in a variety of contexts, their unique manufacturing process, and in some cases the large size and use of exotic raw materials for their manufacture may suggest that these objects were used to convey social information. For these objects to be costly signals, however, they must convey information that is linked to reproductive fitness in these social contexts. If these points embodied a desired quality of masculinity, they may have been important tools in displaying that quality. Work to evaluate costliness, audience variability, and contextual utility of Kimberley points may provide evidence to link this point technology to either costly or non-costly signaling.

Kintampo Points: Formalization among Informal Assemblages

The Ceramic Late Stone Age Kintampo Complex lithic technology from Ghana, West Africa is characterized by expedient and informal tools produced through bipolar reduction (Casey 1998). Not all tools in these assemblages were informal and expedient; the people who produced the Kintampo assemblages did produce highly formalized hafted biface points. The co-occurrence of large quantities of informal tools (presumably used for the majority of utilitarian tasks) and only one type of highly formalized points suggests that the points may have been used to transmit socially relevant information (Casey 1998). Given the relatively higher investment in time to produce these formalized tools, their potentially visible role associated with hunting forays, and the increase in audience sizes with sedentism during the Ceramic Late Stone Age, it is possible that these points were utilized as costly signals of manufacturing skill and hunting ability.

Northwestern California Bifaces: Exotics and Performance

In ethnographic and archaeological contexts in northwestern California, obsidian bifaces were considered important markers of wealth and social rank (Hughes 1978; Kroeber 1905; Rust 1905; Thompson 1916). Obsidian was an important tool stone in much of California before and at contact with Europeans; however, the lack of sources in northwestern California meant that in this region the stone could be acquired only through long-distance exchange networks or long logistical forays to source sites (Hughes 1978). In these communities, large obsidian bifaces (also referred to as "blades" in the literature) served an important role in the construction and maintenance of individual and communal identity and were often a direct embodiment of fitness-related characteristics of wealth and status. These important markers were used in a variety of contexts, and their value was based off of their sources, their size, their color, their completeness, and their display (hafted or worn from necklaces) (Hughes 1978). Early ethnographic work by Horatio Rust, who made an attempt to acquire several of these items from indigenous Californians, provides an incredible insight into the social function of these objects, their use and depositional patterning, and the awareness by these local communities of the link between the material objects and the information that they signal:

> These obsidian blades pass from father to son, with hereditary rank, and are retained with pride as heirlooms; consequently it was only by much persuasion and considerable expenditure that they could be obtained. In several instances the Indians regarded the blades as tribal property, and in

> one case I found it impossible to persuade the holder to part with the one in his possession at any price.
>
> One old Indian, living alone in abject poverty, exacted a promise that I would not tell his neighbors that I had bought his blade. He said: "Now they call me rich. If they know I sell him, they say 'He poor Indian-no account.'" The promise was given and his reputation for wealth and honor saved." (Rust 1905:688–689)

This quote highlights the blurred lines between the information (in this case, "wealth and honor") and the material object used to signal. Obsidian bifaces were only brought out for dances and during normal daily events they were stored with much care (Rust 1905), which highlights their use as signals at times with the largest and most attentive audiences. The deposition of these objects in mortuary contexts may mark the end of their use by the interred individual as a costly signal, or might mark a conspicuous consumption event by the people burying the deceased. The use of these stone points made of difficult to acquire and costly raw materials in highly visible displays during periods of aggregation and ritual suggest that these objects may have been materialized signals of reproductive fitness characteristics of exchange network access, wealth, and status.

DISCUSSION

Costly signaling is a strategy of resource consumption that people in the past utilized to increase social capital and reproductive fitness, and the identification of this phenomenon is only the first step in realizing the explanatory power of this theoretical perspective. There is important evidence of synchronic patterning in the materialization and utilization of costly signals that can provide insight into communal social dynamics. Measures of differential access and utilization across a community provide evidence of different signaling strategies being employed. Diachronic patterning in materialized costly signaling can also provide evidence of stability or dynamism in signaling strategies. Changes in the information being conveyed, the characteristics that impact reproductive fitness, or the material culture assemblages of a group can potentially be used to reconstruct signaling practices and complex behaviors in the past.

Just because a raw material is exotic, rare, spatially discrete, or difficult to work does not automatically make it a costly signal. That information must be encoded in the material by the individuals making, using, and discarding the artifacts. Materials that have these qualities, however, are more likely to be used as costly signals than materials that do not fit these qualifications. In lithic assemblages where these material conditions are observed, it may be appropriate for archaeologists to apply models and hypotheses from costly signaling theory.

Costly signaling theory is not intended to explain all or even most behavior in the past. This is particularly true for its utility in examining the relationship among information exchanges, people, and lithics. Its power as a theoretical approach lies in accurate application to the archaeological record in cases where it is appropriate. With costly signaling theory, it is possible to (1) track the development of social practices in which people embed lithics with information, (2) develop hypotheses about the stability or dynamism of signaling practices using material culture, and (3) reconstruct the role of lithics in the construction, modification, or negotiation of identities and interpersonal relationships.

There must be careful considerations of the archaeological record from both directions: the soundness of applying the theory to a particular set of research questions as well as the suitability of the data set for addressing these issues. I encourage researchers who are looking to costly signaling theory as a mechanism for explaining seemingly wasteful behavior in the archaeological record to do so carefully, with diligence to the theory as well as the data. Although its applicability in studies of lithic technological organization is likely not as wide reaching as its use in studying other types of archaeological materials (such as personal adornment items), there are still particular criteria that some archaeological cases meet where not only does the use of lithics in negotiating social relationships lend itself to costly signaling theory, but also perhaps costly signaling theory can best explain these phenomena.

Evolutionary theory can inform our models and approaches to lithic technological organization in the past. Models and approaches derived from evolutionary theory must be critically incorporated to anthropological archaeological investigations of the past, modified to realize the specifics of human cultural behavior and the structure of the archaeological record. When done well, as evidenced by this volume, these approaches can inform our understanding of past human activities and the complex relationship between people, their environment, and the materialized manifestations of their cultural behavior.

CONCLUSION

In this chapter I have attempted to explore the utility and method of applying costly signaling theory to studies of lithic technological organization. In the process, I have highlighted the potential utility of looking at fitness-related information embedded and signaled in stone objects. I have also warned about the dangers of inappropriately explaining past behavior as costly signaling when certain social and material criteria are not met. Studying costly signaling in lithics is a difficult task, made even more difficult by the multiple lines of evidence required and the ways in which other social phenomena and different types of artifacts can affect the presence of costly signaling and the way in

which it was materialized. Although I urge caution in applying this concept to the archaeological record to avoid perpetuating a series of just-so-stories, the causal mechanisms, evolutionary stability, and explanatory power of costly signaling theory are a valuable approach that can provide new insights into lithic technological organization.

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