

SYMMETRY: ART AND SCIENCE

**SYMMETRY:
THE CONNECTIVITY PRINCIPLE OF ART***

Tsion Avital

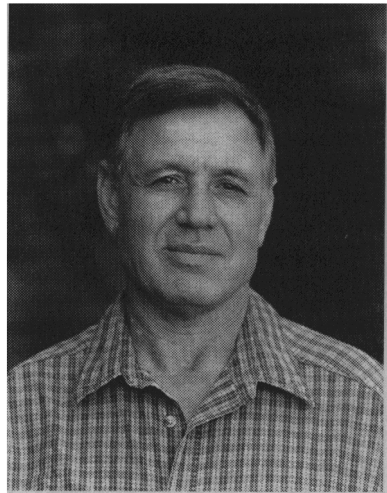
Artist, philosopher (b. Sefrou, Morocco, 1940).

Address: Center for Technological Education, affiliated with the Tel-Aviv University, 52 Golomb Street, Holon campus 58102, Israel; E-mail: avital@barley.cteh.ac.il .

Fields of interest: Art, Philosophy, Aesthetics, Paleoanthropology, Cosmology, Carpentry, Ironwork.

Publications: The complementarity of art and design, in: Cupchik, G. C. and Laszlo, J., eds., *Emerging Visions: Contemporary Approaches to the Aesthetic Process*, Cambridge: Cambridge University Press, 1992, pp. 64-82; *Footprints Literacy: The Origins of Art and Prelude to Science* (forthcoming) Part I: The origins of art: An archaeological or philosophical problem? Part II: Footprints, mindprints, art and science. Is there abstraction in abstract art? Figurative versus abstract art: Levels of connectivity.

Shows: National Library Gallery (Jerusalem, 1974): *Artonomy - Systemic Art*; Ika Braun Gallery (Jerusalem, 1985): *The Black System*.



My central thesis can now be approached in words: *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 patterns which connect*.

Gregory Bateson (1979)

Abstract: *The central thesis of this essay is that the most basic function of symbols is at one and the same time connectivity and differentiation. However symbols of different types serve this function in different ways. This difference is especially noticeable in the special way in which figurative paintings connect and differentiate the objects they symbolize, in contrast to the way in which all other types of symbols do this. This essay attempts to show that the special connectivity of figurative art is based upon*

maintaining a certain symmetry of a relative nature, between the object and the symbol which denotes it. This symmetry is a structural common denominator of the class of entities connected by that symmetry. In this sense, symmetry is a connecting pattern in art as in science. Thus every challenge to this symmetry has far-reaching implications for the cognitive functioning of art. This matter is especially relevant to non-representational art, which completely abrogates symmetry or similarity between symbol and symbolized as a principle of representation, and has thereby lost the cognitive function of connectivity-disconnectivity that has been so central to figurative art throughout the whole of its history. It is implied that the breakdown of symmetry as the connectivity principle of art, is at the very root of the breakdown of art itself in our century. One of the conclusions of the essay is that sooner or later art will have to implement anew the principle of symmetry as a foundation for its functioning. However, this will not be a return to figurative symmetry whose potential of connectivity and metaphorization has been totally exhausted, but symmetry of a more general and abstract character. This possibility is almost certainly unavoidable since symmetry, or more precisely the complementarity of symmetry-asymmetry, is one of the most basic means of organization of Mind or Being in all of its manifestations: on the material, the biological, and the noetic level, of which art is one sub-aspect.

The most important property of symbols of all kinds is, that they connect the things that they denote. However, that very fact implies that they also separate the things they denote from all the things they do not denote. For example, a painting that depicts 'A Cherry Tree in Bloom', is a pictorial name for all cherry trees in bloom, it therefore connects all those trees. On the other hand, the same picture also separates or differentiates the cherry trees in bloom from every other object in the world. The attribute of connectivity-disconnectivity (or *CODIS*) is an epistemological oxymoron or paradoxical property found in every symbol, of every kind – whether it be verbal, formal, or of any other kind. This property is therefore almost certainly the very essence of denotation, and it is a necessary condition for all symbolic thinking. Every symbol is, then, a kind of connector, but symbols of different kinds connect things in entirely different ways. As we shall see in what follows, this difference is especially noticeable in the special way in which figurative paintings connect things, in contrast to the way all other symbols do so. In this essay I shall try to show that the special connectivity of figurative art is based upon preserving a certain symmetry between the object and the pictorial symbol that depicts it. Every challenge to this symmetry therefore has far-reaching implications both for the cognitive function of the painting, and also with regard to the question whether a painting without this symmetry is still a work of art, or whether it is not merely an aesthetic-perceptual phenomenon. (Comprehensive discussion of symmetry as a transdisciplinary phenomenon, including art, is presented in several publications by members of ISIS-Symmetry since 1989. Over those, on the importance of symmetry-asymmetry in the physical and cosmological context, see e.g., Pagels, 1985; Barrow and Silk, 1984.)

One of the most important characteristics of twentieth century art is the total annulment of any similarity or symmetry whatsoever between the object and its pictorial symbol as a principle of representation. From the historical point of view, this is not the first time that figurative symmetry has been abrogated as a principle of representation. It happened for the first time during the fourth millenium B.C., when writing systems began to be developed. The final abolition of symmetry as the basis for representation occurred in the middle of the second millenium B.C., when different peoples in the Middle East developed syllabographic and alphabeticographic writing systems. This completed the great revolution: from paintings which depicted objects, to writing which depicted *the sounds of speech*. The creators of writing renounced figurative symmetry because it contained an inherent limitation: it is possible to depict by its means only things that can be seen or visualized. Writing, on the other hand, was one of the decisive factors leading to the development of philosophy and science, and thereby eventually made possible the discovery of symmetries of a conceptual and formal character, which are immeasurably more complex, general, and abstract than the figurative symmetries that it abolished. As against this, artists in the twentieth century pride themselves on having broken, or at least freed themselves from the symmetry between symbol and object as the principle of representation; but they proposed no *other type* of symmetry in its place, and no other way of creating a linkage between the symbol and the symbolized. This leads to the question whether representation is possible in 'abstract art', and if not, whether it can function as art at all?

One way of evading this problem is to argue that 'abstract art' does not represent things, but certain feelings and states of mind of the artist which have no form at all, so that figurative symmetry has no relevance to their depiction. We need not take this argument seriously, since if we were allowed to see in every collection of arbitrary marks the expression of anything we care to think of, then that collection of marks in any case expresses and denotes nothing. Another, far more sophisticated, way of evading this problem was discussed thoroughly in another essay, and here we recall it only briefly (Avital, under review). According to this argument, the prominent proponent of which is Nelson Goodman, figurative symbols are basically merely conventions, and any similarity that we see between symbol and symbolized is itself an outcome of our ingrained habit of describing things by means of certain graphical conventions (Goodman, 1968). The implication of this is, that not only is 'abstract art' arbitrary, but so too is figurative art. Here, however, because we have been using figurative symbols for so long, habits have by now been formed, of connecting symbol and symbolized, whereas these habits have not been formed regarding 'abstract art', and therefore we do not yet connect symbol and symbolized. In any case, similarity or symmetry are not relevant to pictorial representation. In the above mentioned essay, some ten counter arguments were presented, which were aimed at refuting this conventionalist approach. On the one hand it was possible with the help of these counter arguments to force the supporter of the conventionalist standpoint to admit that there is indeed an inherent connection

between the figurative symbol and the object it represents; and that this connection can be formulated in terms of similarity or symmetry. On the other hand, he can still argue that, since there is an infinite number of possible representations that preserve a given symmetry with the object, any choice we make regarding any particular representation is thus arbitrary, and representation is therefore in the end an arbitrary matter. The present essay is intended to complement the earlier one in that it is designed to block this last resort of the conventionalist. For this purpose, the most important meanings of symmetry in figurative art have to be uncovered. But it is first of all necessary to present an overview that will somewhat clarify the concept of symmetry, which is one of the constitutive foundations of Being in all of its manifestations, one of which is figurative art.

