Implications of Lateralisation of Brain Function for Art Education: a critical review

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ABSTRACT *Reasons are given for interest on the part of art educators in brain research findings. It is suggested that caution has to be exercised in interpreting and evaluating arguments based on brain research because of special difficulties which point to the need for a critical review. A brief descriptive account is given of the structure and function of the brain and of experimental study methods. Extreme views on hemisphericity are contrasted and the characteristics associated with the hemispheres are tabulated. The evidence is taken to suggest that the two distinct modes of thinking are mutually incompatible and that they therefore alternate; but together they embody what we experience as the single stream of consciousness. The non-verbal component, tacit consciousness, contributes significantly to artistic knowing. Although the balance between the verbal and tacit components of consciousness appears to be influenced by educational experience, the challenge is to encourage coordinated development rather than to find ways of training specialised functional areas.*

The Need for Caution

In recent years experimental research into brain function has stimulated a good deal of informed and careful speculation concerning the character of human thought. Put simply, the proposition is that most of us have two brains; two *kinds* of brain. Under special laboratory conditions, in which these 'brains' have been separated, we are told that both of them "may be conscious simultaneously in different, even in mutually conflicting, mental experiences that run along in parallel" (Sperry, 1974, p. 11). This is interesting because it promises to throw light on a conflict which seems to exist between the two modes of thought and expression involved in fine art education—that is, on the fact that, under certain conditions, verbal analysis can disrupt the art student's engagement in activities reflecting his/her primarily visual and spatial concerns (Cornock, 1984, 1983). The apparent implication is that students of fine art confront the need to handle two distinct forms of knowledge and that the dynamics of the information-processing involved are such as to present them with special problems; this question of the forms of knowledge involved in the study of fine art is discussed elsewhere (Cornock, 1982).

A consideration of brain research is also interesting because it has formed the basis for interpretations with far-reaching implications. For example, Edwards (1979) suggests that "tapping the special functions of the right hemisphere of your brain can help you to learn to draw", and echoes the belief earlier expressed by the psychologist Ornstein (1972) that we should encourage a shift from a verbal and logical mode of thinking to one which is visual and holistic. The organising principle of these interpretations has been stated by an art professor:

> We apparently feel that if we can demonstrate scientifically that there is a dichotomy between right and left brain function and that teaching art "pumps-up" the educationally deflated right hemisphere, we will have proven that the remote value of art education has become an urgent educational concern. (Youngblood, 1979, p. 4)

He asserts that neither language nor drawing is, in fact, the exclusive province of one hemisphere. But it may be that, even if Youngblood is correct in doubting the beliefs of Edwards and others, an understanding of the evolutionary development and functional organisation of the human brain can illuminate our understanding of art education.

However, interpretation and, more particularly, evaluation of the arguments drawn from brain research is made difficult not only by the sheer volume of relevant publications (they run into thousands), and the fact that scientists are not univocal on the topic, but also by reason of some limitations imposed on researchers by the nature of the topic. For example, it has been suggested that researchers tend to show interest in reporting unusual cases and so introduce a bias in the literature towards rarely observed syndromes which can lead to mistaken inferences concerning the characteristics of the normal population (Levy, 1974). Turning to the brain itself, we find it necessary to reconcile paradoxical findings. It has been observed for example that, although an individual who suffers limited damage to part of the brain may lose his colour vision, or his ability to recognise faces altogether, removal of an entire lobe or even hemisphere of the brain may *not* result in such a severe deficit; hence greater loss leads to better cognition (Kinsbourne, 1974, p. 260). Again, according to Bogen & Bogen (1969) "certain brain functions can be independent of or even inversely related to brain mass" (p. 197). In characterising the two 'halves' of the brain, caution is urged by Teuber (1974) who refers to the elusiveness of such characterisations—something of which will become apparent in the discussion which follows. Broadbent also urges scepticism in reviewing the division of functions, drawing attention to the need to account for the overall integration of behaviour (Broadbent, 1974). One of the standard textbooks on medical anatomy echoes Broadbent's warning:

> As in any fruitful field of discovery the original impetus is necessarily towards *analysis,* to establish differences and details. . . . it is necessary, as a corrective, to preserve also an impulse towards *synthesis.* (Williams & Warwick, 1980, p. 1027)

This need is expressed in quite different terms by Buffery (1974) who counsels against oversimplistic interpretations and, in particular, against the use of similar pairs of opposite and mutually exclusive terms such as rational/intuitive and verbal/non-verbal which can cloud empirical observation with dogmatic assumptions. But perhaps the greatest danger lies in the nature of the source of our evidence. For all the abundance of literature our knowledge is based on the study of relatively few cases. These cautionary observations must apply even to our consideration of what has perhaps been the best-known and most important research programme in this field during a key period. One of the most influential centres for study of lateralisation of brain function is the University of California: here (at Irvine) the so-called 'split-brain' operations were carried out by Philip Vogel and Joseph Bogen on just 16 patients between 1961 and 1972; these were the cases studied post-operatively (at the Institute of Technology) by Nobel laureate Roger Sperry and his colleagues and research students, including Bogen, Gazzaniga, Trevarthen, Levy and Nebes.

We have to remember also that most cases come to our attention because the people concerned had already suffered brain damage as a result of, for example, war or disease. Surgery and drug therapy (including for example the temporary anaesthetisation of one hemisphere) are administered to them as patients and not as experimental subjects. These are patients who, by the time that they are invited to participate in a research enquiry into lateralisation, have had their brain functions modified not only by anti-convulsant drugs etc., but also by the spontaneous reorganisation of cerebral functions within the individual's head as he struggles —often successfully—to overcome his disabilities. The nature of these functions have then to be inferred by researchers on the basis of reports which tend, in the nature of things, to be biased towards the verbal mode.

The idea that there is some fundamental separation of brain functions can be taken to have important implications for art education. But for a variety of reasons we have to be cautious in our evaluation of the arguments and what follows is a critical review of relevant aspects of the literature.

Lateralisation of Cerebral Function

The nervous system has its terminations in the senses and musculature, an information channel and processing system in the spinal chord, and is connected via the brain stem with what we see as the characteristic shape of the brain. The brain (encephalon) has three major divisions: the hindbrain (rhombencephalon), which includes the ribbed cerebellum at the lower rear and parts out of sight within the central mass; the midbrain (mesencephalon), which also rises out of immediate view into the central mass; and the forebrain (prosencephalon).

The forebrain has a complex set of central systems, the more central of which form what is known as the between or inter-brain (diencephalon) and from which issue upwards and outwards the two cerebral hemispheres whose surfaces form the outer and much convoluted extremity of the brain, which is therefore known as the endbrain (telencephalon). As a broad generalisation we can say that the nerve fibres comprising much of the central mass of the forebrain are conductors which are therefore sheathed in non-conducting myelin (analogous to the plastic sheath on a metal electrical conductor). These central masses of sheathed conduction fibres are referred to as the 'white matter'. The 'grey matter' consists of unsheathed or partly sheathed and therefore interconnecting nerve cell bodies. These form groups (nuclei or ganglia) within the brain and a sheet wrapped around the cerebral hemispheres. The convoluted outer sheet (or 'cortex' from the Latin for tree bark) is some 2 mm thick and within it much of the high level information processing takes place.

It has been suggested that a way of conceptualising the relation between the anatomy and function of the brain is as a set of four conical masses of nerve tissue, each having some of the central nuclei at its apex and each extending outwards to include related areas of cortical tissue at the surface (Dimond, 1980, pp. 514 *et seq.*); these four 'brains' deal respectively with the higher mental processes; with emotion; with the motor functions; and with sex and sleep. Another scheme considers the forebrain as divided into two blocks: the block to the rear (parietal, temporal and occipital lobes) which is mainly concerned with the analysis, coding and storage of information, and a frontal block, which is involved in the programming of intentional action (Luria, 1970). But the scheme which has been taken to have important implications for art education is that which associates the physical cleavage between the cerebral hemispheres with a broad separation of functions.

