Animal consciousness and human self-consciousness

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1. Introduction, with special reference to W. R. Hess

I am delighted to contribute to this great occasion in the memory of a pioneer investigator of the nervous system, Professor Walter Rudolph Hess. I had the pleasure of visiting him several times in his world-famous institute at Zurich. My lecture will be related to the important philosophical contributions of his later years: the book 'Psychologie in biologischer Sicht' of 1962, which I have in the English translation of Gerhardt von Bonin of 1964, 'The Biology of Mind'[10], and an article 'Causality, consciousness and cerebral organization in Science' of December 8th, 1967[11].

It should be recognized that in 1962 Hess was maintaining the existence of conscious experiences in animals at a time dominated by behaviorists who denied animals any significant mental experiences, as has been so meticulously documented by Griffin[8]. In the preface, Hess states very wisely in contrasting patients and animals:

'In a discussion of symptoms and syndromes one can achieve communication by speech. It is much more difficult to inform oneself about the subjective experiences of animals that one observes. Although the idea is well-founded that even here, sensory stimuli become conscious and that many highly organized species are moved by feelings and moods, one can with great probability base his conclusions only on indications. If one knows the 'functional inventory' of each species and its 'repertoire' concerning psychic effects, the various modes of behavior can be interpreted in a kind of sign language.'

Because of his knowledge of the structure of the nervous system, and of his study of the complexity and variability of behavior patterns, he restricts, by default, conscious experiences to animals with highly developed brains, mammals and birds. It is unfortunate that in a well documented study of animal awareness Griffin[8] makes no reference to Hess. Had he done so he might have hesitated to endow honey-bees with consciousness.

By contrast Hess[10] starts with some warnings: 'We try to discuss correlations between modes of behavior which are psychically motivated on the one side and the functional organization of the brain on the other side; we also try to keep an order which corresponds to the integral organization of man and of animals which have a psyche...everybody knows only what he himself experiences...the observer who is not especially schooled has an inclination to transfer human sensation and experiences such as moods and feelings and even intellectual functions to animals without the necessary precautions.'

His caution is illustrated when discussing motivational drives that are expressed in various autonomic responses that need not be connected with consciousness. Instinctive behavior that does not have a superimposed learned response need not give a conscious experience. He rightly stresses that in behavior determined by feelings and moods: 'Man and animals are here even nearer to each other than in the sector of the comparatively more frequently controlled intellect.'

2. Consciousness, animal and human

Griffin[8] has made an important advance in the subject of ethology by introducing into it mental experiences. The complexities of animal behavior seem to have so much in common with human behavior that it becomes pertinent to postulate that there are associated mental experiences. His definitions are valuable though orientated to human experience:

'Every normal person thinks about objects and events that are remote in time and space from the immediate flow of sensations, and this is what I mean by *mental experiences.* A *mind* may be defined as something that has such experiences. *Awareness* is the whole set of interrelated mental images of the flow of events; they may be close at hand in time and space...or enormously remote. ....an *intention* involves mental images of future events in which the intender pictures himself as a participant and makes a choice as to which image he will try to bring to reality. ...The presence of *mental images,* and their use by an animal to regulate its behavior, provide a pragmatic, working definition of *consciousness.*'

Yet he warns that: 'The term consciousness is widely and strongly held by behavioral scientists to be useless for scientific analysis.'

His book represents a courageous attempt to introduce consciousness into the explanatory discourse of ethology. In general I am in agreement, but I would limit the consideration to birds and mammals. Unfortunately Griffin is not aware of the tremendous difference in brain performance when he argues that the rich communication symbolism in the dance patterns of honey-bees has an associated mental experience. He states:

'Because neurophysiological mechanisms appear to be very similar in men and bees, the mental experiences resulting from their operation must, according to this line of reasoning, be equally similar. If this seems an

embarrassing conclusion, we can try to escape from it by postulating that neurophysiology is seriously incomplete, having failed, so far, to locate those functions that differ so widely between taxonomic groups that they generate incomprehensively divergent mental experiences.'