Discussions of symmetry usually commence with a reservation that the subject is too wide and too vast to be encompassed within the bounds of the given essay, and I do not intend to be an exception to this rule. Indeed, vast it is, because in one sense or another it is *everywhere*; Being at all levels – the physical, the botanical, the biological and the noetic – is a codex of symmetry. There are symmetries that exist in space, in time, or in space-time. There are different types of geometrical symmetry that exist in one, two or three dimensions. Physical symmetries that exist in four dimensions. Symmetries that exist on the sub-atomic level and which do not allow distinction between particles of the same type such as electrons, symmetries on the atomic level which create the spectacular structure of crystals, for example, and symmetries exist beyond the atomic level and up to the cosmic level. Symmetries in plants; in leaves, flowers and trees. Symmetries in the whole of the living world: in water, beneath and above the ground, in the air, and at every evolutionary level – from the simplest organisms and up to the mammals, including man. The enormous frequency of symmetry is also the source of its vagueness: Hermann Weyl points out two of the many meanings of this concept: "...the word *symmetry* is used in our everyday language in two meanings. In the one sense symmetric means something like well-proportioned, well-balanced, and symmetry denotes that sort of concordance of several parts by which they integrate into a whole." (Weyl, 1952, p. 3). However, there are symmetries of many kinds, on different levels, and with different meanings. In its rigorous meaning, as in mathematics and in science, symmetry is another word for invariance, self-resemblance, and even identity. In a looser meaning, it is another word for similarity at different levels, from identity to rough resemblance as manifested in different kinds of mapping and modeling. In fact, there are also in the realm of science those who maintain that symmetry should not be treated as an 'all or nothing' characteristic, but rather as a property that may be present at different levels over a given continuity: "Yet we argue that the treatment of natural phenomena in terms of 'either/or', when it comes to a symmetry characteristic property, may become restrictive to the extent that some of the fine details of phenomenological observations and of their theoretical interpretation may be lost... symmetry can be and, in many instances, should be treated as a continuous 'gray' property, and not necessarily as a 'black or white' property which

exists or does not exist." (Zabrodsky et al, 1992). Such a flexible approach to symmetry as this is quite rare in the context of science, but in figurative art no other approach is possible, because in this area there can be no complete symmetry between the object and the pictorial symbol system that depicts it, but only one degree or another of concordance or similarity between them.

Throughout this discussion the main meaning of symmetry will be the concordance or similarity between an object and its pictorial symbol. In other words, it is the concordance or isomorphism between one visual pattern which is the object, and another visual pattern which presents a partial pattern of the first one; and this is the figurative symbol. From the moment that one becomes aware of symmetry, it is impossible not to see it wherever we look, for symmetry is not only one of the building blocks of nature, but it is also at the foundations of civilization.

It is doubtful whether atoms, crystals, flowers and butterflies are *aware* of the symmetry enfolded within them, or of the symmetry of which they are components. By contrast, Man is aware of symmetry, and he made it, like a work of God, into one of the most basic patterning principles of every facet of the culture he constructed. Symmetry can be seen in everything designed by human beings in every period; from the very first stone tools, to houses and spacecraft. The earliest expression of symmetry as an organizing principle can already be seen in those first products of human civilization: stone tools. Already in the first chopping tools, one can clearly see bilateral symmetry, and this was increasingly improved in hand axes in the course of some two million years, reaching breathtaking perfection in the production of arrow heads of many kinds. Just how symmetry-obsessed these prehistoric technologists were, can be seen in Acheulean hand axes of some half-million years ago, and even more so in later axes. In these hand axes, the hewers removed chips even from that part of the stone used for holding the tool. That is, for the sake of the tool's symmetry, they deliberately renounced convenience when holding it, even to the extent of the risk of hurting the hand every time it was used! Apparently the fathers of human civilization were more poetically minded than modern designers, for they did not maintain that 'form follows function' but rather that 'form follows symmetry'! Another aspect of symmetry that can already be seen in the first stages of civilization, is that the possibility of consciousness is to a great extent due to the comparison we make between the properties of the given particular and the properties of a universal of one sort or another (such as image, concept, pattern, model, myth, theory, and so on.) On the other hand, every such comparison is directed towards examining the degree of congruence or symmetry/asymmetry between the given particular case and the universal, which is always preconceived. The same prehistoric tool maker could not have constructed the hand axe without comparing the tool, throughout the whole process of its making, with an image of the tool that he saw in his mind's eye and which functioned for him as a proto-symbol. (Avital, 1992). In the process of production of the first stone tools two aspects of symmetry can already be seen: the symmetry that we perceive in the shape of the tool; and

the symmetry between the image or symbol, and the object. However, it is very important to remember that the source of the symmetry of the tool is in the mind of the tool maker, and symmetry is therefore an organizing principle of the mind rather than an attribute of 'the things'.

Another early manifestation of thinking in symmetries can be seen in beadwork, adornment, ornaments and jewelry in all periods and in all civilizations, especially among primitive tribes. In beadwork, for example, symmetry is often to be found whose rigour is no less than that of symmetry in the mathematical and physical context, the main characteristic of which has, since Leibniz, been *indiscernibility*. Thus for example Bushmen to this day construct bead neck adornments made out of ostrich egg shells, which may comprise as many as a thousand beads of identical size and shape. Less rigorous, but more interesting, examples of symmetry may be found in the body paintings and jewelry of many tribes in Africa. Certain tribes in the Amazon still paint their bodies, and consider as uncivilized anyone who does not do so. It is important to note that these paintings do not depict objects of any sort, but are symmetrical patterns only. The most spectacular examples of thinking in symmetries are to be seen in the self decoration of the natives of New Guinea, especially in the way they customarily paint their faces. (The following books are listed in the order of the examples mentioned in the text: Woodhouse, 1980; Fisher, 1987; Levi-Strauss, 1973; Kirk and Strathern, 1987).

It is clear from all of these examples, that human beings thought in terms of symmetry in a visual manner millions of years before they developed language and art, and certainly long before they developed symbol systems based upon language. This is to say, that human beings implanted symmetry in objects many years before they implanted it in pictorial or other symbols. Nevertheless, it is possible that human beings thought in terms of symmetry on a very sophisticated level at least two million years before they made any stone tools. This can be deduced from the fossilized evidence of footprints literacy left by human beings in Laetoli in Northern Tanzania. (In a forthcoming essay titled: *Footprints Literacy: The Origins of Art and Prelude to Science* I try to show that thinking in symmetries, which is the foundation of footprints literacy, led – among other things – to the creation of art and science.)

On the one hand it may be deduced from this that thinking in symmetries is only a necessary condition for the invention of figurative painting, but not a sufficient condition. On the other hand, it may be understood how deep are the roots of thinking in symmetries, which is at the foundation of figurative art. All of these examples point towards an evolutionary stage from the cognitive point of view which is a preliminary and essential stage for the transition from the design of symmetrical *objects*, to the design of a *symbol system* that presents objects on the basis of symmetry between the symbol and the object. The transfer of symmetry as an organizing principle from objects to symbols was the birth of figurative art, and

the first precedent for its application in one form or another in every symbol system created thereafter, from totemism to science and mathematics.