During the 1860s it was reported that damage to a particular area of cortex resulted in speech disorder in the overwhelming majority of clinical cases: what became known as 'Broca's area' of the cerebral cortex is situated towards the front of the left cerebral hemisphere. Since that time there has been compiled a map of many of the functional areas of the cortex and of the bundles of fibres interconnecting some of them, but the details of the map do not concern us here. What must be considered are what are claimed to be the gross functional asymmetries of the brain.

During the period in which Broca reported his localisation of a speech area the neurologist Hughlings Jackson put forward the view that the two cerebral hemispheres may each lend to consciousness its own special character. That there was some scope for independent function on the part of each hemisphere was suggested by the observation that the loss of speech ability, following lesion in Broca's area, left patients able to *sing* both fluently and melodiously. Further dramatic reports have been published in cases of more or less normal behaviour on the part of patients who have suffered damage to a part of the brain, or a part of whose brain has effectively been isolated, and evidence assembled as to the anatomical location of cerebral functions. These remarkable results have been accomplished in several ways.

A method pioneered more than 50 years ago is the physical removal of much of the information processing tissue from one lobe (lobectomy) or from one cerebral hemisphere (hemispherectomy or, more accurately, 'decortication'—reviewed by Dimond, 1972, pp. 91–110; 1980, p. 506). Another approach, begun a few years later, was the severing of the corpus callosum—a bundle of some 200 million nerve fibres interconnecting the two cerebral hemispheres at a level well above the midbrain (an operation called commissurotomy, studies of the results of which are reviewed by Sperry, 1974). The other major sources of evidence include the temporary anaesthetisation of one cerebral hemisphere, either using an injection of sodium amytal (Wada, 1949) or by unilateral electrical shock treatment (as practised in the USSR and referred to in a popular article by V. Deglin in the *Unesco Courier*, January 1976); and studying responses to sounds presented separately to each cerebral hemisphere (dichotic listening, described by Kimura, 1967) [1]. Table I provides a summary of the defects which have been noted in patients who have suffered damage to one of the cerebral hemispheres.

What has been well established through this and other research is that each cerebral hemisphere can function independently to support intelligent life. So the sheer mass of brain is *not* a critical determinant of intelligence and either hemisphere can support the higher functions; further, there is considerable plasticity in the infant brain and some residual plasticity in the adult, which means that following

TABLE I. A summary of defects following lesions to each of the cerebral hemispheres (based on Levy, 1974, p. 147)

Left hemisphere lesions	Right hemisphere lesions
Aphasia (loss of speech and reading)	Facial agnosias (inability to recognise faces)
Alexia (loss of reading)	Spatial alexia
Agraphia (loss of writing)	Spatial agraphia
Loss of verbal memory consolidation	Loss of form memory consolidation
Loss of abstract categorising	Defect in visual closure
Amusia (loss of musical sense)	Amusia
Ideomotor apraxia (dissociation of thought and muscular action)	Topographoagnosia (deficit in drawing spatial relationships, e.g. maps)
Ideatory apraxia (confusion of thought and muscular action)	
Constructional apraxia (inability to arrange objects in order)	Constructional apraxia
Autotopoagnosia (loss of sense of localisation and orientation of body-image)	Hemisomatoagnosia (neglect of the contralateral half of the body)
Simultanagnosia (loss of ability to perceive an embedded figure)	Spatial agnosia (impairment of spatial location and orientation)
Loss of left-right discrimination	
Absence of detail in drawings	Absence of proper form in drawings
Poor on Raven's Progressive Matrices	Poor on Raven's Progressive Matrices
Poor on performance IQ	Poor on performance IQ
Worse on verbal IQ	

very severe damage, remaining brain tissue may be able to share or to take over some of the functions affected.

Yet each hemisphere appears to lend a different character to human thought. What is by no means clear is the nature and extent of functional asymmetry (or 'lateralisation') in the human brain. The evidence is copious, but there has been a vigorous argument between those who, at one extreme, regard the left hemisphere as both necessary and sufficient to establish the distinctively linguistic and mathematical intelligence of the human being, leaving the right hemisphere as a mere passenger; and those who, at the other extreme, proclaim the right hemisphere as the seat of a more fundamental and mystic form of consciousness, leaving the left hemisphere to serve as a useful appendage to perform calculation and linguistic functions.

