

SYMMETRY: ART AND SCIENCE

**FOOTPRINTS LITERACY:
THE ORIGINS OF ART AND PRELUDE TO SCIENCE**

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Abstract: *Art is a far too complex cultural phenomenon to have been invented ex-nihilo. However, no adequate explanation has so far been given regarding the graphic and cognitive skills which preceded prehistoric art, and made its actual emergence possible. This essay proposes that prehistoric art was preceded by a more primitive kind of pictorial literacy, namely footprints literacy. The obvious attribute common to many early prehistoric paintings and footprints is that both represent their subjects by*

contour and negative. A deeper analysis of these two kinds of visual literacy reveals many other common attributes: connectivity-differentiation, classification, abstraction, generalization, signification, visual class-names, symmetry-asymmetry, schematization, complementarity, induction, deduction, hypothetical thinking and others. Thus, it is probable that footprints are the proto-symbols from which figurative art evolved. It is striking that the same attributes which appear in footprints literacy and in art, appear much later as basic attributes of modern science, but at a much higher level of sophistication. Possibly, these three domains represent successive stages of noetic evolution. Probably, this finding points to fundamental cognitive attributes or "mindprints" that are basic not only to these areas, but to human intelligence itself and probably to all other phases of Being. Pointing out the origins of art might be a substantial contribution to the lifting of the veil from the most fundamental attributes of art since its very beginnings. This may provide a new key to the delineation of the demarcation lines between art and non-art, which seems to be the problem that haunts modern art.

The problem 'Which comes first, the hypothesis (H) or the observation (O)', is soluble; as is the problem, 'Which comes first, the hen (H) or the egg(O)'. The reply to the latter is, 'An earlier kind of egg'; to the former, 'An earlier kind of hypothesis'.

Karl R. Popper (1969, p.47)

*In the beginning was my end,...
...in my end is my beginning.*

T. S. Eliot, East Coker

1 IN THE BEGINNING WAS THE END

In recent decades the consciousness has become increasingly established, that modernism has indeed failed and that in our century art has reached a dead end. Aestheticians, historians and not a few art critics explicitly maintain this, albeit at differing levels of decisiveness, and in the light of analyses at varying levels of sophistication. (Appleyard, 1984; Avital, 1996, 1997a, 1997b, Avital, in press; Belting, 1987; Field, 1970; Fuller, 1982; Gablik, 1984; Habermas, 1985; Lang, 1984; Ripley, 1969; Wolfe, 1975, and others.) On the one hand, it is doubtful whether it can still be

denied, that art is in a paradigmatic crisis which is the inevitable result of the fact that in the name of unlimited creative freedom in the twentieth century, the demarcation lines between art and non-art have been completely breached. On the other hand, art theory at all levels has not to this day provided a clear way of distinguishing between art and non-art. From this arises the central idea of this essay, that an attempt has to be made to uncover the sources of art, and to understand what its attributes were at the earliest stages, before it underwent so many transformations, and served so many functions in the course of tens of thousands of years. The uncovering of the basic attributes of art at its very sources can in any case help us today to distinguish art from non-art. This idea indeed seems promising, but on turning to an examination of the known theories of the origins of art, it is found that they contribute nothing to such an understanding. For this reason, an attempt is made in this essay to propose a more adequate theory of the origins of art which both has wide implications regarding culture as a whole, and furthermore places in a new light the profound connection between art and science.

In another paper entitled: *The Origins of Art: An Archaeological or Philosophical Problem?* (under review)—three theories have been examined regarding the origins of art: Breuil's imitation theory (Breuil, 1981), Gombrich's projection theory (Gombrich, 1962) and Davis' mark-thing confusion theory (Davis, 1986a). These theories differ in their points of departure and in their degree of elaboration, but equally failed to fulfill the three basic requirements that must be met by an adequate theory of the origins of art:

1. The three theories failed to explain the graphical and cognitive evolutionary stages that must have preceded the emergence of pictorial representation.
2. None of them contributes anything to our understanding of the attributes of art, and these theories therefore cannot help us in solving the central problem of art today, which is the problem of demarcation between art and non-art.
3. None of these theories teaches us anything about the structure of the intelligence of the human beings who created pictorial representation, and therefore none of them helps us towards understanding the deep cognitive structures common to art and to other branches of culture all of which are in the end products of the same intelligence.

This being so, a completely different theory is needed, that on the one hand will meet the requirements that have been established here concerning theories intended to explain the origins of art, and on the other hand will be free of the fallacies and inconsistencies which have been exposed in the above mentioned theories. An alternative theory to those must first and foremost single out the activity or cognitive capacity that was the stage preparatory to prehistoric art. Such capacity would have to be of a much earlier origin than prehistoric art, and

probably earlier than tool making as well. This cognitive capacity would have to be common to all hunters everywhere and at every period, and would thus explain the fact that very similar representational systems appeared in all hunting societies. In what follows I shall try to show that this capacity is *footprints literacy*.

Not a few archaeologists and anthropologists have of course noticed the fact that footprints and handprints are among the earliest subjects of prehistoric art, and that it is therefore possible to connect these pictures with the *graphical origins* of image making. (Breuil, Leroi-Gourhan, Delluc and Delluc, and others.) It must be stressed that these scholars deal *exclusively with the graphical aspect* of footprints as a possible origin, to one degree or another, of image making; and in this respect the present article makes no claim to innovation. What is new in this essay is firstly, the argument that image making has two kinds of origins: graphical origins, and cognitive origins, between which there is a profound connection. Secondly, an attempt is made here to show that the *cognitive mechanisms* required for the reading of footprints, which are a much more fundamental stratum than the graphical stratum, are basically the same cognitive mechanisms as those required for image making, and are also the same cognitive mechanisms as those that are identifiable in modern scientific activity. That is to say, there is here an attempt to point out a certain noetic evolution, the manifest beginnings of which can already be clearly identified in footprints literacy. For this reason it is quite certain that this is one of the likeliest and most important (although not the only) origins of image making, not only graphically speaking but also, and mainly, cognitively speaking. The graphical and cognitive components of image making cannot be independent of one another, but it is clear that the cognitive component is the one that conditions the graphical component and in fact makes its existence possible, just as certain cognitive properties condition the very existence and functioning of our language and thinking. This being so, it is of at least as much importance to examine the cognitive properties involved here, as it is to understand the graphical evolution of image making. Art historians and archaeologists either ignore completely the cognitive attributes which must have been a precondition for the emerging of image making, or totally deny the need—or even the existence—of such attributes (Davis, 1986a). However, in the light of the analysis of Davis's theory presented in the above mentioned paper, it is absolutely clear that the fact that scholars do not deal with the cognitive properties required for image making or deny their necessity, does not mean that they do not assume them implicitly. For this reason a cognitive approach, even a speculative one, to the problem of the origins of art is no less legitimate than the empiricist and behaviorist approaches, granted that it provides us with insights that enhance our understanding of the origins of art, its nature and the nature of the intelligence that created it. Art is a phenomenon that is not only too

complex for it to have had only a single origin, but it is also too complex for any specific approach to suffice for the understanding of its origins.

The alternative theory to be put forward here regarding the origins of art is actually a considerable broadening and deepening of the projection theory. But the concern here is not with the projection of contents such as fears and desires, as assumed by Gombrich, but the projection of structural or organizational principles of mind. According to Gombrich, whose point of departure is basically cognitive, projection is only another word for classification (Gombrich, 1962, 89). Ironically, it transpires that if we were to make a thoroughgoing examination of what cognitive attributes were required in order to classify, then we would arrive more or less at the same list of attributes as that implicitly assumed by his opponent (Davis, 1986a), who sets out from a behaviorist standpoint. But Gombrich did not ask what cognitive attributes were latent in the image we project, nor did he ask what attributes were required in order that one could classify, just as Davis did not ask what attributes were required in order that one could recognize similarities between things or marks. The attributes assumed implicitly by both are the attributes that I have called "mindprints". These unique attributes, which will be briefly discussed below, seem to be the meta-structures of the complementarity of mind and reality. However, the archaeology of mind is not necessarily an archaeological problem. Before we approach the main discussion, which shows how these mindprints appear at the deepest level of footprints literacy, image making, and most probably in science and all branches of culture, we shall first review several basic aspects of footprints literacy that make this phenomenon the point of departure for the alternative theory.

2 FOOTPRINTS LITERACY: THE EGG THAT PRECEDED THE HEN

Human beings learn to utter sounds before they are able to speak, and learn to read words before they are able to write them. To the same extent human beings also learn to read a picture before they are able to draw. The fact that a person is capable of reading does not imply that he can write, but if he is capable of writing it can safely be assumed that he can read as well, since writing includes reading as a prior condition, but not the contrary. That is to say, writing is a skill of a higher level of order than reading and it is therefore natural that it always appears at a later stage than reading. From this it is clear that *human beings must have known how to read something very like pictures before they were able to draw pictures!* If this is indeed so, what pictures did the hunters read

before there were pictures? The answer is written on the ground: they read marks that were a kind of 'natural drawing' outlined on the ground without intention or awareness on the part of those who 'drew' them; these were the footprints of animals and human beings. As we shall see, it is almost certain that hominids were already able to read footprints some four million years ago. It seems very reasonable to assume that for the early hunters, as for trackers of all times, footprints were graphic indications, substitutions or even representations of the creatures that produced them, and this is therefore probably the beginning of symbolization and of the capacity of reading graphic representations. If one of the essential attributes that characterize human consciousness is the capacity of thinking in marks related to hypothetical entities, then the reading of footprints is almost certainly the earliest expression of the ability of man to think referentially. On the other hand, some millions of years were needed before the hunters could generalize from the reading of these natural representations, to the 'writing' or drawing of footprints and handprints on the walls of caves and rock shelters (See Fig. 2.). After this, only a short while was needed for them to generalize from the depiction of hands and feet by the contours of those limbs, to the depiction of the prints of entire animals and men by the contours of their bodies. If image making is indeed a generalization of footprints literacy, it has to be shown that the footprint has the overwhelming majority of the most important attributes possessed by drawings, even if on a less developed level than drawing. Another aspect of the same matter that must be shown is, that the reading of footprints requires skills and cognitive abilities similar to those needed for the reading and use of pictorial symbols. In other words, it has to be shown that footprints are the *proto-symbols* from which the symbols of figurative art may have developed.