He is referring to the basic structures: neurones, synapses and neuroendocrine mechanisms. But neuroscientists recognize that it is the organization of these basic elements that gives the enormous range of behavioral performance of birds and mammals. By contrast in the honey-bee's central nervous system the neuronal connectivities appear to be rigidly determined in a stereotyped pattern (Strausfeld[25]), certainly much more so than in the immensely larger brains of the higher vertebrates. Surely it is sufficient to describe the remarkable signalling by dance patterns, for example of bees in search of a new cavity for the hive without introducing such mentalistic expressions as: 'This bee *likes* one cavity better than the other, and *wants* her swarm to occupy the preferred one.'

Griffin sums up the problem of the postulated mental experience of bees: 'Thus, I may interpret the phenomena of bee dances as evidence that workers intentionally and consciously communicate information, whereas a classical behaviorist may argue with equal force that the bees are complex automata, that the dances are correlates of certain physiological states, but that no conscious intention need be assumed to exist merely because symbolic communication is taking place. How can we work our way out of this dilemma?'

Any attempt to propose that insects have mental experiences in their more sophisticated behavior will embarrass neuroscientists who recognize that only with the higher animals have the brains a size and complexity of organization that potentially could give rise to mental experiences (fig. 1). The brain of a chimpanzee for example is similar to a human brain except for its smaller size (about 30%). In fact in the micro-structure they are indistinguishable with our present techniques. The approximate neuronal numbers are: human, 10,000 million; chimpanzee 4000 million; bee, 1 million, about 70% being in the visual system.

We can speak of an animal as conscious when it is capable of assessing its present situation in the light of past experience and so is able to arrive at an appropriate course of action that is more than a stereotyped instinctive response. In this way it can exhibit an original behavior pattern which can be learnt, and also which includes a wealth of emotional reactions. A good example is the ape in a closed room with a moveable box in one corner and a bunch of bananas in the other, but suspended too high to reach. After long cogitation the ape moves the box under the bananas and succeeds. A quite different demonstration of conscious experiences is given by the spontaneous play of mammals, particularly of the young. Already reference has been made to the statement by Hess that man and animals are closer with moods and feelings than with more abstract experiences. There is also similarity with the more emotional drive-like behavior from stimulation of the limbic system.

On analogy with our knowledge of lesions of the human brain it would be expected that in higher animals it is the cerebral cortex that gives them a behavior that we attribute to conscious experience. It is therefore of interest that, when the cerebral cortex was surgically removed by Bard under anesthesia, the awakening decorticate animal exhibited a completely changed behavior. It had become an automaton with no trace of the friendly intelligent behavior it had before. It incessantly tramped around in a meaningless manner, displaying no interest in its surroundings or in its actions. This evidence of course will not convice the behaviorists who would merely retort that the subtle behavior centers of the brain have been removed.

Griffin[8] gives a good summary of the problem of his book: 'The evidence and ideas reviewed above lead to the continuously stated conclusion that complex, versatile, and adaptive responses may or may not be accompanied by conscious awareness. How can we hope to find out? If an animal communicates about its internal image, this provides at the very least some data about them, but it does not, strictly speaking, tell us conclusively whether the animal is consciously aware of those images or other relationships. But the general principle of evolutionary kinship and continuity between animals and men suggests that an animal which communicates about its internal images may also be aware of them on some occasions'.

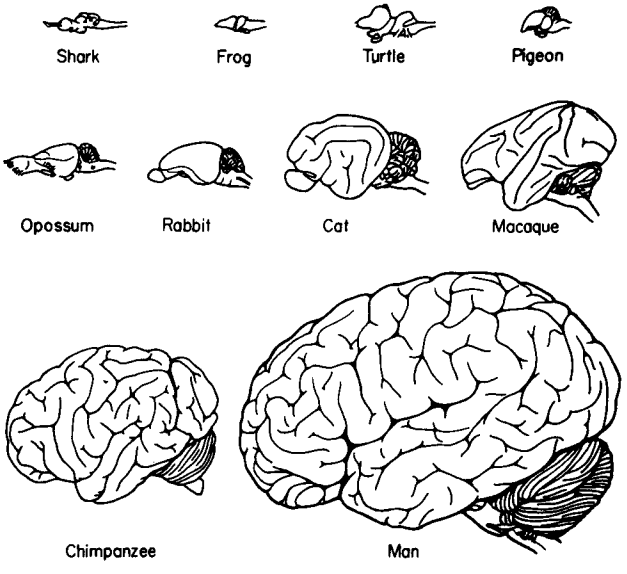

Figure 1. Brains of vertebrates drawn on the same scales. (Courtesy of Professor J. Jansen.)