Symmetry is among other things a *way of connecting* things, and therefore also a mode of order. The enormous importance of symmetry as an organizing principle at different levels and at every level of generalization, can be seen only after human beings made the upward leap from the design of objects to the creation of symbol systems. And indeed one may see the organizational aspect of symmetry in the symbol systems created at every period, and these provided models of order in the light of which men tried to understand reality and their place within it. Thus for example totemism, which is almost certainly the earliest symbol system based upon language, assumed a homology (which is a type of symmetry) between nature and human society, and thereby provided classificatory and organizational principles for society and the individual within it. Levi-Strauss maintains with reference to this homology between the orders of nature and of human society: "...the real link between the two orders is indirect, passing through the mind." (Levi-Strauss, 1963, p. 13). At one point he proposes a far more general formulation of this idea in a manner that is true not only with regard to anthropology, but with regard to *every* complex symbol system: "In every one of its practical undertakings, anthropology thus does no more than assert a homology of structure between human thought in action and the human object to which it is applied." (*ibid.*, p. 91). This characterization holds not only for verbal symbol systems but also for pictorial symbol systems. Throughout its history, figurative art depicted the world by means of figurative symmetry between things and graphic symbols. Mythology proposed models of order even more comprehensive than those of totemism, and philosophy proposed conceptions of order that were even more general by far. Modern science depicts and explains natural phenomena with the help of widely comprehensive theories, which posit the existence of a symmetry or correspondence between conceptual and formal systems and certain aspects of reality. In a sense, the history of culture entails the evolution of connectivity-disconnectivity or *codis*. If the different types of symmetry are different manners of connectivity and separation, then the evolution of culture coincides with the evolution of the types of symmetry by means of which human beings formed orders which enabled them to understand the world around them and their place within it.

In concluding this overview of symmetry, I would emphasize that this essay will not deal with any one of the many types of symmetry mentioned above, nor with the geometrical symmetries present in every figurative painting and every ornament, but rather with an essential function of symmetry present only in figurative art, namely *the connective function* of symmetry. The fathers of 'abstract art', who so enthusiastically broke figurative symmetry without proposing another in its place, did not understand that, as we shall see in what follows, without that symmetry art cannot fulfil its main cognitive function: connectivity.

It has already been remarked that every symbol, whether verbal, pictorial or other, is a connector. A verbal symbol like the word 'apple' connects all apples in the world, because it is a class-name or abbreviated code for the class of characteristic attributes of apples, which the name *implicitly* assumes. These attributes are not arbitrary but are rather the properties we customarily ascribe to real apples, and which are also the attributes that distinguish the apple from other fruit and from other things. Some of these attributes are visual, and some are connected with taste, smell and so on. By contrast, the pictorial symbol for 'apple' connects all apples in the world by *explicitly* showing or representing the group of the most important visual attributes that characterize apples, especially with regard to their shape and colour. The pictorial symbol cannot show or represent other attributes of the apple that are not visual, such as taste, but implicitly assumes them. The two symbols are connectors because they create a common denominator for all the particulars they connect, but they do so in entirely different ways. The verbal symbol 'apple' connects all apples by a name that denotes the group of properties common to apples. However this common denominator is given an *arbitrary* name which in this case is the combination of phonemes or sounds that comprise the word 'apple', which functions like a file name for the attributes of the apple. That is to say, the name in this case is arbitrary but the attributes that it denotes are not. In contrast to this, the pictorial symbol for 'apple' connects all particular apples by means of a symbol composed of sub-symbols from different levels, which together display especially prominent visual patterns and attributes of apples. A painting depicting an apple is not an arbitrary filename for the object 'apple', but rather a kind of *image* of the file's visual content; and the file is not the object apple, but the *image* that we have of the apple. That is to say, we do not really paint the objects but rather the images we have of those objects. It is thus fallacious for the conventionalist to argue: "How can the resemblance between the representation and the object be a condition for representation, if most paintings depict fictitious objects?", since we do not paint objects, but the images we have in our consciousness. Some of these images are figments of our imagination, and some are images that also have referents in the empirical world. Thus it should not be concluded that there is an absolute object of which we construct an image; but rather that the construction of the image, and in its wake some kind of object we think we see, are dependent upon prior information that we possess: our picture of the world, the special richness and differentiation of every language, our complex of beliefs and ideas, the motives, needs, interests, values, expectations, our whole experience and the special characteristics of the context in which we see 'the object', and so on. In other words, the images we have regarding objects, and the objects themselves, depend upon and are relative to our preconceptions. This understanding of the relation between the observer and the observed phenomenon is one of the most important things derived from the Kantian revolution. In the philosophy of science this issue is known as the problem of observer as participator; some philosophers call it more specifically: seeing-as. These philosophers rightly maintain that there is no such thing as seeing, but rather seeing-as. (The issue of seeing and seeing-as

is widely discussed in contemporary philosophy. See for example: Austin, 1962; Swartz, 1965; Wittgenstein, 1963). This philosophical conclusion also has support from a neurophysiological viewpoint: It is a fact that the visual cortex in which the act of seeing is centred, is blind! With the aid of a hierarchical system of neurons constructed so as to identify different aspects of lines, angles and edges, the visual cortex builds a scheme that displays the main contours of the seen object. On this schematic level, it is almost certain that the picture received on the visual cortex of different observers is very similar, since we all have the same neurophysiological system. But the visual cortex does not *identify the object*. Knowing what we see requires a decision of the neocortex, which compares the patterns appearing in the visual cortex with the pictures stored in the memory, and in the light of the complex of information there, determines what kind of object we actually see, if any. (For a brief and clear explanation of the processes of seeing in the brain, see: Jastrow, 1983, For the topic of relativity of vision, see Gregory, 1966). Thus, neocortices that are fed with different information see different things, even though they are apparently looking at 'the same thing'. It follows from this that there is not, and cannot be, perception of things 'as they are' any more than there can be any knowledge whatsoever of things 'in themselves'. Perception is visual knowledge, and all knowledge is hypothesis-dependent. But different observers have different hypotheses about what they expect to see, and every perception is therefore necessarily *relative*. It is very important to clarify, however briefly, the issue of the relativism of perception, since this issue has many implications for the question of whether the symbols of Realism are arbitrary or not, and also for the status of symmetry as a pictorial means of connection and classification which, as we shall see in what follows, is also of a relative character.

The subject of the relativism of perception is indeed too deep and too far-reaching to be discussed here on the theoretical level, and we shall therefore content ourselves with a few examples that clarify the matter very well even for those without a philosophical background. The literature is full of such examples, but I should like to evoke firstly an example from my personal experience, which demonstrated to me the relativism of perception in an almost traumatic manner. A few years ago I was invited to give a series of lectures at Stellenbosch University in South Africa by my friend Prof. Larry Scully, who was then Head of the Department of Fine Arts. Perfect host as he is, he took me for drives in the marvellous landscapes around Cape Town. On one of these drives, I saw a *dog* at the roadside, walking along about fifty meters in front of us. As we passed it, I saw to my amazement that it was not a dog but a baboon! With a slight sense of shock, I noted to myself that here was a good example of the relativism of perception. The next day we drove in the same area, and as we came out of a curve in the road, I saw a *baboon* strolling along, on the other side of the road and a short way in front of us. This time I smiled to myself, recalling my mistake of the previous day. But when we passed the baboon, I saw to my amazement that it was not a baboon but a dog! For several days afterward I felt a slight loss of confidence in my own eyesight.