An extreme proponent of the 'dominant' left brain theory is Henschen (1926), who describes the right brain as 'inferior', 'regressing' and 'primitive in almost every respect'. Table II presents a set of distinctions between the putative styles or characteristics of the hemisphere: of this table Eccles (1973, p. 220) says that "It is quite surprising how sharply these distinctions can be made." He also declares that "the minor hemisphere deserves its title" (ibid.), and that, although the right cerebral hemisphere "can carry out remarkably skilled and purposive movements ... it is almost devoid of linguistic ability, so it is impossible to communicate with it at the symbolic level that is requisite for discovering if it has conscious experiences of its own." (Popper & Eccles, 1977, p. 312. We return to this question of consciousness later.)

TABLE II. "Various specific performances of the dominant and minor hemispheres" (Eccles, 1973)

Dominant hemisphere	Minor hemisphere
Liaison to consciousness	No such liaison
Verbal	Almost non-verbal
Linguistic description	Musical
Ideational	Pictorial and pattern sense
Conceptual similarities	Visual similarities
Analysis over time	Synthesis over time
Analysis of detail	Holistic-images
Arithmetic, computer-like	Geometrics and spatial

Those who have argued the significance of the *right* hemisphere have been prompted to do so because of the significance which they attach to the functions associated with it. But here the evidence is much less compelling than is the case with the localisation of language. This uncertainty reflects greater difficulty in specifying exactly what we mean by such putative right hemisphere functions as for example 'synthetic thinking' or 'affective responses'—difficulties which become particularly evident when we set out to measure the extent of such functions. Precisely because it is difficult to diagnose impairment of right hemisphere functions there is:

(i) a tendency for damage to become more extensive before an individual presents for examination; and

(ii) neurosurgeons have tended to feel less inhibited in removing material from the right hemisphere than the left, with consequently greater damage (Warrington, James & Kinsbourne, 1966; Williams & Warwick, 1980, p. 1026). A further complication is introduced by the apparent diffusion of right hemisphere functions (in contrast with the rather strict localisation of, e.g. Wernicke's area on the left) [2]. For all of these reasons interpretations of right hemisphere function are hedged about with qualifications; among the more compelling interpretations are those of Bogen (1969a,b); Bogen & Bogen (1969); Bogen *et al.* (1972); Kimura & Durnford (1974); Levy (1974); Milner (1971); Warrington *et al.* (1966); Winner & Gardner (1977).

In a discussion of the prospects for developing a chess playing automaton, Roland Puccetti (1974) crystalised right hemisphere function as the *recognition* of significant wholes; Puccetti contrasts all-at-once recognition with the more explicable but more plodding process of identification, whereby the left hemisphere works out (for example) that "That couldn't have been Dick because he wasn't wearing glasses, nor Paul because I didn't see a moustache, so ..." (ibid., p. 144). Another related characteristic forms the basis of Joseph Bogen's view: he cites a contribution made by Denny-Brown (1962) to a discussion in which he questions the characterisation of the left hemisphere as devoted to the processing of symbolic information; instead, he observes that lesions on the left side tend to impair ability to handle short words such as 'as' and 'if' and characterises this deficit as the loss or impairment of what Hughlings Jackson had, much earlier, termed 'propositional' thinking. Bogen accepts this characterisation of left hemisphere thinking as 'propositional', and posits 'appositional' as the other pole of thought (Bogen, 1969b). The notion of a mode of reasoned thought using such propositional forms as 'If A then B' is consistent with Puccetti's description of the process as one of identification. But Bogen's appositional-propositional dichotomy (Bogen *et al.,* 1972) only helps to clarify the fundamental character of right processing by telling us what it is *not:* the right hemisphere can recognise and even produce words but cannot use verbs or generate propositions (it was even suggested by Levy, 1970, p. 73, that—if the left hemisphere can be held in check—then the right may even be able to handle verbs); thus "the rules by which appositional thought is elaborated on the other side of the brain will need study for many years to come" (Bogen, 1969b).