3. The evolution of consciousness

Thorpe[27] made a valuable introduction to this fundamental topic: 'The evidence suggests that at the lower levels (of the evolutionary scale, fig. 1) consciousness, if it exists, must be of a very generalised kind, so to say, unstructured; and that with the development of purposive behavior and a powerful faculty of attention, consciousness associated with expectation will become more and more vivid and precise'.

He also states: 'The evolutionary problem is as follows: Given a brain of a given degree of elaboration, is it likely to be a more effective mechanism - more effective in an evolutionary sense - if it has consciousness, so to speak, attached, than if it has not?'

I give these quotations to indicate that the problem of the evolution of consciousness is so enigmatic that it is at the most obliquely referred to in phylogenetic considerations. If we agree that it emerged gradually to higher animals with the growing complexity of the performance of their brains, then we are confronted with the question: How did this completely novel non-physical entity come to be associated with a material structure? All types of panpsychists evade this problem by proposing that there is a proto-consciousness in all matter, even in elementary particles (Rensch[20,21]; Birch[2]). Thus they solve the problem of origins at the expense of catastrophic trouble with physicists (Shapere[23]; and Popper[19], p. 71).

According to panpsychism the phylogenetic development of brains is associated merely with an amplification and refinement of what was already there as a property of all matter. Thus there would be no problem of the evolutionary creation of mind in organisms that apparently were heretofore mindless. I do not regard this as an acceptable solution. It is a too easy evasion of the problem by proposing a radical transformation of physics. As Popper[19] states: 'We should not assign inside states, or mental states, or conscious states to atoms: the emergence of consciousness is a problem that cannot be avoided or mitigated, by a panpsychist theory. Panpsychism is baseless.'

If as neurobiologists we study the behavior of simple organisms, even honey-bees, we can plausibly account for even the most complex behavior by the concept of inherited instinct with a superimposed learning. The instinctual performance of an animal is based on the ontogenetic building of its nervous system and related structures by means of genetic instructions. And learning can be the increased effectiveness of synapses following usage. Thus we can stay entirely within the materialistic order. By far the most studied behavior of animals below birds and mammals is the honey-bee, but I do not accept Griffin's[8] mentalistic assumptions for the honey-bee on the grounds of dance patterns that display an elaborated coded symbolism with patterns in space and time. There is no reason to assume that the bees know what they do.

Even at the level of the amphibian, Lettvin, Maturana, McCulloch and Pitts[13] were able to account for the very effective fly-catching of frogs in simple terms of visual recognition (bug detectors) and reaction thereto. So far as I know there have been no comparable studies with reptiles. Hess (1962) gave evidence from experiments on parrots that these birds have mental experiences based on vision, and even considers this possible with fish. Lorenz[14] from his immense experience with birds describes behavior patterns indicating mental states. Thorpe[27] gives experiments on number recognition by birds (cf. Rensch[20]) which leads him to conclude that: 'We have here extremely strong evidence that animals can perform the mental abstraction of the quality of number which in human children can only be accomplished by conscious cerebration.'

It would seem that the range of our problem of phylogenesis is reduced to birds and mammals. The simplest strategy would be that we study consciousness in performance of the highest nonhuman animals, the anthropoid apes, before considering the more marginal cases of the lower orders of mammals and the birds. We have to adopt a cautious approach. As Popper[18] says: 'We cannot know, of course, how far animals are conscious. But novelty can excite their attention; or more precisely, it can excite behavior which because of its similarity to human behavior, many observers will describe as 'attention', and interpret as conscious.'