In these two incidents the confusion did not arise from impaired eyesight or impaired visibility, but rather from my impaired *hypotheses* regarding what I ought to be seeing. In the first incident my expectation was to see a dog, because in my village near Jerusalem, a dog walking at the side of the road is a normal sight and there is no expectation whatever of seeing a baboon, since there are no baboons there. By contrast, in the second incident I did not see that there was a dog in front of me, because after the experience of the day before, I had managed to correct (perhaps too hastily) my hypothesis about what I was likely to see at the roadside in South Africa, and therefore saw a baboon even though the animal was quite definitely a dog. On the first day, if Larry had stopped the car before we passed the 'dog', and I had been asked to draw the creature in front of us, I have no doubt at all that I would have drawn a dog and not a baboon, because at that moment I had in my mind the image of a dog and not that of a baboon. Similarly, if Larry had stopped before we passed the 'baboon' and I had been asked to draw the creature in front of us, I suppose I would have drawn a baboon and not a dog, because at that moment I had in my mind the image of a baboon and not that of a dog. That is to say, *we draw our visual images or hypotheses and not the objects*, because the objects have no independent existence apart from our visual, conceptual or formal hypotheses. These hypotheses determine what kind of objects we see. An instructive and amusing demonstration of the argument that we draw the images in our mind and not the objects, is to be seen in the Nikko Toshogu Shrine in Japan. In the Shogun palace there are many paintings, among them one that depicts a *kirin*, Japanese for giraffe. The artist who painted this giraffe some two hundred years ago, had never seen a giraffe in his life, but painted it according to accounts and descriptions he had heard. The painted animal is so strange that it would never occur to anyone who had seen a giraffe or the photograph of one, that this kirin was a giraffe.

Another far more instructive example is the fact that in the language of the Zulu there are 115 separate words indicating different shades of brown. Members of the Zulu tribe do not possess eyes with a different structure from other human beings, but in their culture a man's economic and social status is determined mainly according to the number of heads of cattle he possesses, and their *colour*. That is to say, the economic value of the cattle is determined as a weighting of the quantitative index and the qualitative index, and the latter is determined by the colours, the value of which increases inversely to the frequency of their occurrence. The great relevance of shades of brown in this culture created the need for making many distinctions and hypotheses, which together create a kind of brown colour theory. Thus they *see* many more shades of brown than do people from another culture. For a similar reason, Eskimos can distinguish some 21 types of snow. Because of the enormous relevance of every type of snow to their existence, they learned to distinguish between them, and also gave them different names. In this context it is worth mentioning that Kant's dictum that 'the innocent eye is blind and the virgin mind is sterile' is true not only of beings whose thinking is mainly verbal or

conceptual but also of beings whose thinking is mainly visual. On the other hand, these facts should not be regarded as evidence for linguistic relativism or determinism of the "Sapir-Whorf hypothesis" variety, according to which our perception of reality and our thinking are entirely conditioned by the language we speak. (Whorf, 1956) . In its extreme form at least, linguistic determinism ignores the fact that visual perception and thinking existed millions of years before spoken language developed. It is probable that from the moment human beings began to use spoken language, it had a very profound effect upon both visual thinking and perception, but it does not follow from this that language exclusively determines the contents of visual perception or thinking. After all, we have images for which we have no words, as frequently happens in dreams, hallucinations and in Surrealist painting. We also have words for which we have no images, such as all words denoting entities with which we are not familiar, or which have no space-time existence. That is to say, the fact that there is interaction between these two modes of thinking does not invalidate the possibility of the autonomic activity, however limited, of visual thinking. Condon rightly maintains: "Unfortunately, it is no more possible to prove that 'language shapes our perception of reality' than to prove the opposite, more conventional, view." (Condon, 1975, p. 28; for a more thorough criticism of linguistic relativism, see: Leech, 1975.) In any case, every figurative painting begins with a visual image or class-name, whether we have a verbal name for it as well, or not. Today we are neither pure visual thinkers nor pure verbal thinkers, but our thinking is rather a hybrid of the two modes of thinking. These two modes of thinking create two different modes of *knowledge*. Moreover, in certain areas thinking or knowledge of the first kind is more dominant; in other areas, thinking or knowledge of the second kind is more dominant, and in most cases our perception and thinking are composed of interaction between these two modes of thinking or knowledge. In a sense, figurative painting is the writing system or 'speech' of visual thinking or knowledge, and as such possesses universal attributes, as can be seen from prehistoric painting. But as verbal language became more dominant, a new state of affairs developed in which conceptual knowledge fashions and interferes with visual thinking to some degree or another. Since verbal and conceptual thinking is not universal, but is relative to the conceptual system of the specific language in which it is formulated, it is also relative to the culture, place and time in which it was created. It therefore clearly also introduces a relative element into the images we construct regarding objects. That is to say, verbal language is the chief abode of the relativism of perception. A second cause of the relativism of our images regarding objects is the angle or projection from which we usually perceive different objects. Because of this, while it is true that every object has countless sections and projections that could serve as the source of the symmetry by means of which we are likely to represent the object, clearly most of these projections are irrelevant to this need, because we only encounter them in the most exceptional circumstances, if at all. Thus for example, it is highly probable that a bull would be drawn from the side or the front, since those are the most frequent and efficient angles for connecting the painting with the bull. There

is no point in painting the bull from behind, because although that is a frequently encountered angle, it is not efficient for making the connection between the painting and the bull. Furthermore, there is no point in painting the bull from above or below, since only in very rare cases do we see a bull from above, and if we were to see it from below it is doubtful whether we would retain sufficient vitality to paint it.

The two sources of the relativism of our images – the linguistic source and the characteristic angles from which we usually see the object – are not subjective but are common to a certain public. Every spoken language is the property of a particular group of people probably comprising hundreds, millions or even milliards of human beings. Likewise, the angles from which we usually see things are not special to a particular observer, but are common to most human beings. After all, we all have a similar neurological apparatus, and no organic brain is large enough to retain in memory everything that we see, from every possible angle; rather does the brain only construct schemes denoting characteristic aspects of the things. The angles from which we are accustomed to view and remember things are a relative matter, but not a *subjective* one. Indeed everything relative is dependent upon the viewpoint of a specific observer, but it is also open to confirmation and refutation in the light of the degree of correlation with the observations of others, whether these are taken from the same, or from other viewing angles. As against this, what is subjective is not open to confirmation and refutation, since in this case we have only the correlation of the person with himself, and not much is to be learned from that. Thus for example, if twenty people stand in a circle looking at a cow, *they all see a cow*, even though each one sees it differently, from his own viewing angle, and has different thoughts about it. That is to say, the fact that they all see a cow is the invariant element in their perception even though the creature does not possess cyclic symmetry, but only bilateral symmetry, and therefore appears different from different angles. A similar thing would happen if each person were to photograph or draw the cow; each of them would easily recognize the results as drawings or photographs depicting a cow, even though the animal looks different in each of the twenty pictures. This is possible because our brain is capable of performing the transformations necessary in order to confirm the fact that in the end all of the pictures depict the same animal. By contrast, if a person maintains that he has the toothache, there is no way in the world that we can verify or refute it. Relativism is, then, an inter-subjective matter, whereas subjectivism is solely the business of a specific person, and is therefore not relevant to art or to any other component of culture. From all that has been said, it is clear that there are no absolute objects that we might paint, and there are no absolute images of things, but the two are rather relative to our preconceptions. What makes objects 'real' is not some absolute attribute of existence, but the degree of permanence of the entrenchment of the preconceptions and selections that determine what we see things as, and correspondingly, what kind of visual vocabulary of images we retain in our minds. I do not think that Goodman's conclusion, that representation is basically an arbitrary