Hunters invented prehistoric art, and the hunter's chief skill is not killing but tracking; this is the ability to decipher the enormous plurality of marks that make up his environment. Footprints are one of the most important kinds of marks that the hunters of all times must have been acquainted with, for as a rule it is easier to find footprints than to find the animals that leave these footprints. Very great expertise in deciphering marks is a necessary condition for the hunter's existence both in securing food for himself and his family and furthermore not to become himself food for another animal. Marks based on the senses of hearing or smell are only very effective at a short distance from their source, and they are therefore efficient mainly for creatures that are sufficiently strong to be able to attack their prey without danger to themselves, such as the large predators; or sufficiently swift to flee quickly enough when sudden danger is revealed. But for man, who has neither of these advantages, and particularly when he had as yet no weapons at all, his only advantage was perhaps the ability to decipher a special kind of marks even

at a very great distance from the animal that left them: footprints. According to the type of footprints and their characteristics, the hunter could choose whether to ignore them, to rapidly reduce the distance between himself and the animal in order to make a kill, or to distance himself from it. The main difference between footprints and the other marks or indications such as all kinds of secretions, smells, sounds, etc., is that all of these are real entities with positive existence, and in most cases are an actual part of the animal that has become detached from it. By contrast, footprints derive from the absence of soil in an amount and of a shape that fits the foot of a particular animal. The footprint then, is not material but is the *pattern* of the foot that left it. A pattern is a kind of abstract indication of the animal, but not of a kind from which it is possible to generalize with the aid of one of the senses to the identification of the animal that left it, but only by means of very complex cognitive activity of the kind required for symbolic thinking. Munn describes an instructive example of a special integration of footprints literacy, drawing, and verbal thinking among present-day hunter-gatherers, the Walbiri in Central Australia: "Among the most prominent of the graphs that Walbiri draw in the sand are track prints of animals and birds and circle or circle-line notations referring to places and journeys... Footprints are impressed in the sand by holding the hand in various special positions; their production is a casual play activity in which men, women, and children may indulge." (Munn, 1973. 119). If footprints literacy is likely to be such a basic component in the thinking of contemporary hunter-gatherers, it may be supposed that among prehistoric hunter-gatherers, footprints literacy was almost certainly an even more basic component in their thinking, for they were chiefly visual thinkers, and only to a marginal degree verbal thinkers as well.

The identification of an animal by means of its footprints entails cognitive abilities that have a great deal in common with the capacities needed by the prehistoric draughtsman, and the capacities needed by the scientist today. In the three cases, footprints literacy, prehistoric image making and modern science, the same attributes are required, but at different levels, and these attributes can be identified for the first time in footprints literacy: connectivity, differentiation, grouping, classification, abstraction, generalization, thinking in visual universals or visual class-names which in this case are visual schemes of an object derived from its contours, pattern recognition: the identification of symmetries and transformations of those symmetries, complementarity of figure and ground, induction and deduction, construction of hypotheses and their empirical testing, thinking in terms of spatial order, in time and causality, the ability to reconstruct in the imagination and thought, hypothetical processes connected with the

behavior of the animal, et cetera. All this and more is required for a hunter to deduce which animal left the footprints. It is true that a similar cognitive activity is also present when trying to deduce what animal left particular droppings. But this activity is at a far lower level, for in this case a part of the animal itself is given, and therefore there are in this case far fewer possibilities of making a mistake in obtaining a correct solution. The awareness of the cognitive mechanisms involved in footprints literacy makes obligatory a theory of a level of conceptualization and abstraction that is quite high even today, when our thinking is much more conceptual than visual. It is therefore obvious that the cognitive mechanisms involved in footprints literacy among hunters of all times, are mostly unconscious. The same is true, not only concerning the prehistoric hunters who initiated image making and whose thinking was undoubtedly much more in visual (and other) terms than in verbal terms, but also with regard to image makers of all times. Now it is easier to show that the emergence of image making probably followed from generalization and elaboration of the principles of the visual thinking that had served hunters for millions of years before in footprints literacy and tool making.

3 CONTOUR IN PICTORIAL SYMBOLS AND FOOTPRINTS

It is quite easy to show that Breuil's imitation theory does not explain the origins of figurative painting, but his empirical findings are among the foundation stones of the study of prehistoric art, and they may also help us to put our finger on the origins of art. One of his most interesting findings was that the earliest prehistoric paintings were handprints, finger meanders, and sometimes also depictions of human or animal footprints (Breuil, 1952). From this finding, he concluded that the imitation of the footprints of animals and men is one of the sources of art because this is one of the first subjects they imitated. It must be noted that there is no agreement among archaeologists with regard to the time of the beginning of image making; nor with regard to the place where it began, nor regarding the aims it fulfilled, and it is therefore not to be wondered at, that there is no agreement on whether pictures of hands are indeed the earliest motif in prehistoric image making. On the other hand, nobody disagrees that this is one of the earliest motifs in prehistoric image making, and this is supported by many findings in Europe and elsewhere. Thus for example, handprints painted on a rock shelter in Kakadu National Park in Australia are dated by some archaeologists at 40,000 B.P. (before the present). Similarly, in the recently discovered Cosquer cave, the paintings of hands are estimated at 27,000 B.P., whereas the paintings of horses found there were produced only some 9000 years later. According to Delluc and Delluc (1981, 1984) the earliest paintings are mainly those depicting animals, female and phallus signs, and these

are estimated at around 30,000 B.P. The most important characteristic of the earliest image making is that the pictures are always *incomplete*. These authors suppose that the *simplification* of the representations is a kind of quasi-symbolization, and in this connection they propose the principle of *la partie pour le tout*. That is, the representation of the animal or the figure by means of a schematic representation of only a certain part of it. This principle seems very logical, inasmuch as it cannot be supposed that the first paintings already depicted figures in their entirety. According to the logic of this principle, it is correct to argue that a footprint, whether a natural footprint or a painted or engraved one, was for the hunter a kind of representation of the entire animal. Delluc and Delluc (1985) also mention many places in which footprints and partial footprints of animals have been preserved, and also sites in which marks have been painted or scored, that have in the past been interpreted as female marks; but they believe that these marks are more like footprints belonging mainly to predators, and sometimes also footprints of men and of birds. Paintings of footprints are found in stationary places and also upon moveable objects. Sometimes they did not engrave the whole footprint but were content with an engraving in the shape of a U or V. Their very logical conclusion was that the draughtsmen who produced these marks were Palaeolithic hunters, and that they created footprints of the animals and men that they customarily tracked. They displayed these creatures by means of simplification, schematization or geometrization of these figures. It seems to me that there is no contradiction between the supposition that pictures of hands are the earliest, and the supposition that pictures of parts of animals are the earliest, both because it is impossible to deny the possibility that the two subjects were coeval, and also because in both cases the whole is represented by its part. In what follows, I shall try to show that the drawings of handprints which are quasi-prints of hands on the wall, are the first generalization of footprints literacy, and therefore the link connecting footprints literacy with the symbol system of figurative art. We shall begin the comparison between footprints and painting with regard to two very simple attributes: representation by negative image and contour of the object, before we approach the deeper and more complex attributes that exist within the two phenomena.

It is no accident that hunters noticed the contours of footprints and afterwards generalized this principle to painting. Research today has discovered the high sensitivity of the brain to contours, and in fact this is the basic strategy of the visual cortex in constructing the image from the information received from the retina. New research points to the possibility that the brain stores the visual information in memory as a two-

dimensional picture and not a three-dimensional one (Bulthoff and Edelman 1992). The construction and storing of visual information by means of contours is of course very economical, especially when the concern is with visual information that requires a large amount of memory. Handprints fall into two groups: a minority of them were indeed done by imprinting with a hand that has previously been dipped in or smeared with pigment, in this way obtaining a positive image of the hand, but in most cases the handprints were produced by spraying paint over the hand which was pressed to the wall of the cave. In this way a picture was obtained which is the negative image of the hand, just as a footprint is the negative image of the foot that produced it. The negative in the picture is two-dimensional only, whereas in the footprint the negative is a three-dimensional configuration. But this difference is marginal in comparison with the common ground shared by the two phenomena and which is, that in both cases the configuration resulting by means of the negative traces a contour of the hand or foot. Depictions of feet painted by this method are to be found at many prehistoric sites, and sometimes even whole creatures were painted in the same way. (This subject is extensively discussed in all prehistoric art books, and there is no need to discuss it here. See for instance the now classic books: Breuil, 1952; Giedion, 1962; Leroi-Gourhan, undated). A generalization of the principle of representation by means of contour, not by spraying but in a much more economical way, can be seen in most early prehistoric paintings. Since even for super-hunters it was difficult to hold a whole mammoth pressed to the wall simply in order to obtain its contour by spraying, they drew the animals by first outlining the contour and afterwards scoring it and filling the incision with pigment. The history of the contour and what happened within it is more or less the history of art, and we shall not discuss it here. We shall mention only that in later stages the hunters gradually filled the area within the contour with color, partially at first and later on completely. At later stages a retreat took place in the opposite direction - towards greater and greater schematization which led in the end to the creation of writing. For this it was essential to renounce the principle of representation of the object by its contour, for the graphic marks no longer represented objects, but the sounds of speech. The generalization from the reading of given footprints of animals and human beings, to the deliberate depiction of 'prints' of images that we have regarding real or fictitious objects by means of their contours, was an invention of vital importance in the continued evolution of human culture. For the first drawings were already the beginning of the pictorial writing from which there developed, by a long evolutionary process, the syllabographic and alphabetic writing systems without which it would not have been possible to construct the conceptual hierarchies required for the creation of philosophy and science. The invention of prehistoric art signals a singular upward leap in the history

of man, since this was the first time that human beings produced an extension of the brain or memory and not of the hand; they transformed visual thinking from a private experience into a public one, for drawing is the 'speech' and also the documentation of visual thinking. That is to say, prehistoric painting is visual thinking exorcised of its privacy in the mind (eyes) of the beholder, to become communal and communicative, i.e. to become visual language. In this way, for the first time a means was created of storing information and human experience for subsequent generations, outside the skull. Only the invention of the computer in our time is equal to the invention of prehistoric art, in being the second extension of the brain created by man; although infinitely more powerful, it is doubtful whether it would have been possible without the first. In the last two sections we have seen in what sense footprints literacy is likely to explain the *graphical origins* of image making. In the next sections we shall see that footprints literacy is likely to explain its *cognitive origins* as well. Before we can examine other aspects that footprints and painting have in common, which are far less obvious than contour, but infinitely more important, it is necessary to explain even if very briefly the new key-term: *mindprints*. (For a more comprehensive presentation of this concept see Avital, 1997b.)