Griffin[8] states: 'To recognize that any mental experiences (that) animals may have need not be identical, or even necessarily similar, to those of a man under comparable conditions, opens up a wider range of potential interpretation, but, at the same time, makes it more difficult to gather convincing data.'

Studies of chimpanzees in the wild reveal a rather limited performance: a very marginal use of 'tools' without any conservation; an inability to use stones or sticks in effective combat; a restriction of interest to pragmatic considerations, food, social dominance, sexual activity; an aggressiveness with at most a limited altruism in food sharing. Yet, when trained from babyhood, it has been possible to teach a considerable sign language (for example, 130 for Gardner's Washoe) that is skilfully used for pragmatic requests - for food, for tactile pleasure, for play, for expression of emotions, moods, and feeling tones, all at a level of a human child of 1.5-2 years. It can hardly be doubted that they have experiences of the same general nature as what we term conscious, but not necessarily self-conscious. Yet they fail to develop linguistically as does a human child using sign language because they use language almost entirely pragmatically (Sebeok and Umiker-Sebeok[22]). There

is little or no attempt to ask questions about the surrounding world in the effort to understand it (the mathetic use of language) as is done by a 2–3-year-old child with its torrent of questions. What perplexes me is the rudimentary character of the mental performance of an anthropoid ape when considered relative to its rather large brain of a distinctively human character (fig. 1).

If we refer to the definitions given by Griffin for mental attributes, there can be no doubt about domesticated animals, the dog, cat and horse. I feel that the play of young animals is a convincing criterion of consciousness, as also curiosity, and the display of emotions, in particular the evidence of devoted attachment. Still we must be cautious about identifying these assumed mental states with those humanly experienced. We lack symbolic communication with them at the subtle level possible between human persons.

We can now ask: what advantage was given by this emergence of mental experiences associated with cerebral actions? Griffin[8] barely touches on this problem: 'Applying the same balanced approach to mental experience leads to a cautiously open mind concerning the possibility that both genetic and environmental influences, and interactions between them, may be important in the causation of mental processes, including awareness.'

There are suggestions that consciousness is valuable in that it gives some holistic experience to the animal. I would like to develop this idea further in respect of visual experience.

In the last two decades there has been an immense scientific study on the processing of visual information in the brains of cats and monkeys. In this sequential processing there is a progressive abstraction from the features of the original picture that existed as an image on the retina. At no stage in the nervous processing can neurones be found that would be instrumental in an eventual neural reconstruction of the picture - the mythical 'grandmother cells'. Yet we perceive the picture. The immense diversity of the patterned activity of neurones carries the coded information that could be used for reconstruction of the picture, but such an holistic operation apparently cannot be done by the neural machinery of the cerebral cortex (cf. Weiskrantz[29]). It is however accomplished in the conscious experience that in a magical manner appears when we open our eyes, and that changes from moment to moment in apparent synchrony with the visual inputs. The complex processing operations of the neural machinery of the visual cortex and beyond carries the coded information that is represented in the spatio-temporal patterns of the neuronal activity in the cerebral cortex. It can be postulated that in evolution the emergence of conscious mental experiences matched the evolution of the visual processing mechanism and its usage in guiding the behavior of the animal.

Simpler visual inputs guiding simpler animal behavior may not require integration into a global visual picture. For example, as referred to above, the visual system of the frog may function without any integrative operation, but merely be a 'bug detector' that enables the frog very effectively to capture small flying insects. But, with the greatly improved visual systems of the higher animals, birds and mammals, an integrated picture gives a great evolutionary advantage. Moreover this integration could include other sensory inputs, sound, smell and tactile, so giving some unified mental experience such as we enjoy.

Thus the hypothesis is developed that the emergence of mental experiences can be understood as providing for integration of the wide diversity of inputs into the brains of highly developed animals. Animals with simpler nervous systems and more limited sensory inputs and behavioral outputs have no such requirement of integration beyond what can be given by the central nervous system. Popper[18] (p. 125) proposes: 'That the evolution of consciousness...should be considered teleologically... as serving certain purposes, and as having evolved under certain selection pressures.'