convention, follows from this, but rather that representation is *relative*; and the two are not interchangeable. The analysis put forward here rejects on the one hand Goodman's argument that in figurative art as in other symbol systems, every thing can represent any thing, so long as we are in agreement about it. On the other hand, this relative conclusion supports Goodman at least halfway, inasmuch as it rejects any absolute connection between representation and object, such as that implied, for example, by the argument that representation is the result of imitation of the object, something that assumes the existence of an absolute object. Likewise, it is clear that the symmetry existing between a figurative painting and the object it depicts is relative too, since every symmetry is dependent upon a visual, conceptual, or formal point of view, or a combination of these, and even upon the soundness of the perceptual apparatus of the observer. Morrison highlights the two aspects of symmetry: "For Leibniz, symmetry is related to the indiscernibility of differences." But, "...indiscernibility stresses the idea of perception, which is why I want to use it as part of the definition. What is symmetrical under one aspect of perception may not be so under another." (Morrison, 1988, p. 55). In other words, symmetry is founded upon invariance in one sense or another, but what type of invariance we see is determined by our perception, and that is influenced by our knowledge and motivation, and also the context within which we perceive a given pattern. Morrison maintains that symmetry may even be a subjective matter; a colour-blind person, for example, does not see a difference in places where a normal person does, and thus there may be symmetry for a colour-blind person where a normal person sees none. However, symmetry in this case is not really a subjective matter, since every colour-blind person may see the same symmetry.

Every relativism encompasses a dualism of two opposite but complementary aspects: on the one hand, relativism always assumes a certain aspect of the phenomenon that is unique and variable; and on the other hand, it assumes a certain aspect of the phenomenon that is constant and universal. In different domains different weight is given to these two opposing aspects of relativism: in mathematics and science more weight is given to the constant and universal aspect, while in art more weight is placed upon the unique and variable aspect. On the other hand, it is not to be concluded from this that art could exist without the constant and universal aspect, for in such a case, relativism would become a meaningless subjectivism. Relativism of symmetry is of course present in science and mathematics as well, but in these contexts symmetry is clearly much more rigorous than in the context of art. Relativism in the context of art and even in the context of philosophy suggests rather the degree of tolerance towards the variance that arises from difference of viewpoint, than towards the degree of invariance present beyond the different viewpoints. In other words, in art there is not, nor can there be, a state of identity or of indiscernibility between different paintings depicting the same object, even if all of the paintings were done by the same artist; and even less so if they were made by different people, from different viewpoints. Symmetry in art is at the most on the level of *similarity* of one degree or another, and this measure of sym-

metry was fully sufficient for the functioning of the figurative art of all times. As against this, in most cases the relativism of symmetry in mathematics and in science is not satisfied with similarity between the transformations of a specific figure but demands nothing less than indiscernibility. Thus, for example, Salomon Bochner argues: "Now, the mathematical notion of symmetry demands that there shall be given some group of automorphisms. If such a group is given and held fast, then a figure in space is called symmetric if each automorphism of the group leaves it unchanged. Thus, symmetry is a relative concept. A figure is not just symmetric *tout court*, but it is symmetric relative to a given group of automorphisms, which, in a logical sense, had to be given first." (Bochner, 1973, p. 351.) This argument can be simplified a little with the help of Hermann Weyl, who explains that automorphisms are "...those transformations which leave the structure of space unchanged" (Weyl, 1952, p. 42). He calls these transformations both 'congruent transformations' and 'congruent mappings', and it can therefore be said that a figure is symmetric relative to a given group of congruent transformations or congruent mappings of that figure. Similarly, in science too, relativism of symmetry stands upon no less than invariance, and Nigel Calder explains this matter with great clarity: "Einstein is often said to have held that 'all things are relative'. He did not. 'Relativity' is in fact a thoroughly bad name for the theory: Einstein considered calling it the opposite: 'invariance theory'. He discovered what was 'absolute' and reliable *despite* the apparent confusions, illusions and contradictions produced by relative motions or the action of gravity. The chief merit of the name 'relativity' is in reminding us that a scientist is unavoidably a participant in the system he is studying. Einstein gave 'the observer' his proper status in modern science." (Calder, 1983, p. 13.) In a certain sense, relativism is a mediation between subjectivism and absolutism; the one is mute, and the other an impossible ideal. From this there follows another profound difference between figurative art and 'abstract art', namely that figurative art is a relative phenomenon, exactly like every science and every cognitive concept. As against this, 'abstract art' is not a relative phenomenon but an arbitrary and subjectivistic phenomenon.

Painting is in a certain sense a *second order* description, since every painting is a partial description by graphic means, of images that we have in our minds or our consciousness. Unlike the world of verbal symbols, in the world of pictorial symbols there is no sharp distinction between the pictorial name and the attributes it displays, since the painting or photograph performs both of these functions simultaneously. The visual attributes which the visual symbol displays are not arbitrary, but have a more or less *inherent* connection with the attributes of the real apple ('real' according to our preconceptions), the one we like to eat. That is to say, in this case the pictorial name (which is in simple terms the figurative painting or the photograph that depicts the apple), and also the attributes it indicates, are not arbitrary, since the name is constructed from sub-symbols denoting the most common attributes of apples. The immanent connection between the attributes of the pictorial symbol and the visual attributes of the apples can be formulated in terms of

symmetry, isomorphism, homology, homomorphism and even 'similarity', which researchers like Goodman and others have come to regard as a vulgar word. For the purposes of the discussion I prefer to use the more general term – *symmetry*. A profound insight of Gregory Bateson will help us to clarify the central point of this whole discussion: "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 patterns which connect*." (Bateson, 1978, p. 9; or 1979, pp. 6-23. Emphases in the original.) Indeed every symmetry is a pattern, but the symmetry which is at the base of figurative art is also a meta-pattern that connects all of the entities it symbolizes. I shall try to clarify this general principle with the aid of a very simple example: I suppose that in almost every house, in some kitchen drawer or other, there are metal or plastic patterns for stamping out rolled pastry when making biscuits of uniform shape. These patterns are frequently in the form of a heart, a flower or the like. If we take for example a flower-shaped pattern, it is symmetrical in shape with all the biscuits that have been stamped out using the same plastic pattern. That is to say, the form of the plastic pattern is a meta-pattern in relation to the form or pattern of all the biscuits, and it is the common structural ground of all biscuits made by means of that plastic pattern. Therefore, the form of the plastic pattern *connects* all of the biscuits. The pattern of the plastic pattern is a kind of universal; and the form of each biscuit is a special case of this universal. Putting this metaphorically, one may say that the form of the pattern is a kind of idea, in the Platonic sense, in which each biscuit partakes, and thus the form of the pattern is an entity of a higher level of order than the form of each specific biscuit made by means of the same plastic pattern. As a rule, connectors or connecting patterns are of one or more levels of order higher than the entities connected by them, whether the entities connected are objects, or in fact connectors or connecting patterns. This fact is true whether the connecting pattern is of the figurative symmetry type, or symmetry lacking any figurative characteristic, like the formal symmetries expressed in formulae that describe mathematical or logical principles, or natural laws.