4 MIND, MINDPRINTS AND THE ORIGINS OF ART

One of the reasons for the fact that to this day we do not know what are the properties that really distinguish art from other domains, is that until today the basic question has not been studied: What were the cognitive attributes that were a precondition or necessary condition for the emergence of prehistoric art? The basic assumption of this essay is that all domains of culture and among them art, are different expressions of certain fundamental properties of human intelligence, or mind. This being so, the uncovering of these properties which are a priori in relation to the possibility of the emergence of art, is likely to enable us to anchor the nature of art in the nature of mind. This essay attempts to show that footprints literacy includes not only most basic aspects of the graphical sources of prehistoric art, but also most of the cognitive attributes without which it is impossible to paint or to read a painting. The cognitive precedence of footprints literacy in relation to art is on at least two levels: on one level, footprints literacy requires highly developed thinking in *images*. If footprints literacy indeed preceded tool-making, as I presume, then the visual thinking that developed within the context of footprints literacy also served the making of stone tools. This matter is understandable if we remember that thinking in images (which are a kind of proto-

symbols) is the necessary condition for the making of stone tools, for it is impossible to make any stone tool at all unless the maker has some preconceived image of the tool it is wished to make. It is reasonable to suppose that the thinking in images that developed within the context of footprints literacy and tool-making, was a stage preceding the capacity for thinking in images, which was a necessary condition for image making. Thinking in images is a necessary condition in these three domains, but it served different purposes: in footprints literacy the images serve the identification of the animals which created the footprints; in tool-making, the images were patterns or a kind of guiding plan for the design of tools; and in prehistoric art the images served the creation of a *system* of pictorial symbols which was mainly intended to preserve information and to give expression to the creative character or the open-endedness of human intelligence by means of a visual language. However, at a second level the cognitive attributes common to footprints literacy and painting are at a much deeper stratum and they possess, not a visual but a structural character. (These attributes are common to tools as well, but I shall discuss this matter in another essay.) I have called these attributes *mindprints*, seeing that for reasons extensively discussed in the history of philosophy, and other realms, all of the knowledge that we have is necessarily only some *interpretation*, and we shall therefore never be able to know what is Reality in itself; and we shall never be able to know what is the mind in itself, but only indications at the most: shadows and its “footprints” insofar as these are manifested in a way that organizes reality and the contents of consciousness. From the outset the main aim of mindprints theory was not to provide a new basis for epistemology and ontology as did most of the theories of categories put forward throughout the history of philosophy, but rather to try to point out the most basic properties of mind that appear in all paintings, and thereby to anchor the nature of art in the nature of mind. Together with this, the fact that these properties, which will be briefly discussed in what follows, appeared throughout perhaps millions of years in footprints literacy and in tool-making, and throughout tens of thousands of years in paintings, independently of place and time, perhaps hints at the possibility that these properties are not special to art alone, but to all domains of culture and perhaps even to all aspects and levels of Being. The idea of mindprints is discussed extensively in another essay (Avital, 1997b) and I shall therefore content myself here with only a minimal explanation to be clarified in the following paragraphs in discussing the appearance of most of these attributes in footprints literacy, in prehistoric painting and to some extent in science as well. So that the reader may already obtain at this stage a synoptic view of this issue, it is desirable to study the two comparative tables which appear at the end of this essay.

At this point I wish to propose a tentative table of mindprints:

- 1 Connectivity–Disconnectivity (Codis)
- 2 Open endedness–Closed endedness
- 3 Recursiveness–Singularity
- 4 Transformation–Invariance
- 5 Hierarchy–Randomness
- 6 Symmetry–Asymmetry
- 7 Negation–Affirmation (Double Negation)
- 8 Complementarity–Mutual Exclusiveness
- 9 Comparison - (No Comparison?) Imparison
- Determinism–Indeterminism (Probability, Selection, Choice)

As already indicated, mindprints are probably the meta-structures of the complementarity of mind-reality. In other words, these special attributes are perhaps the structural bridge between mind and reality, or the structural interface of the complementarity of epistemology and ontology. I shall briefly indicate a few characteristics of mindprints so that in what follows it will be better understood in what manner these attributes are most fundamental in footprints literacy, and in art as well.

1. The most prominent characteristic of all of the mindprints is that every one of them is constituted from a pair of complementary opposites. That is, like yin–yang, every mindprint is an oxymoron comprising a pair of opposed attributes which generate a complementary unity. Thus for example, Connectivity–Disconnectivity does not indicate two attributes but rather a single attribute of a higher level having two opposing aspects one of which we call Connectivity and the other Disconnectivity. Since Western culture is much more influenced by Parmenides' law of contradiction than by Heraclitus' principle of complementary opposites, it is little wonder that in Western languages there are almost no concepts that are oxymorons like the Chinese concepts of Dao or yin–yang. Since Connectivity–Disconnectivity is a very central mindprint, I propose the term *Codis* for it, which comprises the combination of the connective prefix 'co' and the separative suffix 'dis'. It is easy to show that most of our cognitive activities such as: grouping, distinction, analysis, synthesis, classification, generalization, abstraction, symbolization and many other activities connected with organization, ordering, lawfulness and the like, are special cases of connectivity–disconnectivity. It is moreover possible that this is a central mindprint not only on the noetic level but also in the biological, the social and the material world. It is likewise worth mentioning that almost

all of the mindprints have an entropic pole of a negentropic character, but there is always a certain predominance of the negentropic pole. Thus, for example, the pole of connectivity is more dominant than the pole of separation, for otherwise a material world, life and culture would not be possible.

2. Another prominent attribute of mindprints is that some of them are primary, or not derivable from other mindprints, while with regard to others it is clear that they are comprised of other mindprints. Thus it is, for example, easy to show that hierarchy–randomness and symmetry–asymmetry are composed from other mindprints whereas open-endedness—closed-endedness or connectivity–disconnectivity are not composed from other mindprints. Nevertheless, all of the mindprints assume explicitly or implicitly negation–affirmation (double negation), and for this reason this is perhaps the most basic mindprint of all. It is worth noting that the most complex mindprint is hierarchy–randomness, which includes most of the other mindprints, and for this reason several students of mind are unjustifiably tempted to reduce mind to hierarchical or systemic patterning (Bateson, 1979; Stamps, 1980, and others). Special importance for our subject attaches to Open-endedness—Closed-endedness, which together with Connectivity–Disconnectivity (Codis), Recursiveness–Singularity and Transformation–Invariance, generates attributes such as novelty, originality, creativity, metaphor, evolution, new orders, induction, extensivity, hypothetical thinking, etc. Another aspect of mindprints is that the products of the operation of some of them may accumulate, whereas the products of the operation of others do not accumulate. Thus for instance, the recursion of connectivity is likely to generate hierarchy, and recursion of separation is liable to break all connections and thereby to generate a state of randomness. By contrast, there is no accumulation in the case of recursion of negation, affirmation, comparison or complementarity.

3. In a certain sense, there is a non-rigid hierarchy among the mindprints, and in another sense there is no hierarchy among them, since almost certainly mindprints are all different aspects of a structuring meta-principle that is far more abstract and general than all of the mindprints mentioned in the foregoing. It would appear that our conceptual system will have to develop to a considerable degree in order for us to be able to understand a principle of such a level of abstraction, and perhaps it will remain forever beyond our grasp, for in a certain sense it is another name for a totality which is in principle beyond our grasp. However, the totality is an infinite system of nested hierarchies and therefore it is reasonable to suppose that the mindprints too are, in a manner not clear to me, holons in a system of inconceivable abstraction. In sum, I am sure that any understanding of mindprints I may have is at best very partial, and I can

only hope that in the future I may understand the idea a little better. At the same time, even the limited understanding I have of this concept has helped me to understand art more than all of the theories of art that I have read over many years, and I hope that the reader too will be able to derive benefit from this concept. (Again I emphasize that the exposition of the idea here is perhaps too concise, and that the reader who wishes to obtain a deeper understanding of the idea of mindprints is therefore recommended to study another essay which deals with it more extensively—Avital, 1997b.

Here a last debt must be paid to W. Davis whose theory I have criticized harshly in another paper (Avital, under review). The strongest argument of Davis against any kind of idealist or cognitivist view regarding the origins of art is that it assumes a priori capacities for the perception and creation of images and representations. His argument is that such a standpoint is built on a tautology and leads to an infinite regression, since the Idealist has to assume language 2 in order to explain language 1, and to assume language 3 in order to explain language 2, and so on ad infinitum (Davis, 1986a, 201). In the same discussion I tried to refute the first part of his argument, concerning the tautology supposedly present in the Idealist standpoint, but the argument of regression remained unanswered. Only now, after the schematic presentation of the idea of mindprints, is it perhaps possible to counter this argument as well. The answer to this argument is already to be found in a very concentrated form in the quotation from Karl Popper which appears at the head of this essay: Before the chicken, there was *a different kind of egg*. If we assume that in order to understand language 1, language 2 is necessary, and language 3 in order to understand language 2 and so on, as in Davis's argument, then we do indeed enter an infinite regression. However, this happens because we assume that the languages 1, 2, 3 are languages with content of the same type *and of the same level*. But if we accept Popper's insight, there is no need for us to be trapped in an infinite regression, since if the egg that precedes the chicken is a *structural system* such as the system of mindprints, which is likely to explain the language of content that is below it, then we need not be caught in an infinite regression. I suggest that mindprints are basic organizational patterns of mind that precede every language of content, whether visual or conceptual. Here Davis is likely to press with the demand: "And what preceded the mindprints?" My reply is that I simply do not know. But if there was something that preceded them, it was something different from them, and of a level of abstraction that is beyond my understanding. Then he may ask: "Have we not again entered an infinite regression?" and my reply is - perhaps, and perhaps not; for, if the mindprints or something like them are the highest patterns of mind-

reality, then there is in any case no regression; but we shall never know whether beyond them there are no higher levels of structuring. However, even if there is here the possibility of a regression, at least at this stage we do not know whither to retreat beyond the mindprints. Secondly, even if we accept the possibility that there is a regression, this is not necessarily a fault. Thus, for example, in fractal drawings, a kind of infinite regression can be generated by repeatedly zooming in, each time on a tiny part of the picture created by the preceding zoom-in, and each time we shall get the *same structure* despite the probable change of scaling and color. It may be that this is the situation with regard to the case of mindprints, but I cannot be sure. The logical conclusion of this argument is that mindprints as principles of organization of the mind precede, at least logically, not only all perception and cognition but life and matter itself, and are perhaps a precondition for their coming into being. The conclusion that intelligence and its mindprints, which are the structuring function from both the ontological and the epistemological point of view, precede what they structure, seems to me far less absurd than the paradoxical argument of the Behaviourist who does not think that he thinks.