It is recognized that this hypothesis provides no explanation of the mysterious evolutionary emergence of mental experiences in a world hitherto purely physical in its attributes. It merely suggests how this emergence would give evolutionary advantage.

It will be realized that the modern Darwinian theory of evolution is defective in that it does not even recognize the extraordinary problem that is presented by living organisms acquiring mental experiences of a nonmaterial kind that are in another world from the world of matter-energy, which heretofore was globally comprehensive. The Cartesian solution is no longer acceptable, namely that human beings have conscious experiences that are attributable to the Divine creation of souls, and that higher animals are merely machine-like automata devoid of mental experiences. Likewise, we cannot accept the panpsychist evasion of the problem, as Popper[18] (p. 69) states: 'The main motive of post-Darwinian panpsychism was to avoid the need to admit the emergence of something totally novel.'

The recognition that higher animals have mental experiences, as is so effectively argued by Griffin[8], presents a crucial challenge to evolutionists. Popper[18], (p. 438) raises the question: 'How did consciousness come to exist? I think that the main answer which we can give and which has some evidence in its favor, though not very much, is the answer 'by degrees'. I would say that anything like conscious awareness - not self-consciousness; rather resembling our own conscious awareness of a lower degree, let us say, the

conscious awareness which we attribute to a child before it has learned to speak...)

There is also the problem of how mental experiences are derived from the neural machinery of the brain and how they feed back to bring about the appropriate reactions of the animal. These problems will be discussed in the section on human self-consciousness.

It is disturbing that evolutionists have ignored the tremendous challenge to their materialistic theory that is presented by the emergence of mentality in the animal evolution. For example there is no reference whatsoever to the evolution of mentality in Mayr's classic book 'Animal Species and Evolution'[15] or in Monod's 'Chance and Necessity'[16] or in Wilson's 'Sociobiology: The New Synthesis'[30]. The explanation presumably is that, as is well documented by Griffin in his 'The Question of Animal Awareness', the climate of opinion of biologists has been governed by the dogmas of the behaviorists. But 'animal awareness' at least for the higher animals must now be accepted, and with that there is the challenge to the evolutionists. We have reached the stage where it can be said that ignoring the problem will not cause it to go away. Darwin very naively asked 'Why is thought being a secretion of the brain, more wonderful than gravity, a property of matter?' (Gruber[9] C Notebook, p. 166). So he set the tone for all subsequent evolutionists to ignore the problem of the emergence of consciousness in the evolution of animals, including human beings. It was regarded simply as a derivative of cerebral development. By contrast Popper[17] states that: 'The emergence of consciousness in the animal kingdom is perhaps as great a mystery as the origin of life itself. Nevertheless, one has to assume, despite the impenetrable difficulty, that it is a product of evolution, of natural selection.'

I believe that the emergence of consciousness is a skeleton in the cupboard of orthodox evolutionism. At the same time, I must state that, although the holistic concept gaves meaning to the emergence of consciousness, no explanation of this emergence is provided. It remains just as enigmatic as it is to an orthodox evolutionist as long as it is regarded as an exclusively natural process in an exclusively materialist world. The panpsychist solution is rejected, as stated above. In the Epilogue of my first Gifford Lecture, 'The Human Mystery' (1979), I concluded: 'In the context of Natural Theology, I believe that there is a Divine Providence operating over and above the materialist happenings of biological evolution...we must not dogmatically assert that biological evolution in its present form is the ultimate truth. Rather should we believe that it is the main story and that in some mysterious way there is guidance in the evolutionary chain of contingency.'

This concept will be further developed later.

4. The emergence of self-consciousness

It is proposed to use the term *self-conscious mind* for the highest mental experiences. It implies knowing that one knows, which is of course initially a subjective or introspective criterion. However, by linguistic communication it can be authenticated that other human beings share in this experience of self-knowing. Two quotations from Hess show that he was aware of the deep problems of human self-consciousness and its relation to the brain.

'Civilized man has the possibility of objectifying the widest and deepest reaches of his consciousness and guiding his peers in their thinking or being directed by them. It is still a riddle how the principle of correspondence is established between the object-forming symbolism and the flowing contents of consciousness'[10].