The symmetry by means of which each domain explains or describes the world is always *partial*, since no symbol system is capable of encompassing all attributes of the object described. Secondly, if there were complete symmetry between the symbol and the symbolized, then the symbols would not exist at all, because there would then be unity or identity between symbols and objects and the symbolization would be nullified. Put precisely, the active principle here is not symmetry alone, but *the complementarity of symmetry-asymmetry*, exactly like *yin* and *yang*, or the complementarity of connectivity-disconnectivity, and like the complementarity of hierarchy-randomness, and so on. An insight of Dagobert Frey may help us to understand the most profound aspect of the dialectic enfolded in symmetry-asymmetry: "Symmetry signifies rest and binding, asymmetry motion and loosening, the one order and law, the other arbitrariness and accident, the one formal rigidity and constraint, the other life, play and freedom" (as translated from German in Weyl,

1952, p. 16). That is to say, if symmetry is another name for order and regularity, and asymmetry is another name for disorder and contingency, then the complementarity of symmetry-asymmetry is only another name for the most basic dialectic of being, in all of its facets and levels: the dialectic of order and disorder. Asymmetry is thus a component of being in all its manifestations, no less necessary than is the component of symmetry. The complementarity of these two opposed components is also what made possible the existence and functioning of figurative art for tens of thousands of years, until the artists at the beginning of our century broke up this complementarity into its components. This being so, it is not surprising that most of the works of art created in our century fall into one of two categories: works in which the basis of order is very prominent, and in most cases banal; or works in which the element of disorder is very prominent, and always incomprehensible. Where there is perfect symmetry, there is only uniformity, and therefore nothing happens: there are no distinctions, no events, no process; in a word, time does not exist. On the other hand, where there is complete asymmetry there is only plurality, difference, formless flux, chaos without unity. However, no aspect of being is likely to exist in either of these two extreme states, and neither is art. The same logic is implicit in the argument of modern cosmology which maintains that the creation of the universe began with the breaking of the complete symmetry that existed at a singular point which contained the whole mass of the universe. This is to say, that the complementarity of symmetry-asymmetry is a necessary condition not only for the existence of symbols or of the noetic world, but also for the existence of matter and life. The fact that figurative art created visual-cognitive connectivity by means of figurative symmetry, which is built upon the dialectic of symmetry-asymmetry, was not the chance invention of prehistoric hunters who painted their thoughts on the walls of their caves. It is certainly not a matter the existence of which depends upon the agreement or disagreement of aestheticians, art historians or art critics, but is an aspect of a process that is infinitely wider and more general than civilization and art themselves.

Since there is no concept that denotes the complementarity of symmetry-asymmetry, the term '*broken symmetry*' is sometimes used. But this combination of words does not amount to the lacking concept of which symmetry and asymmetry are the two complementary aspects. This concept x that we lack, is of a higher level of order than the concepts of symmetry and asymmetry, and of course also of a higher level of order than the concept '*broken symmetry*'. The fact that we have no paradoxical concepts or oxymorons of this kind in our language, almost certainly limits the level of abstraction and generalization of the philosophical and scientific theories by means of which we explain our world. On the other hand, the invention of such concepts is among the most difficult intellectual tasks for several reasons, the simplest of which is the fact that it is so difficult to think in concepts that simultaneously say a thing and its opposite! In the fascinating essay by Philip Morrison entitled *On Broken Symmetries*, he explains that in nature perfect symmetries are not in fact possible, but only symmetries that are broken to some extent or another.

It is my impression that Morrison would have been happier if our language had a *meta-concept* that would denote the complementarity of symmetry-asymmetry. (How about 'Symma'?) It seems to me that such a concept would far better express the ideas he presents in this essay than does the concept 'broken symmetry': "The symmetry of the array is broken, really because of time. Since no process, certainly no spontaneous process, can go on for infinite time, some irregularity must occur to propagate its mismatch faintly through the entire system... What we regard as highly satisfying works of art, even many natural things of beauty, contain broken symmetries. The symmetry is made manifest in some form, yet it is not carried out to perfection." (Morrison, 1988, pp. 69-70.)

It will now be easier to understand why symmetry between the object and the symbol is the *connectivity principle special* to figurative art. Thus for instance, a pictorial symbol depicting a sunflower, is symmetrical or isomorphic with the characteristic pattern of sunflowers, with regard to both the configurations and the colours usually found in these flowers. The painting of a sunflower is a meta-pattern with regard to every particular sunflower and therefore connects all sunflowers. In this sense the symmetry realized in the painting of the sunflower creates a generalization of sunflowers, but at the same time also classifies sunflowers and distinguishes them from other entities that are not sunflowers. In figurative painting, symmetry thus serves at one and the same time as a means of connection, distinction, generalization and classification. From what has been said, it is clear that the painting of a sunflower is a visual universal, and therefore of a higher epistemological and ontological level than each specific sunflower, exactly like every conceptual or formal universal in relation to the particulars it connects. More generally, it may be said in Russellian terms that every figurative painting is a logical type of at least one level higher than the objects it denotes, even if there are no such objects in reality. This is to say, that from an epistemological and ontological point of view every figurative painting is *a priori* at least one level higher than the world of objects. Since the business of figurative art is the organization of visual universals, an extremely basic aspect may be pointed out that is common to the figurative artist, the poet, the scientist, the philosopher and the mathematician – namely, that all of them are concerned with connecting and the invention of universals. The difference between them lies in the type of universals they connect, and there are corresponding differences in the levels of connectivity they can achieve. We shall now look at a more complex example, which also highlights another important aspect of symmetry as a connecting pattern. If we look at any portrait painting, we see in fact a hierarchical system of patterns and meta-patterns. The pattern for the face includes patterns for the eyes, nose, mouth and so on. Each of these patterns includes sub-patterns from lower levels. That is to say, the pattern for the face connects a complete entirety of patterns of lower levels. The meta-pattern for the face is to one degree or another symmetrical with all human faces, and the patterns it includes are symmetrical with the parts they denote. That is, higher symmetries have a double function: on the one hand they connect all of the objects they denote

– in this case a human face; and on the other hand they connect symmetries that are from a lower level of order and which are included within the higher symmetries. Generalizing, it may be said that there exists a hierarchy of types of symmetry corresponding to their level of connectivity, and that there also exists an internal hierarchy within each type of symmetry. If in figurative art we find the principle of symmetry in one of its simplest forms, we find it in what is perhaps one of its highest manifestations in General Systems Theory, for this approach is built upon a meta-symmetry among theories that cover different areas of reality. In other words, General Systems Theory is built upon a symmetry among symmetries. I hope to show in another essay that the future of art is bound up with its ability to display this same meta-symmetry and other fundamental attributes, which are in the end attributes of human intelligence, which creates and connects all of these areas.