Whilst, in the absence of more specific experimental evidence, we may have been tempted to join Eccles and others (i.e. in regarding the right hemisphere as no more than a skilled passenger accompanying the active and self-conscious left hemisphere) there are at least two important obstacles to the acceptance of that view.

First, among the difficult-to-specify functions of the right hemisphere are those shown in Table III. As a means of identification these characteristics are typically vague; but taken in context they are characteristics which we may well recognise and so, if we rely upon our tacit sense of 'rightness', then what they mean can become persuasive. (The concept of tacit integration is discussed, with appropriate references, in Cornock, 1982.) For it seems that, whilst those who have to rely upon the right hemisphere do lose an essential tool of thought—propositional language—and become as a result brooding and taciturn. They nevertheless retain what their doctors and nurses can recognise as an otherwise quite normal and human set of reactions to the complex everyday circumstances in which researchers apply their tests. By contrast, those who have to rely upon the left hemisphere cannot be regarded as normal—despite their alertness, logical thought and articulate speech. These patients are unnaturally optimistic (described as "euphoric and maniacal" in discussion by Dimond, 1980, pp. 127 ff), tend to be curiously literal in their interpretation of meaning (Winner & Gardner, 1977), and lack a sense of the absurd (ibid.). This is a case in which we must again invite a tacit integration; for when, for example, Winner & Gardner were presenting their brain-damaged patients with simple verbal and visual tests to establish the extent to which each had retained the ability to understand metaphor, they were struck by the incidental fact that patients relying upon the left cerebral hemisphere failed to see anything funny or absurd in a picture of "a person carrying a large red heart and staggering under its weight" as an illustration of the statement "a heavy heart can really make a difference". These patients "often appear insensitive to their surrounds and inappropriate in their emotional reactions" and show their wit and language skills "with undue frequency in situations where they are manifestly inappropriate" (ibid., p. 726). Overall, the clinical descriptions of patients having to rely on the left hemisphere—with their breeziness, volubility, uninflected speech, cleverness, lack of humour, lack of sensitivity to complex human emotion, and tendency to take things literally—come frighteningly close to the popular image of the humanoid robot.

The second and no less important obstacle to acceptance of the right hemisphere as mere passenger to the left is the fact of functional asymmetry. The linguistic and computational specialisations of the human brain set us apart from other primates and it is only reasonable to suppose that the evolutionary process would have

TABLE III. Summary comparison of characteristics of patients suffering from unilateral brain damage (based on Winner & Gardner, 1977, pp. 725f).

Left hemisphere undamaged	Right hemisphere undamaged
Relevant and accurate in verbal responses	Good orientation to situation or context
Insensitive to surroundings	Sensitive to connotation and nuance
Inappropriate emotional responses	Able to react appropriately to a variety of situations
	Capable of using non-linguistic cues

selected for the most elegant and economical exploitation of the resource. Merely to develop half of the cerebrum would have been curiously wasteful (Levy, 1974, pp. 167f).

What has been said is that brain research has told us a good deal about the nature of thinking processes. The evidence points us to some degree of functional asymmetry but, although linguistic and computational brain functions have been isolated and localised in most cases, a combination of factors has conspired to delay a resolution of the argument; the result has been to sustain a controversy regarding the significance of right hemisphere function. A review of the accummulated evidence suggests that in normal subjects the two hemispheres cooperate and share in a number of higher functions which for a time had been thought by some to be the exclusive province of one or other hemisphere: for example, both conribute in some way to the processing of language (Gardner & Denes, 1973), metaphor (Winner & Gardner, 1977), stereopsis (Danta, Hilton & O'Boyle, 1978) and the perception of form (Kimura & Durnford, 1974). Nevertheless, what we can say with come confidence is that each hemisphere lends to thinking a particular style or character and that the brain makes a choice as to the style of thinking most appropriate to whatever task is in mind. Thus there is a tendency for one hemisphere to assume dominance for the processing of certain kinds of information.