He reiterates the same enigma at the end of his Science paper[11]: 'While neuronal patterns determine the content of consciousness, they fail to provide clues concerning the transformation of such patterns into subjective experience.'

Dobzhansky[3] expresses well the extraordinary emergence of human self-consciousness or self-awareness as he calls it: 'Self-awareness is, then, one of the fundamental, possibly the most fundamental, characteristic of the human species. This characteristic is an evolutionary novelty; the biological species from which mankind has descended had only rudiments of self-awareness, or perhaps lacked it altogether. Self-awareness has, however, brought in its train somber companions - fear, anxiety, and death-awareness... Man is burdened by death-awareness. A being who knows that he will die arose from ancestors who did not know.'

This stage of ultimate concern can first be identified by the ceremonial burial customs that were inaugurated by Neanderthal man about 80,000 years ago. Popper[18] recognized the unfathomable problem of its origin:

'The emergence of all consciousness, capable of self-reflection, which seems to be linked to the human brain and to the descriptive function of language is indeed one of the greatest of miracles.'

Thorpe[28] after discussing in depth the problem of the consciousness of higher animals concludes that they have some rudimentary experiences of self-consciousness, but he feels equally sure:

'That no animals can reflect about themselves, about the abstract quality of their nature, their long-term aims, in short, their past and future history; or certainly not in anything even remotely like the way and to the extent that can man. That is I do not conceive that animals can be said to 'philosophize'.'

The progressive development from the consciousness of the baby to the self-consciousness of the child provides a good model for the emergent evolution of

self-consciousness in the hominids. There is even evidence for a primitive knowledge of self with the chimpanzee (but not lower primates) that recognizes itself in a mirror, as shown by the use of the mirror to remove a colored mark on its face (Gallup[7]). This same mirror recognition is achieved by a child at about 1.5 years old (Amsterdam[1]). It would seem that, in the evolutionary process, there was some primitive recognition of self long before it became traumatically experienced in the death-awareness which achieved expression in some religious belief that is manifested in the ceremonial burials. Similarly, with the child, knowledge of the self antedates by years the first experience of death-awareness.

It may be helpful to attempt some diagramatic representation of the emergence of self-consciousness. In the formal information-flow diagram of brain-mind interaction (fig. 2) there are three major components of World 2, which is the world of conscious experiences. The 'outer sense' and 'inner sense' compartments are integrated in the central compartment that may be labeled, ego, self or soul according to the kind of discourse, psychological, philosophical or religious. It has been conjectured above that higher animals are conscious, but not self-conscious. Thus the information-flow diagram would be simplified by elimination of the central core as is shown in figure 3 with the representation of only the outer sense and inner sense components. Moreover, some of the inner sense components such as imaginings and intentions would be rudimentary at the best, lacking all creativity. The language training of apes (Sebeok and Umiker-Sebeok[22]) has revealed that feelings are domant in their concentration on the pragmatic use of language for obtaining desirables. In the evolutionary emergence of self-consciousness there was creation and development of the central core to give eventually the full emergence illustrated in figure 2. It can be conjectured that in the phylogenetic process of hominid evolution there were all transitions between the situations illustrated in figures 3 and 2, just as occurs ontogenetically from human baby to human child to human adult.

It has been argued (Popper and Eccles[19]) that without memory we would not experience consciousness or self, and that all experiencing is tinged with remembering. An important differentiation was made between *implicit and explicit memories.* Implicit memory gives us the cognitive framework on which is built the experiences of explicit memory and self-consciousness. The most important implicit memory is our knowledge of a language. Without that there could be no development of the human person from the impersonal baby. As another example, because of the implicit memories built up during our life time, we automatically interpret our visual imputs to give experiences of the surrounding world on which we may act with assurance and that relate to and recall consciously perceived memories that are explicit memories.