The reader may rightly argue that if mindprints are cognitive meta-structures that are necessary in one measure or another for every cognitive activity and not only for art, then they cannot serve as a criterion for the purpose of distinguishing between art and non-art. The answer to this argument is very simple: It is true that mindprints are common, in one form or another and at various levels, to all branches of culture, since according to the view presented here, it may be that the highest goal of all branches of culture is to give explicit expression, to one degree or another and at different levels of abstraction, to mindprints or to intelligence. However, the disparity between the various branches of culture is in the different types of symbols by means of which each branch of culture expresses the mindprints in a particular stratum. Thus for example, it can be shown that on the one hand in figurative art and in science all of the mindprints are present, but they are manifested by means of symbol systems having very different attributes. The fact that the one field uses aesthetic symbols and the other conceptual and formal symbols, has profound implications for the level of connectedness and generalization that each field is capable of attaining: the measure of stratification that each field is likely to offer with regard to its subjects; the types of symmetry that each field requires for the description of reality; the types of transformation that each field can offer; the level of ambiguity and communicativity of each of the two symbol systems; and so on. However, beyond all these profound differences, the fact that the two fields are in the final analysis anchored in the same fundamental attributes of the mind is for me far more important, and also gives room for hope that in the future it may

be possible to greatly reduce the alienation of the "two cultures". In a sense—and this is no mere play on words—prehistoric art is prehistoric science. As against this, as we shall see at the end of this essay, in the modern art called "Non-representational" or "Abstract Art" there is not to be found any one of the mindprints that appear in figurative art, in footprints literacy and in science, and I therefore maintain that there is certainly room for doubt as to whether it is art at all. After this schematic presentation of the idea of mindprints, we shall now try to see how these mindprints and other cognitive attributes which are their derivatives, appear in figurative art and in the stage that preceded it—footprints literacy.

5 CONNECTIVITY–DISCONNECTIVITY (CODIS), CLASSIFICATION AND ABSTRACTION IN PICTORIAL SYMBOLS AND FOOTPRINTS

"In each and every case that which unifies is mind."

Aristotle, De Anima 430b.

In order to understand how footprints functioned for prehistoric hunters in a way similar to that in which symbols of all kinds function for us, we should recall some of the main attributes of symbols. All kinds of symbols, whether visual, verbal, formal or any other, have both special attributes, and attributes that are common to all types of symbols. The most basic attribute of every symbol and every image is a seemingly paradoxical one, namely: on the one hand every symbol connects all of the entities encompassed by it, but by this very fact the symbol also isolates and separates this class of entities from all others. That is to say, the fundamental attribute of every symbol is built on a dialectic or complementarity of *connectivity–disconnectivity* which I have tentatively called *codis* (Avital, 1997a). This double-edged property is probably one of the most basic mindprints, because in one way or another some other mindprints are derived from or depend upon it, and it is also multi-leveled. It appears on the material, the biological, and the noetic levels; it is therefore at the foundation of differentiation of any kind. From this basic mindprint, arise the most prominent attributes of our intelligence: abstraction and classification. It is true that there is connectivity on the material level, and also on the biological level, but noetic connectivity is higher than these two types, because it always generates classes of much higher levels. Since noetic connectivity exists mostly through symbols, the very symbolization generates an ascent of

connectivity in relation to the level of connectivity of the things for which we create the symbols. Cultural history is therefore to a great extent the history of the connectivity generated by means of the various symbol systems. It would seem that the fundamental attribute of this evolution is the continuous rise of the level of connectivity, and more precisely of the level of codis, i.e. the simultaneous connectivity–disconnectivity that every symbol system generates. It is easy to discern this phenomenon if we observe the levels of connectivity of the following symbol systems: verbal language, totemism, mythology, philosophy and science. However, all of these symbol systems are based on an increasingly efficient recycling of conceptual connectivity to ever higher levels. Science includes conceptual connectivity and also mathematical-logical or formal connectivity, which is the highest yet to have been generated. By contrast, the connectivity of pictorial symbols does not belong to this evolutionary continuity, but to the evolution of visual thinking. This type of thought preceded verbal thinking by hundreds of millions of years, for it has existed as long as vision, and vision is a mode of thinking. Visual connectivity exists in all kinds of visual thinking such as vision, dreams, imagining, and reaches its peak in footprints literacy, tool making and image making. Despite the fundamental difference between visual connectivity and conceptual connectivity, it is very probable that the first type served as the basis for the second, and that the second served as the basis for the next leap in the level of connectivity: formal connectivity. In order that it may be easier to see the connection between pictorial symbolization and footprints literacy, it is worthwhile noting here a number of properties of symbolization in general.

The attribute of connectivity–disconnectivity or codis is also at the base of the mechanism by means of which we create symbols of all kinds: abstraction. In every abstraction there are three components that act together simultaneously: we create a grouping of certain entities; secondly, we eliminate all of the specific attributes of each of these entities, and thirdly, we preserve only the most important of the attributes that are common to all of them. That is, we preserve under a certain class-name the common denominator which is an idealization and generalization of the attributes of these entities. The relation between the symbol and the object it denotes, is the relation between a type and a token or event, and a symbol is therefore an entity of at least one order higher than all those which it encompasses. Thus for example, the word 'dog' is a verbal symbol for all dogs that have been, are, or will be in the future. This label does not only connect all these dogs, but also distinguishes them from all other things. That is to say, symbols allow us to create differential groupings of various entities and thereby to classify, organize and order our world view. The same principle of differential grouping holds for pictorial symbols. As in the case of verbal and formal symbols, so

too are pictorial symbols constructed, by exactly the same processes of abstraction by means of which we generate the other types of symbol. So, for example, a prehistoric drawing of a horse does not describe some specific horse but is a pictorial class-name for all of the horses that have the attributes described in the drawing, and distinguishes all of these horses from all other living things. As in the creation of symbols of any type, here too we ignore very many aspects of all specific horses. But we preserve certain visual aspects that are common to most horses, such as the characteristic contour of a horse seen in profile, and this configuration becomes a pictorial label or connector for all horses of the same kind. In order to read the picture, it is essential that the reader be aware of most or all of the aspects of the horse that we have eliminated in the process of making the symbol for a horse. It will now be easier to see that the attributes of connectivity–disconnectivity, classification and abstraction that are present in every figurative picture and in all other kinds of symbol, are also present in footprints literacy.

Every hunter is a tracker, and every tracker is an expert at reading all kinds of footprints. Unlike the case of verbal or pictorial texts, footprints are not written but only read. But in exactly the way that the picture of a horse is a class-name for horses, so the type of footprint of the horse's hoof is for the hunter a visual class-name for *a* horse, even though it was created by the hoof of a specific horse. More precisely, if the footprint is that of a certain kind of horse, whose attributes such as age, sex, weight, characteristic manner of walking etc. are expressed in the type of footprint, then the footprint is a visual class-name or proto-symbol for all horses that possess these attributes. The relation between the footprint and the animal that created it is the relation between the type and its individual case. In a sense, the animal is a specific case of its footprint type, as every red apple is a specific case of a picture representing a red apple. Secondly, as in the reading of every symbol, footprints cannot be read without abstraction, since the tracker must reconstruct hypothetically the way in which the footprints were created. In this process, he knows that he must ignore most of the visual aspects associated with the animal that created the footprint, and treat the print as a formal common denominator characterizing the feet of all animals that are of the same kind, and have the attributes represented by the footprint. By generalization, the type of footprint represents for the hunter the whole animal even though in actuality it represents only a very small part of its body. The footprint is therefore a means of grouping, exactly like any verbal, formal or pictorial symbol; and every grouping requires abstraction since every grouping is made selectively and by classification, in the light of preconceived criteria of attributes. For the reading of footprints the tracker must have a kind of system of images or a

'theory', either explicit or implicit, about footprints. This visual preconception must include a general concept or image of the footprint as a sign left on the ground by a creature in certain circumstances. His visual vocabulary must include images for the footprints of different creatures, among them human beings. It is also essential that he have images of the footprints of these creatures at different ages and weights, with differing health and gait, and in different conditions of terrain and weather. That is to say, the reader of footprints must have a profound understanding of causality: between the fact of the gait of X and the formation of a footprint of the specific shape and attributes. He must also be able to estimate, according to the characteristics of the footprint, the time that has elapsed since the footprint was made, for there is no point in following stale footprints. By establishing the time, he must be able to estimate the distance between the maker of the footprints and himself. It is instructive that Kant, one of the greatest philosophers of all time, considered that the orders of space, time and causality were the most basic instruments of reason, and clearly these were the basic brain tools of the hunters of all time, even before there was verbal language. The prehistoric tracker-hunter had, then, an extremely complex visual or imaginative theory of footprints as a condition of survival. This theory included a system of images of different levels of connectivity and generalization and as in every symbol system, in footprints literacy too there is stratification of the system of images from the general to the specific. It has already been noted that every symbol is a connector - whether the symbol be a word, number, equation, law of nature, figurative picture, or footprint. Each of the different kinds of symbol and sign connects in a way special to the type. The question is in what way a footprint connects between living beings whose feet have the same pattern. The answer to this question brings us to the next set of mindprints common to figurative art and to footprints: symmetry–asymmetry.

6 SYMMETRY–ASYMMETRY, TRANSFORMATION AND COMPLEMENTARITY IN PICTORIAL SYMBOLS AND FOOTPRINTS

One of the most basic attributes of symbols is the actual duality of the symbol and the symbolized. In principle, the symbol differs from the symbolized and is not dependent upon the latter for its existence, since symbols can denote entities that are not perceptual–fictitious or hypothetical entities. In most symbol systems the connection between the symbol and the symbolized is fundamentally a convention which becomes entrenched through the use of the symbols, as with all linguistic and formal symbol systems. In figurative art too, there is in principle a duality of the symbol and the

symbolized, only that here the connection between the two is not the outcome of convention and habit, but is *inherent*. This internal linkage between the figurative symbol and the object symbolized by it, springs from the fact that the symbol in this case is built on a certain symmetry between the two. It is easy to ascertain this fact by looking at some of the very earliest pictures: those of handprints. Since these were created by blowing a spray of paint over the hand, it cannot be denied that there is symmetry between the shape of the hand and the shape of the negative image produced by the spraying. The principle of symmetry between symbol and symbolized is also preserved in the more complex pictures produced not by spraying but by drawing the contour of the depicted animal. Besides figurative painting, the only area in which an inherent connection of this kind is to be found between the sign and the signified is that of footprints. Since all footprints are produced by the imprint of the foot on the ground, it cannot be denied that there is symmetry between the form of the foot and the shape of the footprint it created. It is an instructive fact that in footprints and in handprints the configuration is of the same type: symmetry that is a mirror image or reflective transformation of the shape of the object that produced the footprint or the picture. It is this transformation that produces the duality between the symbolized and the picture, or between the sign and the signified in the case of footprints. However, it also exemplifies a much more general principle: that there is no symbolization or signification without transformation of one sort or another, and this principle is already evidenced for the first time in a quite advanced manner in footprints literacy. The fact that figurative art and footprints are based on a certain symmetry between the object and the symbol or the sign that represents it, is of great importance on at least two levels: firstly, it is this fact that makes figurative art readable at all periods and in all places, even tens of thousands of years after it was produced, as with the very earliest prehistoric art. We can evaluate better the universal readability of figurative art, if we bear in mind that contemporary 'abstract art', founded precisely on the breaking and negation of this symmetry, cannot be read by anyone, including the artists who created it. This symmetry is also the factor that makes footprints readable not only to the skilled tracker who read them soon after they were made, but to us as well. This is actually so even when footprints were made millions of years ago and have been preserved only because of special conditions and circumstances, as in the case of the footprints left by hominids and animals at Laetoli in northern Tansania (Leakey, 1987). These tracks were produced some 3.5 million years ago at least, and one of these tracks is especially relevant to the topic of footprints literacy, because it seems to have been produced as the result of a certain hominid treading exactly in the footprints of another hominid with larger feet who walked before