In summary, the character of the right hemisphere is to facilitate the immediate recognition of patterns of relationship and significance: visuospatial awareness (e.g. pictures, maps); musical awareness; the figurative use and interpretation of language in appropriate situations. In processing these kinds of information the right hemisphere performs parallel rather than sequential operations, and thus contributes in a direct or existential manner to our appreciation of events. Finally, the right hemisphere attaches emotional significance to the phenomena whose recognition it achieves. This character is normally submerged in the richer character lent to awareness by the traffic between right and left cerebral hemispheres and with the brain stem.

Conscious Knowing

One of the workers contributing to brain research interpreted the emerging evidence to mean that the right brain, or the 'dark side of the mind' had been rediscovered by Western science. Ornstein (1972) caught the mood of the period when he declared that *two* modes of consciousness exist in man. He went on to argue the need to cultivate the newly recognised consciousness of the right hemisphere—the "intuitive and holistic aspect of ourselves" whose mode is "receptive and constitutes the dark, subtle area of consciousness, metaphorically, the night" (ibid., p. 194). Ornstein voiced a widespread feeling that our scientific and technical culture was associated with an educational system devoted almost exclusively to the encouragement of the left hemisphere and, hence, of its particular mode of consciousness.

To the artist it will seem reasonable to regard Ornsteins' 'receptive' mode as constituting a level of consciousness. However, if we are to accept the proposition that there are two complementary modes of consciousness then two conditions must be satisfied: first, we have to know that at any given moment aggregate mental activity takes alternative forms and second, that Ornstein's 'receptive' mode involves consciousness.

(i) *Alteration of Mode.* Most individuals have clearly lateralised brain functions. Each hemisphere is equipped to translate information into a form suitable to the type of processing undertaken within its boundaries; this preparation is what is referred to as encoding. A conscious effort can be made to *re*code a body of information so as to produce an image from a symbolic and sequential description or vice versa but this may not always be successful (Joseph, 1982). Our perception of a task can, apparently, have a dominating effect on our attention so that, for example, non-verbal coding may inhibit the kind of left hemisphere processing necessary to solve particular kinds of problem (Golding, 1981). Thus we are obliged to make moment-to-moment decisions about the information we shall extract from a stimulus and, hence, where it will be processed. Trevarthen (1974) proposes that the brain stem is perhaps responsible for the rapid 'switching' of conscious attention between the various functional areas of the endbrain. This model is taken further by Dimond (1980, p. 440), who proposes a specific anatomical location for consciousness in the corpus callosum and areas of the parietal lobe and cingulum—areas of the brain which are able to 'recruit' any other area of the brain and so incorporate into consciousness the specific cerebral functions whose outputs are channelled through this putative consciousness zone.

The system produces an alternation between the two modes of consciousness because the explicit processes of identification and propositional logic are incompatible with the tacit processes of recognition and 'apposition'. Each is capable of being disrupted by, and therefore suppresses, the other (Levy, 1970, pp. 82ff; Levy-Agresti & Sperry, 1968; Levy, Trevarthen & Sperry, 1972; Teuber, 1974).

We can take this point about the alternation of the modes of consciousness one step further by considering the work of Smith (1975), who conducted an experiment in which she measured brain waves from both cerebral hemispheres so as to establish which hemisphere is dominant during the performance of analytic and synthetic tasks. Smith tested a number of individuals whose high-level training and experience might be expected to have induced a tendency to either left cerebral dominance (the 'analytic' group) or right cerebral dominance (the 'synthetic' group).

The tests supported her hypothesis (see Table IV). So, performance of such specialised tasks as arithmetic and picture recognition have the effect of engaging one of the cerebral hemispheres whilst temporarily causing the other to go into a resting state. What is more, Smith shows that sustained engagement in either analytic of synthetic activity tends to increase the likelihood that that mode would be adopted in a range of situations—even where it is inappropriate. Hence the engineer's approach to many tasks involves use of the left hemisphere; that of the artist the right. Thus we *can* expect to influence an individual's type of mentation through the education system. This finding is supported by other studies, e.g. Charman (1981).

