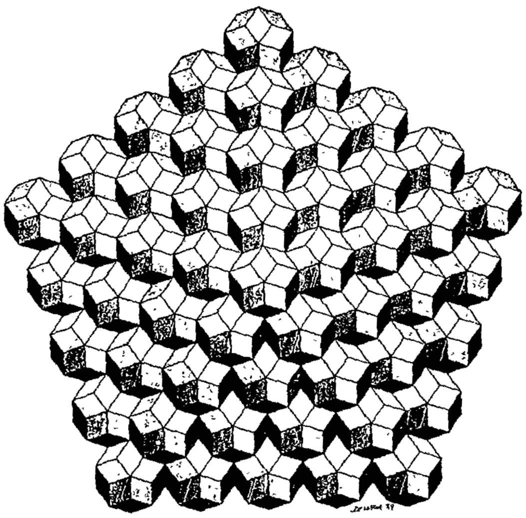
Symmetry of STRUCTURE

an interdisciplinary Symposium

Abstracts

II.



Edited by Gy. Darvas and D. Nagy

Buda
pest

August 13-19, 1989

hungary

SYMMETRY AND THE ARCHAEOLOGY OF MIND

Thomas Wynn, Department of Anthropology, University of Colorado at Colorado Springs, Colorado Springs, 80933-7150, U.S.A.

Abstract

The nature of symmetry as a pattern imposed on artifacts has changed significantly over the course of human evolution. The symmetry concepts employed by modern humans have no antecedents in the conceptual repertoires of our nearest relatives, the chimpanzees. It is clear that they must have evolved.

Modern humans not only produce symmetrical patterns, they use symmetry as a principle to transform patterns. Leaving aside for the moment an explanation for this phenomenon, let us first examine some examples.

The Shipibo Indians of Peru use a distinctive style to decorate textiles, pots, and so on. It employs a few simple motifs and rules to transform those motifs. Most of these rules are rules of symmetry, bilateral and rotational. The motifs are not symmetries but the rules transform them into symmetries. Each individual artisan employs these rules differently, yielding idiosyncratic styles within the general style (Roe 1980).

Ban Chiang pottery from northeastern Thailand presents a similar situation, though in this case the example is from recent prehistory (first millennium B.C.). Ban Chiang potters used several rules of symmetry to fill the decorative field on their pots. The most favored rules used combinations of longitudinal and transverse reflection, sometimes combined with rotation. Once again, the motifs are fairly simple, mostly curved lines and loops. It is the symmetrical transformation that supplies interest and complexity (Van Esterik, 1979).

Comparable rules of symmetry can be found in house building in colonial Virginia, U.S.A (Glassie 1975). The tradition of house building was imported, primarily from England, in the 17th and 18th centuries. In it, certain basic structural elements, including basic room dimensions, window size, etc., are combined using basic rules of assembly. Many of these rules are rules of symmetry and, occasionally, asymmetry. For example, if an exterior was has a central door, it must have an equal number of windows on either side. Once again the elements are simple and are "added" together using rules of symmetry.

These three culturally separate groups of modern humans employ symmetries as a transformational principle in producing patterns of material culture. If not a universal, it is certainly very common and suggests that the modern human mind turns easily to symmetrical transformations.

Symmetrical transformations are unknown for modern chimpanzees, our nearest relatives. Indeed, symmetrical patterns are almost unknown. Thirty years ago much publicity was given to paintings produced by captive chimpanzees. Early interpretations made claims for a sense of "symmetry"

or "balance" in the compositions. However, recent controlled experiments have failed to find any evidence for a sense of symmetrical composition in chimpanzee drawing (Boysen et al. 1987). The only consistent symmetry produced by chimpanzees occurs in the construction of nests in the wild. Chimpanzees pull in nearby branches and weave them into a platform. The result is a radial symmetry. However, it is almost certainly an unintended consequence of the biomechanics of the task and is not a cognitive competence.

In sum, modern humans not only produce symmetrical patterns, they use symmetry as a principle of transformation. Our nearest relatives, chimpanzees, do neither. When, how, and why did this quirk of human thinking appear? Archaeology presents a record of the evolution of the concept of symmetry. Most of this sequence consists of patterns imposed on stone tools. Stone tools are, unfortunately, not an ideal medium.

Stone is a relatively intransigent medium whose qualities present problems in interpreting artifactual symmetries. For example, some types of stone used for artifacts have cleavage planes that affect the nature of stone fracture. Moreover, the simple physics of stone fracture occasionally produces symmetries. As a consequence, it is possible to have symmetrical patterns that are not clearly the intention of the prehistoric artisan. These must somehow be factored out.

There is also no assurance that prehistoric artisans used their most sophisticated spatial concepts, including symmetries, when they made tools. They could well have used more complex symmetries in realms that are archaeologically invisible. This is the problem of "minimum necessary competence." Because of it we risk underestimating the abilities of prehistoric people.

Despite these methodological caveats, archaeologists can, in fact, document a sequence of development. I will describe artifact symmetries at four points in prehistory: 2 million years ago, 1.2 million years ago, 300,000 years ago, and 15,000 years ago.

Artifacts indicate that by 2 million years ago our ancestors still used the spatial concepts typical of apes. In other words, there is no evidence for a concept of symmetry. Tools from this time period appear to have been manufactured with little or no attention to overall shape. Only shape of edge appeared to interest these early hominids (Toth 1985). In modifying edges, the hominids used relatively simple spatial concepts: proximity, boundary, and order.