him. The result is a double track such that there is superimposition of the smaller footprints of the second subject upon the larger footprints of the first subject. Here it should be mentioned that indeed most researchers believe that there is in fact superimposition of the small footprint upon the larger one, but there are others who do not accept this interpretation and maintain that it is only a single footprint. In my analysis I shall take as my point of departure the assumption accepted by most, that there is superimposition of two footprints here. According to research by L.M. Robbins it is impossible to walk in someone else's footprints by chance, and her conclusion is therefore that the second subject deliberately walked in the footprints of the first (Robbins, 1987). Nevertheless, the fact that the second hominid trod exactly in the footprints of the man in front of him, does not mean that he read those signs *as footprints* and therefore, even if that is very likely, it is impossible to maintain with certainty that hominids could already read footprints 3.5 million years ago. What supports the hypothesis that the second hominid could apparently read footprints is the fact that both for the purpose of identification of the marks or prints in front of him as the *same type* of visual patterns, and for him to be able to step exactly and consistently in those prints, he must have had the capacity of pattern recognition at a complex level that actually includes almost all of the cognitive attributes required for the reading of footprints: connectivity, discrimination, selection, abstraction, classification and generalization: this hominid must have had some latent understanding of symmetry–asymmetry, inclusion–exclusion, transformation–invariance, complementarity of ground and figure, hypothetical thinking, comparison, recursiveness, causality, and others. But we cannot infer from his treading in the man's footprints that he had any understanding of the reference relation between a mark and the thing it indicates, which is necessary for the reading of footprints, but unnecessary for treading in the same kind of pattern. However, if the supposition is correct, it has of course weighty implications regarding the cognitive structures of these hominids, and one of them is the startling resemblance between their mode of thinking and our mode of thinking today, despite the fact that their brain was only about half the size of ours. That is, although their thinking was mostly visual and ours is mostly verbal, we share the same mindprints. If this is true, then we should begin to think of our remote ancestors as visual sages rather than as non-verbal savages.



Figure 1: Trail of hominid footprints fossilized in volcanic ash. This 70 metre trail was found by Mary Leakey's expedition in Laetoli, Tanzania in 1978. The trail probably belongs to *Australopithecus afarensis* and dates from 3.7 to 3.0 million years ago. (Photo by John Reader, reproduced here by his kind permission.)



Figure 2. *Negative hand and dots, Pech Merle.* (Photo by Jean Vertut, reproduced here by kind permission of Yvonne Vertut.)

This matter obviously raises the question whether the primates too are capable of reading footprints. Indeed, this question has bothered me for many years, whereas I have found in the literature no direct reference to the matter at all. Mary Leakey mentions the possibility that the footprints at Laetoli were created by a process similar to that by which chimpanzees and gorillas customarily play the game called 'Follow the leader' (Leakey, 1981, 1987). On this subject she relied upon Schaller (1963), but he does not say anywhere in his book that the gorillas step each *within the footprints* of the one in front. Of course the fact that in this game they walk "in the steps of the leader's" does not mean that they pay any attention to the footprints, especially since they usually live in places where there is abundant and tall grass, so that there is little exposed soil upon which footprints can be seen. Furthermore, in this game they are so close to one another that they have no need to look for the one in front of them, and this game therefore provides no proof for footprints literacy among apes.

Nevertheless, even if someone were to prove that they customarily trod in exactly the same place as the subject in front of them, this would still not constitute evidence that they *read* the graphical pattern in the soil as *footprints* of the subject walking in front. As we have already seen, in order to read the signs on the ground as footprints, many and highly complex cognitive mechanisms are required. So far as I know, there is still no proof that primates are capable, or incapable, of reading footprints. My feeling is that chimpanzees almost certainly can read footprints, for there are experiments carried out in completely different contexts, from which it can be deduced that they indeed have at least a considerable part of the cognitive qualifications required for reading footprints. Nevertheless, anyone who attempts to examine this matter empirically will have to expect very difficult methodological problems. As a matter of fact, a few years ago I canceled at the last moment an experiment I was to have carried out at the Ramat Gan Safari Park in Israel, using two young chimpanzees, with the aim of putting to the test their capacity to read footprints. The chief reason for this cancellation was, that I found no way of proving that they were reading the marks as *footprints*. That is to say, I might have succeeded in teaching them to distinguish between their keeper's footprints, which it was intended should lead to boxes containing bananas, and my own, which were larger and would have led to empty boxes; but I could find no way of proving that they saw the prints of their keeper's feet or my own as transformations of the shape of a foot, and not as visual marks that could as well have been triangles and circles or any other two objects. Another, more amusing but diverting, problem was that the two chimpanzees

were very young and most of the time preferred to hug and kiss their motherly young keeper than to cooperate in any game.

Cognitive evolution is not the central issue of this essay, but it is important at this stage only to indicate the possibility that footprints literacy is a much earlier human achievement than we tend to think. Secondly, the symmetry between the symbol and the symbolized in figurative art, like that between the footprint and the foot, is precisely the means of connection unique to art and to footprints. Indeed, art and footprints differ in this from all other kinds of symbols. That is to say, symbolization produces grouping and classification of things, and this requires abstraction, analysis and synthesis of the aspects and attributes common to the objects grouped under the same symbol. The symbols make the connectivity between the members of the class in different ways: a verbal symbol such as 'bull' tells us nothing about the common attributes of the entities that belong to the class 'bulls'; and if we wish to know what the attributes of a bull are, we have to refer to our own knowledge and memory. By contrast, the pictorial symbol representing a bull represents explicitly the most basic visual attributes of all bulls. That is to say, what is special in the mode of connectivity of the pictorial symbol is that this connectivity is achieved by displaying a particular figurative common denominator of the class of bulls it describes. This visual common denominator is a particular symmetry or isomorphism present among all bulls connected by the symbol, but the same symmetry is also *preserved concisely in the symbol itself*! We find the same characteristic in footprints as well: there is symmetry between the shape of the feet of all bulls of a certain kind, and the same symmetry is also preserved, albeit reversed, in every footprint that one of these bulls leaves on the ground. Each footprint is therefore a means both of connection and of classification for all living creatures that possess a foot that fits or is symmetrical with a given footprint. We have seen that in footprints and in figurative art, symmetry is the connecting principle (Avital, 1996). Since this principle of connection by symmetry must have appeared in footprints literacy long before it appeared in art, it is highly probable that in art this principle is a generalization and elaboration of the same principle found in footprints literacy. The strength of the connection by symmetry, can be seen from the fact that in early hunting civilizations, and even those of them that still exist today, the connection between the animal and its footprints, or between the handprint or footprint and the person they belong to, is an iconic connection between the footprint and the *whole* animal or person, and not only his foot or hand. This connection is in fact so strong that members of these cultures tend to confuse the two: such a footprint or picture might represent the creature it belongs to, but is more often a substitute for the creature. Thus, for instance, the Mehinaku tribe which lives on the banks of the Xingu River, a tributary of the Amazon, has a tradi-

comic story about a man whose sweetheart ran away from him, and who looked for her in vain. "All he could find was her footprint, and he had sex with that." (Gregor 1985).

It has already been noted that connectivity–disconnectivity or *codis*, is one of the most basic mindprints in the hierarchy of mindprints, and it is thus already clear that symmetry–asymmetry is a certain variant of *codis*. It is therefore not surprising that connectivity in general, and connection by symmetry in particular, are among the cornerstones of human intelligence and culture. These characteristics appear not only in the reading of footprints and art, but in different forms in all symbol systems. So for example, pictures and footprints connect bulls in a similar way to that in which the equations of Newton connect the stars: in both cases the connection is made by symmetries, except that in the first case the symmetry is figurative, and in the second case it is formal and relational. In a paper the starting point of which is symmetry in biology, Gregory Bateson maintains that symmetry is the connecting pattern, and he explains: "The *pattern which connects* is a meta-pattern. It is a pattern of patterns. It is that meta-pattern which defines the vast generalization that indeed *it is pattern which connects*." (Bateson, 1978. His emphases.) This fine insight of Bateson's helps us to a more profound understanding of art and footprints: figurative painting is a system of pictorial or visual universals. However, since every such symbol and each of its sub-symbols is built upon a particular symmetry in relation to the part of the body it depicts, painting is thus a *hierarchy of symmetries*. A painting is therefore a system of connecting patterns, and the whole picture is a meta-pattern connecting all of these patterns and all of the objects it describes. Because of this attribute, footprints and pictures do not belong to the same level of being as all objects, but they are a priori at least one level higher than the world of objects. Footprints and pictures, like words, concepts, numbers, equations, models and theories, belong to the world of ideas or patterns and not to the world of objects; they are of the kind of mindstuff that makes possible the complementarity of mind and reality. Complementarity is another fundamental attribute of footprints and figurative pictures.

Footprints are marked by the contours of the lack of soil, following the inclusion relationships between foot and Mother Earth. Like every inclusion relationship, the relationship between the foot and the footprint is one of yin and yang; it is a relationship of *complementarity*. This relationship is also present in the graphic structure of the footprint as mark. Thus it is impossible to read a footprint without the background upon which it exists, for the footprint is a gestalt or complementary unity of figure-ground.