Table IV. Description of group performance for left and right hemisphere dominance and analytic or synthetic group affiliation (from Smith, 1975)

Group and affiliation	Number left dominant	Number right dominant	Total
Analytic			
Mathematics	8	2	10
Chemistry	9	1	10
Engineering	9	1	10
Total analytic	26	4	30
Synthetic			
Art	2	8	10
Music	4	6	10
Dance	3	7	10
Total synthetic	9	21	30
Total combined group	35	25	60

(ii) *Alert and Self-Aware.* It is more difficult to establish whether the mentation associated with those activities in which the right hemisphere is dominant produces conscious experience. This is, obviously enough, because the right hemisphere does not construct verbal reports.

What we are looking for is some particularly vivid type of experience arising out of activities for which the right hemisphere is dominant. Drawing has been shown to be such an activity (Gainotti & Tiacci, 1970). At this point we must rely once more upon a tacit integration: the writer is able to report on the basis of personal experience that the process of drawing at advanced levels generates experiences which are:

(i) highly organised;
(ii) produce a strong sense of the significance that the activity has for the draughtsman; *but* which
(iii) resist even serious efforts to communicate them in words (an example of such an effort is to be found in Brighton & Morris, 1977, pp. 20f).

It is not merely that an image such as a face can readily be recognised whilst being describable only in terms of gross and superficial feature ('... couldn't have been Dick because he wasn't wearing glasses ...'); what is more difficult to communicate is the quality of an image, a quality which is recognisable only to one who has developed the requisite connoisseurship (it is precisely because the requisite knowledge is largely tacit that it cannot be codified in a set of explicit rules). The point which is made by this observation is that the trained artist is conscious of such experiences: conscious of their organisedness, conscious of their quality.

TABLE V. Selected features of hemisphere function alternately affecting the overall character of consciousness (based on Joseph, 1982, esp. pp. 6—9)

The left cerebral hemisphere responsibilities include:	The right cerebral hemisphere responsibilities include:
Perception and labelling of information suitable for linguistic encoding	Conceptualisation of the whole, including form, figure-ground relationships and depth (gestalt, image)
Categorisation of encoded information into discrete units and the organisation of that information into temporal and logical sequences	Spatial orientation of conceptualised wholes based both on external stimuli and on body image
The purposing and organisation of motoric output	Recognition of connotations and emotional significance of speech, facial contours, etc., and mediation of emotional expression
Verbal concept formation	

The model of human consciousness which emerges is of a complex system with many functional specialisations which are brought into play by a mechanism whose main effect is to route the flow of consciousness either through the analytical left hemisphere or through the synthetic right hemisphere. That these modes of processing alternate seems beyond doubt and the fact that the synthetic mode produces conscious experience is well established, both for those with practical experience in the visual arts and for researchers such as Sperry and Ornstein. But one objection to this view has continued to receive attention.

Mention has already been made of the view put forward with characteristic forcefulness by Popper & Eccles (1977) that consciousness is the exclusive province of the left hemisphere. Eccles, whose reputation is based on his study of the cerebellum, a part of the hindbrain, has argued his views on consciousness and the endbrain in a conference held at the Vatican (footnote to Zangwill, 1974, p. 271), and we may surmise that it is coloured by doctrinal considerations. He dramatises his case with a thought experiment: he asks us to consider the hypothetical case of a left dominant commissurotomy patient who seizes a gun with his left hand (i.e. driven by the motor cortex in the contralateral right cerebral hemisphere) and shoots a person dead; should a charge of murder be brought? What he is concerned to say is that the Self has to reside in a mind capable of reflecting upon and making (verbally) reasoned voluntary decisions about its actions. He therefore concludes that such a murder charge should not be brought because the 'minor' hemisphere is incapable of voluntary control.

But Dimond (1980) quotes at length reports made by Roger Sperry's subjects which indicate strongly that each cerebral hemisphere has its own wakefulness; further, a commissurotomy patient reports amusingly on the experience of having her left 'self' woken by a slap from her left hand (i.e. again the contralateral right brain) when *that* 'self' wanted to get up early in the morning! (ibid., p. 434). A specific refutation of Eccles' notions of unilateral consciousness and voluntary control has been the subject of a contribution to a conference on hemisphere function made by Zangwill (1974). Zangwill points to a considerable body of experimental evidence and once again the argument is made more accessible and compelling as he draws particular attention to his personal examination of a left dominant hemispherectomy patient whose behaviour is inconsistent with Eccles' view (this is a case which is fully documented by Smith, 1966).