At this stage it should be clear that painting connects things in a manner similar to that in which a physical law connects all of the individual cases to which it applies. Thus for example, a prehistoric painting of a bull is analogous to Newton's Law of Gravity inasmuch as both present the common ground of the phenomena they deal with, and thereby connect all of the individual cases to which they apply. The difference between them is mainly in their level of connectivity and generalization, which follows from the type of symmetry by means of which things are connected in these two examples: in painting the connection is created by means of figurative symmetry, whereas in science the connection is created by means of symmetries of a relational and formal character. The fact that symmetry is a means of connection is self-evident in the scientific world, but not so in art, otherwise the artists of the twentieth century would not have broken the symmetries of figurative art without proposing others in their place. If physicists were to abolish the known laws of physics entirely, without creating in their place other laws more general and more enlightening than the previous ones, they would thereby abolish physics itself. But the fathers of twentieth century art abolished the principle of symmetry between symbol and object as a representational principle without understanding that they had thereby abolished art itself. The breaking of the symmetries of figurative art without creating an adequate alternative to them, is one of the expressions of the collective suicide of twentieth century art, since art is left without any connecting principle at all. Non-representational art of all currents is built precisely upon the destruction of the connecting symmetries of figurative art, without having constructed a new type of symmetries or connecting patterns of its own. There will be those who argue that there are many 'abstract' works *that do contain* symmetry, such as most Geometrical 'Abstract' works. It is true that among these works there are sometimes configurations that are themselves symmetrical, such as Josef Albers' rectangles, Kenneth Noland's circles and triangles, the parallel lines of Peter Sedgely, Bridget Riley, Frank Stella, and others. But there are several basic differences between symmetry of the kind found in 'abstract' works and the symmetry in figurative painting:

(a) The symmetry in figurative art is the structural common denominator between entities that are the objects connected by means of that symmetry. That is, a figurative painting explicitly or implicitly assumes the existence of real or fictitious objects belonging to a different level from that of the painting itself. In other words, figurative painting has reference to something external to itself. The connecting symmetry in figurative art is not the symmetry of the configurations that appear within the painting itself; as for instance the fact that the right side of the symbol for 'face' is symmetrical with the left side, or is its mirror image; it is the symmetry between these configurations and the objects they denote. The geometrical symmetry found in certain 'abstract' works has no reference to anything external to those works, and therefore does not connect anything, but is on the contrary *connected* by means of a pattern that is external to it. We will clarify this by a simple example: By drawing an elephant, we create a scheme or connecting pattern relating to the creatures that are elephants. That is, we leave the level of objects, or more precisely the level of *the images* we have regarding the objects, and ascend to the level of symbols. The drawing in this case is the abstract symbol connecting all elephants. However, when we draw a rectangle, we do not thereby create a connecting pattern of all rectangles, but create another *special case* of the geometrical type or pattern called 'rectangle'. That is to say, in 'Geometrical Abstraction' we leave the level of geometrical types or patterns (which are not patterns of art but of geometry), and *descend* to the level of its events or tokens. As stated, when we paint something in figurative art, we leave the world of objects and ascend to the world of symbols. However, when we draft something in geometry we leave the world of symbols or patterns and descend to the world of objects. To be precise, in the world of geometry, rectangles are not drawn but drafted. Because of this, even when it is painted on canvas with oil colours and a paintbrush and exhibited in a gallery or museum, this does not transform the rectangle into a painting; it remains forever the draft of a rectangle. Thus for example, Albers' rectangles are not connectors of rectangles but are on the contrary individual and entirely concrete cases of the geometrical type or pattern 'rectangle', which is a truly abstract entity; it has no perceptual character at all, and therefore cannot be shown in a museum.

(b) It has already been remarked that in figurative art the connecting pattern is in fact the result of a dialectic or complementarity of symmetry and asymmetry together. One aspect of this phenomenon that I have already mentioned is the fact that no symbol system is capable of exhausting all attributes of the object it depicts, and for this reason there is necessarily asymmetry between symbol and symbolized. However, unlike other modes of description, in figurative painting there is a further, unique, aspect that by the actual graphical organization of the symbols itself, explicitly displays the complementarity between symmetry and asymmetry. This fact is easily understood when we look at pictures of hands that are almost certainly the first figurative paintings that human beings painted on the walls of caves. They did not make them with a paintbrush or scribe, but placed the hand upon the wall and sprayed paint (usually black or red) from their mouths, over both the hand and

the wall. This process is customary to the present day among the Australian aboriginals living in Kakadu National Park, who mark in this way the ownership of rock shelters that are passed down from father to son. After spraying, a negative pattern of the hand remains on the wall. This pattern is *of necessity* isomorphic or symmetrical with the hand, but this is not true of the background, which is the complement of the figure; and it is *impossible* to see the figure without the ground. It follows that the ground is a no less integral part of the painting than is the figure. But the ground is *asymmetrical* with the figure, and in our case the ground is asymmetrical with the hand. That is to say, the painting of a hand, or any other figurative painting, is built upon the complementarity of symmetry and asymmetry together. This attribute is a necessary component of every figurative painting, but it is not an attribute that exists in 'abstract' painting. Even in those cases where there is differentiation on the canvas between figure and ground, the figure does not have symmetry with anything external to it, and it is therefore meaningless to maintain that the ground is asymmetrical. Instead of the necessary complementarity of symmetry-asymmetry that is present in figurative art, we find in 'abstract art' a polarization towards one of the two components of this dialectic: at one pole we find symmetry without asymmetry as in monochrome paintings in which there is no differentiation at all between figure and ground, but merely an homogeneous space. A uniform ground is a case of perfect symmetry of all points on the space of the canvas, in the sense of absence of all difference of colour or shape. At the other pole we find the accentuated asymmetry to be seen in works belonging to styles such as Action Painting, Abstract Expressionism, Drip Painting, etc.

In concluding this discussion, I should like to point out several examples from culture and from nature that highlight the extent to which symmetry is a basic and profound matter in our being. As everyone knows, the *Old Testament* explicitly and very strictly forbids painting and sculpture, because there was a justifiable fear that they would encourage idolatry. (*Exodus* 20:4; *Deuteronomy* 5:8). The *Koran* too forbids them, but less explicitly and less strictly, but the prohibition was made explicit and threatening in commentaries on the *Koran* (*The Koran*, LIX:24; XL:64). It appears that Islam found a wonderful solution to this prohibition by the frequent realization of symmetry, not in forbidden images, but in architecture and the ornamentation of buildings. The most beautiful example is of course the Alhambra in Granada. Strange as it may seem, profound common ground is shared by the solution of Islam to the prohibition of an occupation with figurative art, and the solution of artists in our own century, who on the one hand found no interest in figurative art, and on the other hand saw nothing attractive in the abstractivist turmoil. These artists, with Escher foremost among them, made symmetry itself the main content of their work. The artists of Geometrical Abstraction did the same thing, in a less subtle way. That is to say, thinking in figurative symmetries preceded figurative painting, and when figurative painting was forbidden or exhausted, some artists then returned to the pursuit of symmetries themselves! Indeed, sooner or later art will have to return to the occupation with symmetries, but of an entirely

different kind from those that served it for 40,000 years. It may be supposed that if there is to be art in the future at all, then the exploration of symmetry and the cultivation of awareness of thinking in symmetries will necessarily be one of the central subjects of Art Education. A strategy of precisely this sort is already proposed by Dreyfus and Eisenberg as a means to the advancement of mathematical tuition: "Symmetry permeates mathematics and it may well be part of our unconscious. But like everything else, our sense of it must be developed... A sense of symmetry may well be the most important of the general objectives we want the mathematics curriculum to impart to students." (Dreyfus and Eisenberg, 1990, p. 59). What has been said of mathematics is true of art, inasmuch as at a profound level, the occupation of mathematics, science, and also of art, is in the end with connectivity with the aid of symmetry. The difference is mainly in the types of symmetry in each of these areas, and in the level of their generality.

Nature, even more than culture, provides us with abundant instances of thinking in symmetries. Thus for example, butterflies copulate only with mates whose wings display an identical or completely symmetrical pattern to that displayed by their own wings. A more impressive example of thinking in symmetries is provided by fireflies of certain kinds. As they fly, the males emit a series of flashes of light in order to attract the attention of the females of their species. A female of the same species ready for copulation replies with the same sequence of flashes. However, some species of females are particularly sophisticated in their comprehension of symmetry: a firefly of this species ready for copulation sends out the correct sequence of flashes relative to its species. But if after achieving satisfaction it is ready for satisfaction of a different kind, it sends out the series of flashes that invites copulation from the males of fireflies of *another species*; however, when the aroused cavalier arrives, she devours him (Lloyd, 1981). I wish to suggest by this, that thinking in visual symmetries is a natural phenomenon for visual thinkers at every level of evolutionary development, and the Cromagnon hunters who invented figurative painting were undoubtedly mainly visual thinkers. The outstanding cave paintings they left, are their visual literature.