However, this gestalt is constructed from a complementarity of symmetry and asymmetry together. For on the one hand, the pattern of the footprint is symmetrical to the foot; but on the other hand, the ground which surrounds the footprint and which is an inseparable part of it, is asymmetrical to the foot. The fact that we are much more aware of the pattern of the footprint from its outer boundaries inward, does not mean that the space surrounding the pattern of the footprint from its outer boundaries and outward is irrelevant or less important to the reading of the footprint. In a way, footprints literacy requires that the tracker-hunter should be able to think in paradoxical terms: he must be capable of identifying the unity of a thing and its opposite; or the complementarity of *symmetry-asymmetry*, and not only symmetry. In a sense the symmetry between the pattern of the foot and the reversed pattern of the footprint is derived from the complementarity of the two patterns. That is to say, the pattern that connects is a symmetry that includes both the symmetry and its complementarity, asymmetry. We observed this paradoxical attribute in codis, which is built upon the complementarity of connectivity-disconnectivity. We also find the same complementarity of figure-ground explicitly, in prehistoric paintings of handprints and footprints in which the contours of those parts were generated by spraying. In a less explicit form we can observe this complementarity in the generalization of this principle to pictures based upon contour, whether emphasized as in early paintings, or deliberately blurred as in later paintings. That is to say, no figurative picture is possible without the integration of the principle of complementarity into its structure. It is possible that the complementarity-mutual exclusiveness that is revealed in both the reading of footprints and in art is indeed one of the cornerstones of human intelligence and perhaps even of Being at all levels. Tens of thousands of years after the emergence of painting and in a completely different context, Lao Tzu in China, and Heraclitus in Greece assumed complementarity as a cornerstone of their philosophies, and in our century Niels Bohr did the same in physics. When he argued that light is a wave phenomenon and a particle phenomenon at one and the same time, he was thinking in the terms of a real hunter; except that he was a hunter-tracker of 'little thoughts' rather than of little animals. In a sense, footprints literacy and general systems theory are two ends of the same issue; the first deals with the symmetry between graphic patterns and various animals, and the second, which is a meta-theory, deals with the symmetry between the various symmetries upon which are based the main areas of knowledge created by man. Totemism, art, mythology, philosophy and science are only intermediate links between these two poles, and all of them assume symmetries of one sort or another as the foundation for the connections and distinctions that they create.

7 HYPOTHETICAL THINKING AND COMPARISON IN FOOTPRINTS LITERACY AND PICTORIAL SYMBOLS

In a sense, footprints literacy is a mode of visual knowledge in which there is reading but not writing; art is a type of visual knowledge that records visual thinking; philosophy is a type of conceptual knowledge that sometimes requires and sometimes rejects visual knowledge, and science is a type of knowledge that integrates visual, conceptual and formal thinking. However, all modes of knowledge and even the simplest perception, are theory-dependent, and therefore all modes of knowledge are also hypothesis-dependent (Popper, 1982, Gregory, 1980). This stems from the fact that every theory, whether explicit or implicit, is a system of connections regarding certain entities, and a hypothesis is the mechanism by means of which we try tentatively to extend the system of connections of the theory, from the known to the unfamiliar and unknown. From the very fact that the theory is a system of connections, it follows that the theory also dictates the types of hypotheses that can be derived from it. Hypothetical thinking is, then, the expression of the inductive dimension, the metaphorical-creative drive of human intelligence which is a derivative of the Open-endedness–Closed-endedness mindprint. In other words, hypothetical thinking is an expression of open–endedness, which is a more basic and general attribute that is revealed in matter, in life and in intelligence. Hence the poetic flavor of every creative process: whether it be artistic, philosophic, scientific, technological or any other. We shall now see that hypothetical thinking already existed on a quite high level in footprints literacy, many years before art, philosophy and science were created.

The reading of footprints is impossible without highly developed hypothetical thinking, since in that situation the animal that produced the footprints is not present, and the hunter-tracker has only a graphic indication of its existence. As a rule, hypothetical thinking is required only in those cases in which there is more than one possible cause or explanation for a certain phenomenon, and in the case of the reading of footprints many possible 'causes', or feet of living creatures, could be the origin of the footprints. Hypothetical thinking is a very complex kind of thinking, involving several cognitive activities, among them the capacity of making a *comparison* between a given sign that the tracker sees on the ground and preconceived images that he sees in his mind's eye. In fact there is no difference in principle between the reading of footprints and any scientific observation. In both cases we assume tentatively that a given empirical phenomenon is a special case of a much wider system of connections formulated in a

system of images or symbols. The difference between the two cases is mainly in the level of connectivity and generality of the theories to which the empirical phenomenon is compared either in footprints literacy or in science. The process of comparison between a perceptual datum and images, like the comparison between an object and a class-name, is one of the basic characteristics of consciousness and a precondition for all kinds of knowledge and all thinking processes, and therefore Comparison–Imparison seems to be a mindprint. To what extent comparison is a basic matter in thinking processes, can be seen in hypothetical thinking particularly, which is impossible without comparison and is therefore eventually a derivative of it. From this point of view there is no difference between visual thinking and conceptual or formal thinking. In all of these cases, the hypothesis is the process in which a comparison is made between two entities, images, concepts etc., that are of two levels of order and produced at different times. Hypothetical thinking therefore always has a temporal aspect which is perhaps mainly the comparison of states of consciousness or knowledge at different times: usually, the past and the present. Occasionally this comparison also has implications for the future, and the hypothesis then has predictive value. In that case there are at least three possibilities. Either a certain entity is given and the symbol or class-name is looked for, of which the entity is a special case; as for example when an unknown animal is discovered and it has to be characterized as to the genus and species to which it belongs. Or on the contrary, when a new symbol or class-name is created on one level of generality or another, and the particulars are searched for that are special cases of that class; as for example when for theoretical reasons the conclusion is reached that there must be a particle x , and only then is an active search initiated for a particle that has the attributes defined in advance. The third possibility is a special variant of the first, and is the case when a certain symbol is given and the super-symbol is looked for of which it is a sub-symbol. Footprints literacy is precisely an example of this. That is, a given footprint constitutes a sub-symbol that indicates the foot of a certain animal, and the tracker's problem is to search his imagination for a particular image of an animal, such that the footprint is a sub-symbol of it. In the three cases we make a comparison of the entities from the two levels with regard to the measure of symmetry and asymmetry in their attributes. Comparison is always followed by affirmation or denial regarding the identity or level of variance between the compared entities and comparison is therefore always intertwined with another mindprint : negation–affirmation. Eventually comparison is an attempt at the *tentative connection* of the two or more entities which are not from the same level. Failure to find a concordance between the entities from the two levels is liable to shake the theory, or lead to the creation of a theory that proposes a new and more coherent system of connections.

The footprint temporarily preserves the pattern of the complement that produced it, and the footprint is thereby a way of coding or mapping the foot that produced it. The hunter-tracker is a gifted expert in solving jigsaw-puzzles; he knows how to decode the mark imprinted in the soil, by means of an educated guess at the foot whose shape is complementary to the pattern of the footprint he is reading. In this process the tracker is searching his brain for the pattern of the foot which is the opposite, or mirror image, of the pattern he sees on the ground. Moreover, for the purpose of connecting the given footprint and a foot of the specific kind that fits it, the tracker must compare the given footprint with the store of images of other footprints that he has in his memory, and he must also compare the shape of this footprint with the store of images of feet that he has in his memory. By a very subtle process of elimination he must select from this enormous plurality the type of foot that according to his best judgment is the most symmetrical or closest fit to the shape of the footprint. This choice is always accompanied by some level of uncertainty, and it constitutes only a hypothesis until data from reality confirm or disprove it. His hypothesis becomes a certain fact only if the tracks lead him to the animal that he expected or predicted would be the cause of the creation of the footprints. In the hunter's world, much more than in the academic world, the survival of the hunter-tracker is totally dependent upon the degree of precision of his hypotheses. Hypothetical thinking thus serves knowledge or survival, which are in a profound sense one and the same. We shall now see how hypothetical thinking is also at the foundation of figurative art.

Like the reading of footprints, the reading of a picture requires a complex hierarchy of hypotheses that classifies it according to many and varied classes and categories. The most important hypotheses of the observer regarding a picture are those by means of which he identifies the phenomenon before him *as a picture*, and the significance of that specific picture. That is, the observer's main hypotheses relate to the validity and relevance of the manner of *reading or decoding* of the pictorial symbol system in the picture. As the correct reading of the footprint is the most important aspect and the only point of treating the footprint as a sign, so the existence in principle of the possibility of a correct reading of the symbols in a picture is the main point of figurative art. In the case of footprints there is no possibility of the creator of the footprints making a mistake in the 'writing' of the footprint signs, and only the reader of the footprints could make a mistaken reading. However, for a correct reading of a picture to be possible, it is essential that the artist make no important mistake in drawing the signs of the picture. We recall that prehistoric art is the record of visual thinking, and that pictorial

representation is the only means of turning it from a private experience into a public language. It seems that the main aim and the highest test of prehistoric art was *communication* between the creator of the visual message and the readers of that message. As in other cases of communication, here too one of the essential conditions for its occurrence is that the creator of the symbols and their reader have common expectations and hypotheses as to the correct way of reading or decoding the pictorial symbols. Unlike the case of footprints, the symbols of art are not a phenomenon produced automatically by some creature, but the *achievement* of the constructor of the symbols, involving abstraction and generalization in relation to the symbolized entities. When man first drew a bison, he created the symmetry between the contour of the animal and the animal itself. For this purpose he chose a certain aspect of the animal in relation to which he created a symmetrical pattern. The basic hypothesis of the creator of the symbol is that others too would be able to recognize the symmetry he had discovered, chosen, created or evoked. The expression preferred here by the reader depends of course upon his epistemological standpoint. Again, as in reading the footprints of a bison, in reading a figurative painting depicting a bison, the reader has to compare the symbols he sees with images that he has of animals in general, and of bisons in particular, in order to read the picture as the depiction of a bison. This subtle process of elimination is only likely to lead finally to the correct reading if the reader and the artist have common hypotheses concerning pictorial representation in general, and the pictorial representation of bisons in particular. The fact that for tens of thousands of years human beings represented things in a similar way, and the fact that we have no difficulty in reading figurative pictures from all periods and places, at least on an elementary level, is the firmest evidence that visual connectivity is indeed fundamentally universal. Therefore our hypotheses regarding the interpretation or correct reading of its products are also similar. We saw that one of the most important aspects of footprints literacy is hypothetical thinking, and this factor is present in the construction and reading of figurative symbols. But in figurative art much more complex hypothetical thinking is required than in the reading of footprints. This matter brings us to a short discussion of the differences between footprints and pictures.