By 1.2 million years ago there is evidence for a concept of symmetry, but it is a relatively primitive kind of symmetry. Many of the early tools termed bifaces have a crude bilateral symmetry. Indeed the symmetry is often so rudimentary that one is tempted to argue that the symmetry idea belongs only to the modern archaeologist! Nevertheless, on some of the bifaces one lateral edge is almost certainly a reflection of the other. Such a symmetry does not require the euclidean concept of congruency but does require the topological concept of reversal of order and some notion of two dimensional, overall shape. At this time there are also remarkably round artifacts termed discoids and spherical artifacts termed stone balls or spheroids, suggesting a concept of radial symmetry.

The use of a symmetry concept, however rudimentary, places these 1.2 million year old hominids beyond the range of ape spatial performance. However, the symmetry concept is far from modern.

By 300,000 years ago, and probably considerably earlier, stone tools present patterns of symmetry that include euclidean congruency. Congruency requires conservation of amounts of space, not just similar patterns. In addition to congruency, these artifacts often have bilateral symmetry in three dimensions, not just two. It appears that by 300,000 our ancestors could conceive of and execute symmetrical patterns that match in sophistication the basic symmetrical patterns produced by modern artisans.

While we do not yet have evidence for symmetry as a principle of transformation we do, by 300,000, see intentional "violations" of symmetry in the form of fine asymmetrical artifacts and "S-twists" in the profile of the lateral edge. These suggest that the concept of symmetry is in fact more elaborate than simple "reflection of congruency."

By 15,000 years ago, which is virtually the present by stone age standards, we have evidence of symmetry as an organizing principle in media other than stone. In Franco-Cantabrian cave art, the figures do not appear to have been placed randomly in caves but arranged according to principles of composition, some of which are elaborations of a symmetry principle. Similar symmetries can be found on mobiliary art of the same period. However, even by 15,000 years there is no good evidence for symmetry as rule of transformation in the sense that we encounter it in, say, Shipibo textiles. This is puzzling because in most other respects the material culture of this time period appears modern (though not western, industrial, of course).

The sequence that I have described is extremely coarse. Nevertheless, it does document the appearance, perfection, and then elaboration of symmetry as a pattern on artifacts. It remains to examine what implications this sequence has for understanding human evolution. The development of concepts of symmetry, while in and of itself interesting, may have been linked to other developments in the evolution of mind. Two of especial interest to me are the evolution of intelligence and the appearance of "transformational rules."

In my work (e.g., Wynn 1989) I have used Piagetian theory and the geometry of stone tools to assess the intelligence of early hominids. The complete lack of symmetry concepts in the material culture of chimpanzees and two-million-year-old hominids suggests that both fall within the earlier "symbolic" substage of preoperational intelligence, Piaget's second major stage of intellectual development. Apes generally test at this level so the lack of symmetry is consistent with other aspects of their behavior. Traditional interpretation grants two-million-year-old hominids greater intelligence than apes. Lack of symmetry is corroborated by other aspects of culture, however, and it appears that traditional interpretation of our early ancestors hay have been too optimistic.

The rudimentary symmetry of 1.2 million-year-old artifacts suggests that these artisans used intuitive preoperations and were therefore demonstrably more intelligent than apes. More importantly, it indicates an intelligence much less centered on ego than that of symbolic preoperations.

The congruent symmetries of 300,000 year old bifaces required concrete operational intelligence, Piaget's penultimate stage. Especially telling are the symmetries in cross-section, which require reversibility and conservation to conceive and execute. These are hallmarks of operational thought. Evidence for formal operations, Piaget's final stage, is virtually impossible to document from material culture of any age. Artifactual symmetries require only concrete operations.

In sum, symmetry helps us trace the development of hominid intelligence from an essentially ape grade at two million to essentially modern by 300,000.

Symmetry may also help document the evolution in cultural complexity in another respect - the complexity of conventional forms (content being unaccessible archaeologically). The material culture of two-million-year-old hominids, like that of apes, presents no arbitrary forms. Shapes of tools appear to have been tied to immediate tasks at hand. By 1.2 million we have the appearance of a conventional form, in the guise of rudimentary symmetry on artifacts. There appears to have been no overriding mechanical reason for the shape and, moreover, it was a community standard or convention, not an idiosyncratic production of one artisan.

By 300,000 conventional, arbitrary form is well-defined. Indeed, fine symmetries as standard patterns probably appear by 600,000 years ago or so. But by 300,000 symmetry as a convention begins to lose its monolithic strangle hold on form. We see aesthetically pleasing violations, in the form of asymmetries that were clearly intentional and S-twists in the profile of lateral edges. All this suggests that symmetries and by implications other conventional cultural systems, were much more dynamic than before.

Symmetry as a transformational rule is common in modern culture (see earlier discussion). We cannot document the appearance of this development until very late in prehistory; indeed not until after 10,000 years ago.

References

Boysen, S. T., G. G. Prentice and J. Prentice (1987). Simian scribbles: A reappraisal of drawing in the chimpanzee (Pan troglodytes). Journal of Comparative Psychology 101, 82-9.

Glassie, H. (1975). Folk Housing in Middle Virginia. Knoxville, University of Tennessee Press.

Roe, P. (1980). Art and residence among the Shipibo Indians of Peru: A study in microacculturation. American Anthropologist 82, 42-71.

Toth, N. (1985). The Oldowan reassessed: A close look at early stone artifacts. Journal of Archaeological Science 12, 101-120.

Van Esterik, P. (1979). Symmetry an symbolism in Ban Chiang painted pottery. Journal of Anthropological Research 35, 495-508.

Wynn, T. (1989). The Evolution of Spatial Competence. Urbana, University of Illinois Press.