In conclusion, I should like to highlight two of the most important conclusions reached in the discussion in this essay:

(1) We have seen that relative symmetry-asymmetry is an absolutely essential attribute of pictorial representation, and from this it may be generalized : that A is a representation of B , if A is a visual class-name or an aesthetic connector of B , and it presents one of the possible symmetries or mappings of B , whether B is a real entity or a fictitious one. Obviously no 'abstract' painting or sculpture meets these requirements, and therefore no 'abstract' work is a representation. In another essay I shall try to show that a genuine abstract art is possible on condition that it displays symmetries that are more abstract and higher than those figurative art is capable of showing.

(2) It seems to me that at this stage, it can already be concluded that works of 'abstract art' are not connectors but the debris of figurative connectors, fragments of pictorial hierarchies, fragments of ruined symmetries. Without the connective attribute of connection by means of symmetry between symbol and object, the only connectivity left for 'abstract art' is connectivity on the material and perceptual level, but not on the symbolic level. On the basis of this fact alone, it may be argued that all works of 'abstract art' are merely aesthetic objects (i.e., perceptual) just like any natural or man-made object, and not works of art.

The dialectic of connectivity-disconnectivity, recursiveness-invariance, hierarchy-randomness, complementarity-discreteness, symmetry-asymmetry and others, are among the basic rules of a cosmic game, in which matter, life, thought, figurative art and other cultural areas partake, but not 'abstract art'. These dialectical or paradoxical attributes are among the most basic properties of Being or Mind in all its manifestations and at all of its levels, and I should therefore like to call these properties *mindprints*. A profound understanding of mindprints may help us to understand what in the end 'art' is, and will anyway help us to characterize the difference between figurative art and 'abstract art'. However, at this stage it is already possible to put forward a tentative generalization: in figurative art, as in other aspects of Being, all of the mindprints are present, each of them in a certain state of balance. By contrast, in 'abstract art', as in a malignant growth, a black hole, the ruins of a building or anarchy, not all of the mindprints are present, and those that are present are not in a state of balance of their two poles, but in a state in which one of them has become overly dominant at the expense of its dialectic opposite. Such a state of affairs is an indication and a symptom of a phase of disintegration and ruin. This is true of a supernova, and it is true of 'abstract art'. In further essays I shall deal more deeply and thoroughly with mindprints and their implications with regard to art; and the conclusions presented here regarding non-representational art in general, and 'abstract art' in particular, will then be seen by most readers as more self-evident. It is not to be concluded from this that there should be a return to figurative art, something that is in any case impossible and futile, since this art is a cultural fossil that has outlived its time; rather has the time arrived for the art world to wake up from the illusion that twentieth-century art has created any alternative to figurative art. The time has come for the art world to understand that twentieth-century art only destroyed the paradigm of the old art, without creating a new paradigm in its place, and that twentieth-century art is therefore only an intermediate stage between the art of the past and that of the future. In the absence of such an understanding we cannot embark upon a serious search for the glimmerings of the art of the future.

NOTE

- * Some statements in this paper are not shared by the editors (cf., the editorial policy on p. 2). However, it contains several original and valuable ideas, therefore we decided to open the floor to make the author's opinion discussed by the public. (Eds.)

REFERENCES

- Austin, J. L. (1962) *Sense and Sensibilia*, Oxford: Oxford University Press.
- Avital, T. (1992) The complementarity of art and design, in: G. C. Cupchik and J. Laszlo, eds., *Emerging Visions: Contemporary Approaches to the Aesthetic Process*, Cambridge: Cambridge University Press, pp. 64-83.
- Avital, T. (Under review) *Is Figurative Representation Arbitrary? Ten Counter Arguments to the Conventionalist View of Art*.
- Barrow, J. D. and Silk, J. (1984) *The Left Hand of Creation*, London: Heinemann.
- Bateson, G. (1978) The pattern which connects, *The CoEvolution Quarterly*, Summer, 4-15.
- Bateson, G. (1979) *Mind and Nature*, New York: Bantam Books, pp. 6-23.
- Bochner, S. (1973) Symmetry and Asymmetry, in: *Dictionary of the History of Ideas*, New York: Charles Scribner's Sons, Vol. 4, pp. 345-353.
- Calder, N. (1983) *Einstein's Universe*, New York: Penguin Books.
- Condon, J. C. Jr. (1975) *Semantics and Communication*, New York: Macmillan Publishing Co., Inc.
- Dreyfus, T. and Eisenberg, T. (1990) Symmetry in mathematics learning, *ZDM – Zentralblatt für Didaktik der Mathematik* (International Reviews on Mathematical Education) 22, No. 2, 53-59.
- Fisher, A. (1987) *Africa Adorned*, London: Collins Harvil.
- Goodman, N. (1968) *Languages of Art*, New York: The Bobbs-Merrill Company, Inc., chap. 1.
- Gregory, R. L. (1966) *Eye and Brain*, New York: McGraw-Hill Book Co.
- Hargittai, I., ed. (1989) *Symmetry 2: Unifying Human Understanding*, Oxford: Pergamon Press.
- Hargittai, I. and Hargittai, M. (1994) *Symmetry: A Unifying Concept*, Bolinas: Shelter Publications, Inc.
- Jastrow, R. (1983) *The Enchanted Loom - Mind in the Universe*, New York: Simon and Schuster, chap. 6.
- Kirk, M. and Strathern, A. (1987) *Man as Art*, Berlin: Medea, Taco Verlagsgesellschaft und Agentur GmbH.
- Leech, G. (1975) *Semantics*, New York: Penguin Books, pp. 31-32.
- Levi-Strauss, C. (1963) *Totemism*, Boston: Beacon Press.
- Levi-Strauss, C. (1973) *Tristes Tropiques*, New York: Penguin Books, pp. 229-256.
- Lloyd, J. E. (1981) Mimicry in the sexual signals of fireflies, *Scientific American*, 245, July, No. 1, 110-118.
- Morrison, P. (1988) On broken symmetries, in: Wechsler, J., ed., *On Aesthetics in Science*, Boston: Birkhäuser, 55-73.
- Pagels, H. R. (1985) *Perfect Symmetry*, New York: Simon and Schuster.
- Swartz, R. J., ed. (1965) *Perceiving Sensing, and Knowing*, New York: Anchor Books.

The Koran, LIX:24; XL:64.

The Old Testament, Exodus 20:4; Deuteronomy 5:8.

Weyl, H. (1952) *Symmetry*, Princeton: Princeton University Press.

Whorf, B. L. (1956) Language, Thought and Reality, in: J. B. Carroll, ed., *Selected Writings of Benjamin Lee Whorf*, New York: John Wiley and Sons.

Wittgenstein, L. (1963) *Philosophical Investigations*, Oxford: Basil Blackwell.

Woodhouse, B. (1980) *The Bushman Art of Southern Africa*, London: Macdonald General Books, pp. 34-42.

Zabrodsky, H., Peleg, S., and Avnir, D. (1992) Continuous Symmetry Measures, *Journal of the American Chemical Society*, 114, No. 20, 7845.