8 THE DIFFERENCE: HIERARCHY AND OPEN-ENDEDNESS

In supporting as far as possible the argument that footprints literacy is the most probable generative source of art, so far only those aspects and attributes have been highlighted that are similar or identical in the two domains. However, now that this matter has been sufficiently established, the most important differences should be pointed out between

these two types of literacy, which constitute two stages in the evolution of human culture. As we shall see, the main attributes that distinguish these two types of literacy, are to a large extent the attributes which distinguish a proto-symbolic phenomenon from a true *symbol system*. This difference is evidenced in two very basic attributes that are strongly connected: the one is the very great gap between the levels of connectivity of these two stages, the clearest indication of which is the extent of *stratification* of the class of signs or symbols in each of the two domains. The other attribute is the measure of *open-endedness* of each of these two classes of signs. We shall briefly detail these differences. As already mentioned, the complementarity of connectivity–disconnectivity or briefly codis, is one of the most basic attributes of being and becoming and also of noetic reality at all levels. Codis has an evolutionary dimension but there are two opposed but complementary trends within it: one has a negentropic or synthetic character, while the other has an entropic or analytic character. On the one hand connectivity develops by means of the recycling in time of previous connections to new and ever higher levels of connectivity. That is to say, throughout evolution connectivity is in a certain sense recursive or turned upon itself. The result of this process is that reality in all its manifestations has many strata or deep nesting, which generates a *hierarchical structure*. On the other hand, a simultaneous and opposite process of *recursive* disconnectivity is present, which at a certain limit generates random or chaotic states of affairs. Hierarchic order and random order are then two complementary orders. They are the two poles of the same process, and they arise from the special dynamic of the evolution of codis. The dynamic dimension of this evolution arises from two mindprints, which are also oxymorons: recursiveness–singularity; and open-endedness–closed-endedness, in both of which the tendencies of connectivity and openness are stronger than the tendencies of separation and stagnation. And indeed, already in prehistoric art, as in the physical, biological and noetic world, we find the dialectic of hierarchy and randomness, or a dialectic of order and disorder.

Every figurative picture is a hierarchical system of symbols that are systemic entities or pictorial holons, but at the same time there are present in such a picture very many elements that are arbitrary, and others that are completely random. However, the connective aspect of the picture is far more dominant than the separative, otherwise it would have no symbolic function whatsoever. Every symbol in such a picture is at the same time a pictorial holon or organization sub-symbols of lower levels of order, and in most cases is itself also a sub-symbol of another symbol from a higher level. The systemic structure of figurative symbols is what makes possible the construction of high

level symbols by the synthesis, recurrence or nesting of different symbols. By means of the combination of symbols of different levels it is possible to construct pictorial texts, and thereby to broaden and heighten the system of connections we wish to describe. The limits of combinations of figurative symbols are determined only by the limits of our imagination and visualization. Because of the inter-relatedness of figurative symbols, their meaning is conditioned by the nature of their connection with other symbols. That is, as with verbal symbols, the meaning of pictorial symbols too is a systemic meaning. Thus for example, a picture of a bull contains sub-symbols for head, legs, tail, etc. The sub-symbol for an eye contains a sub-symbol for the pupil and so on, in accordance with the degree of detail in the picture. In other words, a figurative painting may comprise a very deep nesting of pictorial symbols of various levels of complexity. It is also possible to draw a man throwing a spear at a bull, and we then have a pictorial text which describes a hunting scene. On the other hand, we can also draw a symbol comprised of the synthesis of the symbol for a man holding a spear who has from his waist downward the body of a bull, and we then have a metaphorical use of the former symbols. We may summarize, then: a picture can be 'written' and also read, and pictorial systems can be constructed on different levels of complexity and stratification. We also recall that the artist constructs the symbols by choosing or creating the symmetry by which he depicts the animal. Moreover, by means of these symbols pictorial metaphors can also be constructed and this is the creative, developmental and open-ended foundation of art. In what follows, we shall see that these attributes are almost entirely absent in footprints literacy.

As opposed to pictorial symbols, footprints are not invented and not written; they can only be read as signs when they are created as a by-product of animal and human walking. Footprints are to a great extent of an intermediary nature: they possess certain characteristics of objects, and some characteristics of visual signs, but only at an elementary level. On the one hand, each footprint as a sign is totally independent of other footprints, and cannot be combined with other footprints. The class of all footprints, therefore, like all object-classes, is a class of discrete signs and not a system of symbols. On the other hand, for the hunter-tracker footprints serve as pictorial representations of the feet of animals, and indirectly as a representation of the whole animal as well. However, this mode of representation has two great shortcomings.

The first great shortcoming of footprints as signs is the impossibility of forming any combination. In those cases in which there are more than one type of footprint in the same place, the proximity of one type of footprint to another type does not itself generate a new sign that contains or unifies the significance of the two, and they always

remain discrete signs rather than *nested* signs. That is to say that like traffic signs, different footprints cannot be combined in order to create a new sign or statement on a higher level that includes the different footprints. It is thus not possible to create a hierarchy of signs by the combination of signs of this sort. At the most, it is a very shallow unstratified system like a polymer chain; this is a class of signs all of whose members are of the same level of order, although each sign has minimal stratification. Thus for example, the footprint of a deer includes two similar sub-signs, and the footprint of a tiger includes five sub-signs four of which are very similar; but it is not possible to combine the footprint of a deer with the footprint of a tiger in order to generate a new sign. In footprints literacy there is no recursiveness of old connections to higher levels of connectivity, and thus no accumulation of knowledge likely to generate meta-concepts. There is no meaning to a synthesis or a dividing up of footprints, and therefore there can also be no syntax or connective principle between footprints. Hence there is no stratification of all possible footprints, and no hierarchy of footprints as signs.

The second great shortcoming of footprints as signs is that no metaphorization of them is possible: the use of a particular footprint cannot be extended in order to indicate something else. The footprint of a deer of a particular kind indicates deer of that kind alone, in all places and at all times so long as deer of that kind exist. The vocabulary of footprints literacy is of course limited only to animals that leave footprints, so that we have only footprints of animals that walk on the surface of the earth. We have no footprints of fish, nor of most birds, and there are certainly no footprints of fictitious or hypothetical creatures. Every type of footprint is *closed-ended*, and therefore no creativity is possible in footprints literacy, and as a type of knowledge it is almost completely lacking in any degree of open-endedness. It is thus clear why for so many ages knowledge in this domain was completely static and lacking any possibility of development. Moreover, with the passing of time the domain dwindled, since many kinds of animal became extinct, and the existential need for footprints literacy decreased. Since human intelligence is open-ended, the way to overcome the shortcomings of footprints literacy was only through the radical transformation of footprints into *pictures* of hands and feet! Prehistoric art is the superior metaphorization of footprints literacy. Image making solved completely the shortcomings of footprints literacy, and the way was thereby opened to the continued evolution of culture. Art had its shortcomings too, and these were solved by writing. For that is the rule: in all types of evolution, later stages tend to be more sophisticated than those stages from which they

developed, since they represent solutions to at least some of the shortcomings of the preceding stages. Here lies the profound connection between knowledge and survival.

9 SHADOW, REFLECTION, AND THE ORIGINS OF ART

Throughout the whole discussion thus far, it has been maintained that footprints literacy is the most probable origin of art, because, among other reasons, we see here the beginning of very sophisticated thinking processes utilizing figurative symmetries between sign and signified. On the face of it, it could be argued that there are other origins of thinking by graphical symmetries and that they are perhaps the origin of art—such as *shadow*, and *reflection* in water, which also exhibit visual symmetries of figures and objects. It is indeed highly probable that these two phenomena, which we shall discuss only very briefly here, made a very important contribution to the development of thinking by visual symmetries. Nevertheless it would appear probable that their contribution to the realization of art is secondary in the case of the shadow, and marginal in the case of the reflection.

Firstly, shadow and reflection are inseparable from the figure or object that generated them, and there is thus no clear duality here between sign and signified, and in most early cultures the shadow, for example, is perceived as a totally integral part of the body or being of its owner. In certain cultures this matter is so clear that a threat to one's shadow is considered a threat to the person himself, and is sufficient cause for battle. Because of the unique linkage between shadow or reflection and a specific person or object, these two phenomena are unlikely to have been the origin of the most important attribute of all symbolization and also of symbols in art. This is, that the symbols are class-names for classes of unlimited extent, and not the representations of specific entities. This problem does not hold in the case of footprints, of course. Secondly, if the origin of art had been reflection, it is unlikely that the earliest pictures would have depicted mostly hands and feet—mostly as negative images—and parts of animals in contour. If the shadow had been the main origin of art, it is likely that the first pictures would have represented silhouettes of the whole body and not only silhouettes of the hand or parts of animals; for there was full cognizance of the appearance of the shadow of a whole person and animals, both in sunlight and in firelight. We know that the mastery of fire has existed for some seven hundred and fifty thousand years at least, so that for hundreds of thousands of years human beings saw 'shadow shows' every evening by the light of the fires outside their rock shelters and caves. It is true that there are pictures of hands made by imprinting so that the hand is seen as a positive image like a

shadow, but these are a minority compared with the majority of pictures of hands and feet depicted, like footprints, as negative images. Secondly, if the shadow had been the origin of art, the image makers would not have been content with drawing the contour of the figures, and it is unlikely that they were economizing in black color, which they had in abundance from their fires. True, at much later stages of prehistoric art, images resembling shadows are found, and images lengthened like shadows, as may be seen in Bushman paintings, for example; but this phenomenon is very recent compared with the first pictures, which were based upon negative and contour. Thirdly, as we have seen, one of the most important attributes of figurative symbols is their hypothetical aspect. In the case of the reflection, this aspect is minimal since a reflection is perceived either as linked to an entirely specific entity, or as an independently existing entity. In the two cases, not much hypothetical thinking is required, since there was no duality here between a sign and a signified object or being. By and large, this argument holds in the case of the shadow as well, although in this case more hypothetical thinking is required, since the shadow supplies far fewer details of the object to which it is connected than does the reflection of the same object. Despite these reservations regarding the supposition that reflection and shadow are the direct origins of art, it is very likely that these phenomena had a very important influence upon the development of thinking by visual symmetries. That is to say, the visual thinking that was entailed in reading shadows and reflections included several cognitive mechanisms that were displayed in a far more sophisticated manner in footprints literacy and in image making. Perhaps it was here that human beings learned for the first time the possibility that an object is liable to have two different modes, one of which is concrete in the full meaning of the word, and the second somehow elusive. It is likely that they recognized the great similarity between the two modes of the object and learned to connect them. Again, in this duality there is a certain measure of preparation for the generation of abstraction entailed in the duality between sign and signified. It is possible that the skill of millions of years in identifying shadows and reflections served as a preparatory stage for thinking in symmetry in the context of footprints, which is infinitely more sophisticated; and it is therefore very probable that this skill made an indirect contribution to the emergence of image making.

10 SUMMARY AND IMPLICATIONS FOR PRESENT AND FUTURE ART

"In my end is my beginning."