It therefore seems reasonable to consider ourselves as having two distinct modes of thinking (i.e. of learning, knowing and memory) as characterised by Sperry (1974) but integrated in some such way as that proposed by Dimond (1980) so as to produce a single stream of consciousness whose character and mood alternates correspondingly. We are accustomed to regard an individual's verbal reports as the voice of his conscious self, but all that has been said so far has been directed to suggesting that some part of human consciousness can properly be said to be tacit. Thus, if we associate Polanyi's theory of knowing (Cornock, 1982) and the results of split brain research (Gill, 1980) we have established a basis upon which to discuss the forms of knowing in the study of fine art. Specifically, it will be useful to refer to the product of sustained training and engagement in such ineffable experience as drawing as 'tacit consciousness'.

Discussion

This review of certain aspects of brain research with respect to art education has been prompted by three developments. First, there is the observation that the study of fine art within the context of higher education tends to generate friction between the students' central concerns (which are visuospatial and affective) and the primary channel through which the tutorial dialogue and other teaching passes (i.e. verbal communication). Second, we see the publication of what amounts to an educational doctrine based on the idea that the right hemisphere is both 'artistic' and, customarily, underdeveloped. Third, we have the development of the theory of lateralisation itself, which has to be treated with caution as a particular interpretation of controversial evidence.

The controversy surrounding the concept of cerebral asymmetry has now begun to settle and we are left with a picture which, though clouded with speculation, supports the idea that most of the population and nearly all dextrals are strongly lateralised. (A small number of sinistrals are effectively lateralised in reverse—the language areas being situated on the *right*, and so on; another minority are not lateralised, and have, in effect, two analytic and linguistic hemispheres, equipping them to achieve outstanding verbal IQ scores.) This means not only that a number of 'artistic' characteristics are apparently associated with right hemisphere functions but that the educational system can indeed expect to influence the extent to which an individual will call upon those functions. To some extent we are anticipating here that future findings will support the idea that, although a tiny minority is structurally disposed to remain predominantly logical, analytical, reductive and verbal, for the majority of the population it is feasible to make specific educational provision to elicit a measure of what we have called tacit consciousness. The desirablility of such a course is considered elsewhere (Cornock, 1982).

In sum, it seems that a higher education in fine art serves (when effective) to hold the left dominant hemisphere in check for a significant part of the student's working time so as to allow a recrudescence of the tacit consciousness which begins to be suppressed in most of us with the onset of speech (for a fascinating account of a highly relevant case-study see Selfe, 1977).

A recent view of the perinatal development of cerebral asymmetry has been given by Joseph (1982) in which he describes the way in which the infant is obliged, prior to the myelination of the callosal fibres interconnecting the hemispheres, to try to explain to itself actions and moods initiated by the right hemisphere. The dextral infant babbling to itself is, says Joseph, having to interpret its own (its right brain's) impulses, actions and responses to itself (to its left brain): an extraordinarily difficult task! As the corpus callosum becomes myelinated the child's 'self' becomes an integration of its two modes of consciousness, the explanatory and the tacit. Thus the study difficulties of the undergraduate student of fine art are foreshadowed in the developmental struggle of the infant. That is, the art student who feels constrained to explain or justify his/her central concerns will find that, notwithstanding the presence of some 200 million nerve fibres forming the callosal highway between the hemispheres, it remains difficult to interpret her/his tacit consciousness to the world because, in Joseph's words: "... not all impulses, feelings, desires, fears, cravings, knowledge, etc. have a label ... " (ibid., p. 27).

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NOTES

[1] A further source of evidence is electrical stimulation mapping in awake patients (Fried *et al.*, 1982). A recent review of the methods used to study hemisphericity is included in Beaumont, Young & McManus (1984).

[2] This view has recently been questiond by Fried *et al.* (1982).

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