Mary, Queen of Scots

We have seen that apart from hierarchy and open-endedness, which are present in footprints literacy to only a minimal degree, all of the other important attributes of art are present to a considerable extent in footprints literacy as well. (See two Summary Tables at the end of this essay.) These common mindprints and their derivative attributes are: connectivity–disconnectivity, classification, grouping, differentiation, abstraction, generalization, reference or symbolization, thinking in visual universals, thinking in symmetry–asymmetry, hierarchies of symmetries and transformations of symmetries, idealization or schematization, complementarity, induction and deduction, hypothetical thinking, comparison, and many more attributes that have not been discussed in this essay. Thinking in terms of spatial order and causality are present in the two domains, but in footprints literacy it is much more developed than in art. Thinking in terms of temporal order, which is very fundamental to footprints literacy, is quite absent in figurative art. Thousands of years after the emergence of image making, thinking in terms of spatial and temporal order, and causality, became the basis of science, and with them all the attributes mentioned above. All of these attributes were present in footprints literacy long before the appearance of figurative art, and it is thus very likely that the generalization and elaboration of the attributes and skills already present in footprints literacy, were the origin of art. In other words, footprints literacy and prehistoric art are two modes of visual knowledge on two different levels, but one served as the basis for the emergence of the other. It is therefore highly probable that footprints literacy is the origin of art, not only from a graphical point of view, as we have seen, but also from the cognitive point of view. Similarly, it is easy to see that basically the same attributes are present in scientific thinking too, albeit at a higher level than in footprints literacy and figurative art. In a non-trivial sense the early tracker-hunter was also the early scientist, and the modern scientist is a tracker-hunter of a new kind. Indeed the modern scientist has qualities in common with those of the early hunter, but with very important additions. In addition to visual thinking, the modern scientist has also two new modes of thinking: highly developed conceptual thinking and formal-relational thinking, which his predecessor did not possess. In the two new modes of thinking, we find the same attributes that we found in visual thinking, except that here they appear at a much higher level. These two new levels of thinking are free of the main

shortcomings of visual thinking, which by its nature is confined to the world of appearances and to subjects that can be visualized. However, these two new levels of connectivity are built on the foundation of the visual connectivity that preceded them by millions of years. In other words, the visual knowledge that was first evidenced in footprints literacy and later in art, was also the cognitive basis upon which all of the other symbol systems were constructed, though they served other, more sophisticated, modes of knowledge.

To sum up

- Footprints, then, function in a similar way to pictorial symbols, and a track is a pictorial text. This is usually a quite monotonous text, but occasionally it tells the story of life and death. The hunters transferred that story with dedication, delicately and with endless care, from the animal track prints to the walls in the darkest depths of the caves, so that it would not be erased by the rain and the wind. In their vision they implicitly understood that the prints of things have a different existence from that of the things themselves: that symbols are the connecting link between matter and mind; that symbols bring things into being, and that things persist for only as long as the symbols exist. They understood that symbols, like the gods, exist in a time that is slower than the time in which things exist, and thus always survive them. In the process of the generation of footprints, life touched matter and created the first proto-symbols, or the first link connecting matter, life and intelligence. These footprints seem to be the first stage of art. Moreover, all our forms of literacy are ultimately a transformation on one level or another of footprints literacy, which was almost certainly the first type of literacy that human beings ever developed.

The reader may have noticed that throughout this essay only figurative art has been dealt with and not 'abstract' or 'nonrepresentational' art. This avoidance was of course deliberate and requires an explanation, however short and unsatisfying. It is not very difficult to see that *not one* of the long list of mindprints and their derivative attributes indicated here as being common to footprints literacy, figurative art and modern science, is present in what is called 'abstract art' (Avital, 1996, 1997a). This fact, strange in itself, should arouse many doubts about modern art. The long list of mindprints and their derivative attributes which have been discussed in the previous sections, is in fact a sketch of the demarcation lines between art and non-art; for these attributes appear only in figurative art and footprints literacy, but not in the art called 'non-representational art', of which abstract art is only a part. That is, if something does not look like a duck, does

not swim or fly like a duck, does not quack or waddle like a duck, perhaps it is not a duck. Indeed, in order to prove conclusively that not one of the mindprints and their derivative attributes appears in abstract art, an essay of much wider scope is required. In the meantime, it is suggested that the reader study the two summary tables at the end of this essay.

To put it bluntly, my main argument is, that what is called 'abstract art' is not art at all, and not a new kind of art, but the debris of the old art. In fact it can be shown that the only attribute common to figurative art and 'abstract art' is the fact that 'abstract art' is a perceptual phenomenon too. But the fact that something is perceptual is hardly a sufficient condition for it to qualify as art. It does not follow from all this that figurative art is the only possible art, or that figurative art has to be returned to, something that is anyway impossible. But 'abstract art' is a necessary intermediate stage; a stage of breaking the structures of the old paradigm of art, so that we may build a totally new type of artistic paradigm. As briefly as possible, I shall only point out that the figurative paradigm was content oriented and static, whereas the new paradigm will be structural or systemic, and dynamic (Avital, in press). The first depicted explicitly the contents of consciousness, and contained implicitly the structures of mind. By contrast, in the new paradigm a radical reversal will take place: it will depict explicitly and dynamically the ordering structures of the mind, or mindprints, and the contents will become implicit. In the new art there will again be the same basic attributes or mindprints that we saw in footprints literacy and in figurative art, but at a much higher level (The full exposition of the new paradigm, which I have called Artonomy, and its applications to painting, sculpture, music and movement, will be presented in a book largely completed, and entitled: *Artonomy: The Dark Side of Realism*). In fact, in this new art the differences between art and science are largely dissolved because, in a profound sense, the subject of both is one and the same: the explicit expression or manifestation of the mindprints. I am obliged to content myself with this vague generalization, since any explanation of it would go far beyond the bounds of this essay.

Table 1 - Comparative Table of Mindprints and Derived Attributes in
Footprints Literacy, Figurative Art, Science and Abstract Art.

Mindprints and Derived Attributes	Footprints Literacy	Figurative Art	Science	Abstract Art
Connectivity - Disconnectivity CODIS	Footprints as graphical connectors	Connectivity Present at higher level: pictorial connectivity	Connectivity Present at the highest level: conceptual and formal connectivity	Connectivity: Material and perceptual <i>only</i> .
Classification: Differential Grouping	<i>Classification of certain animals</i>	<i>Classifies all visual entities</i>	<i>Classifies all kinds of entities</i>	<i>No classification</i>
Abstraction	<i>Present</i>	<i>Present at higher level</i>	<i>Present at the highest level</i>	<i>None</i>
Generalization	<i>Present</i>	<i>Present at higher level</i>	<i>Present at the highest level</i>	<i>None</i>
Symbols	<i>Footprints are Proto-symbols</i>	<i>Figurative symbol system</i>	<i>Conceptual and formal symbol systems</i>	<i>NO symbols. Mostly perceptual phenomena.</i>
Universals	<i>footprints as Visual universals</i>	<i>Pictorial symbols are visual universals</i>	<i>Conceptual and formal universals</i>	<i>None</i>
Symbolization: Reference relation	<i>Sign/signified</i>	<i>Pictorial symbol system</i>	<i>Conceptual and formal symbol systems</i>	<i>None</i>
Preconceived theory or image	<i>Preconceived images of footprints</i>	<i>Preconceived images of many kinds</i>	<i>Preconceived theory and images</i>	<i>Usually none; also not essential</i>
Hypothetical thinking: tentative extension of connections	<i>Footprints Lit.. impossible without Hypothetical thinking</i>	<i>Present at higher level</i>	<i>Present at the highest level</i>	<i>Minimal</i>
SYMMETRY - ASYMMETRY	Footprints are figurative symmetries	Hierarchy of figurative symmetries	Formal and conceptual symmetries	Total symmetry or Total asymmetry. Geometrical sym.
Symmetry as connecting principle: common denominator of class represented	<i>Connects only certain classes of animals</i>	<i>Painting: System of connecting patterns</i>	<i>Connects real and hypothetical entities at all levels</i>	<i>Aesthetic phenomena: No meta-patterns</i>
TRANSFORMATION — INVARIANCE	Reflective transformation of foot and footprint	Reflection transformation and others	Various kinds of transformations	None, hence there is no symbolization
COMPLEMENTARITY—MUTUAL EXCLUSIVENESS	Complementarity of figure and ground	Complementarity of figure and ground	Conceptual and formal complementarity	Not essential
COMPARISON - (no-comparison?) IMPARISON	Comparison of footprints and images	Comparison of objects, Images & pictorial symbols	Comparison of phenomena and theory	Seldom

Table 2.- Attributes Differentiating Footprints Literacy from Figurative Art, Science and Abstract Art

Mindprints and Derived Attributes	Footprints literacy	Figurative Art	Science	Abstract Art
HIERARCHY - RANDOMNESS: Stratification	Limited, discrete set of signs. No combinations. Poor stratification	Elaborate pictorial hierarchy	Highly developed hierarchy	None or very meager hierarchy
Dialectics of hierarchy and randomness, order-disorder	<i>Low levels of hierarchy and randomness</i>	<i>Fairly high levels of hierarchy and randomness</i>	<i>Very high levels of hierarchy and randomness</i>	<i>No necessary recursiveness of connections - distinctions</i>
RECURSIVENESS - SINGULARITY. Recycling of connections and distinctions	Minimal recursiveness of connections and distinctions	High recursiveness or nesting of connections and distinctions	Very rich recursiveness, or very deep nesting of connections and distinctions	Very shallow nesting. recursiveness not necessary, mostly: 'One-offs'
OPEN-ENDEDNESS - CLOSED-ENDEDNESS - (CE)	Every sign is closed-ended	Symbol - style open-endedness (OE)	Open-endedness on theoretical level.	No dialectics of OE-CE
Creativity and Metaphorization	<i>No creativity or metaphorization</i>	<i>Creativity and metaphorization</i>	<i>Creativity and metaphorization</i>	<i>Creativity present but no metaphorization</i>
DETERMINISM- INDETERMINISM and Choice	Totally deterministic	Determinism, choice and arbitrariness	Determinism, choice and arbitrariness	Mostly arbitrariness
Causality, Spatial and Temporal Orders	All necessary	Only Causality and spatial order.	All necessary	None are necessary
Syntax, connecting principles between signs or symbols	Elementary connecting principles between signs	Elaborate pictorial syntax	Elaborate formal, conceptual and visual connecting principles	Idiosyncratic, or arbitrary connecting guidelines
Semantics	Discrete meaning of signs or marks	Systemic meaning; mutual dependence of symbols	Systemic meaning; mutual dependence of symbols	No inter-subjective semantics, no interdependence of esthetic entities
Readability	Read only	Read-write	Read-write	No read, no write
Knowledge	Static/fossilized knowledge	Accumulative - non-developing knowledge	Accumulative and developing knowledge	No knowledge, private experiences
Number of symbols/signs	Finite	Unlimited	Unlimited	No symbols and no signs

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