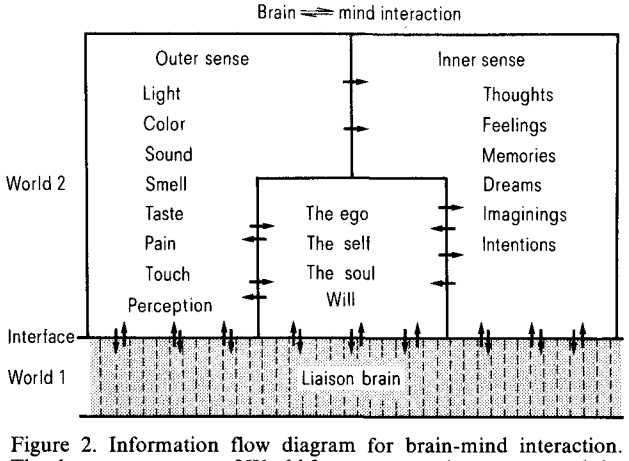

Figure 2. Information flow diagram for brain-mind interaction. The three components of World 2: outer sense, inner sense and the ego or self are diagrammed with their communications shown by arrows. Also shown are the lines of communication across the interface between World 1 and World 2, that is from the liaison brain to and from these World 2 components. The liaison brain has the columnar arrangement indicated by the *vertical broken lines.* It must be imagined that the area of the liaison brain is enormous, with open modules numbering over a million, not just the two score here depicted.

5. *The unity of the self*

It is a universal human experience that subjectively there is a mental unity which is recognized as a continuity from one's earliest memories. It is the basis of the concept of the self. Experimental investigations on the unity of the self have been discussed in 'The Human Psyche', Lecture 1 (Eccles[6]). By far the most important evidence relating to the unity of consciousness comes from the study by Sperry and his associates on commissurotomized patients. In the operation there was a section of the corpus callosum, the great tract of nerve fibers, about 200 million, that

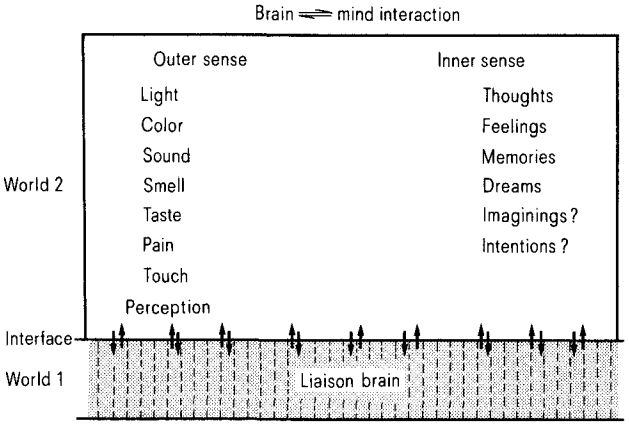

Figure 3. Modified from figure 2 as described in text.

links the two cerebral hemispheres (fig. 4). With the most sophisticated investigations, allowing up to 2 h of continual testing, it became clear that the right hemisphere, the so-called minor hemisphere was displaying evidence of conscious responses at a level superior to those exhibited by any nonhuman primates. The consciousness of the right hemisphere was indubitable. The perplexing question is whether the right hemisphere is self-conscious, meaning by that, that it knows and is aware of its self-hood. In the most searching investigations of Sperry, Zaidel and Zaidel[24] there was testing of the ability of the right hemisphere to identify photographs. A considerable ability was displayed, but was handicapped by the lack of verbal expression.

These tests for the existence of self-consciousness were at a relatively simple pictorial and emotional level. We can doubt if the right hemisphere with associated consciousness has a full self-conscious existence. For example, is there planning and worrying about the future? Are there decisions and judgments based on some value system? These are essential qualifications for personhood as ordinarily understood and for the existence of a psyche or soul (Strawson[26]; Popper and Eccles[19]; sections 31 and 33; Eccles[6]). It can be concluded that there is a limited self-consciousness in the right hemisphere, but the person remains apparently unscathed by the commissurotomy with mental unity intact in its now exclusive left hemisphere association. After commissurotomy the right hemisphere appears to have a self-awareness resembling that of a very young child. The information flow diagram for the right hemisphere would resemble that of figure 3, except that there would be a small central core at a primitive level of self or ego, but with no representation of soul or psyche or personhood.

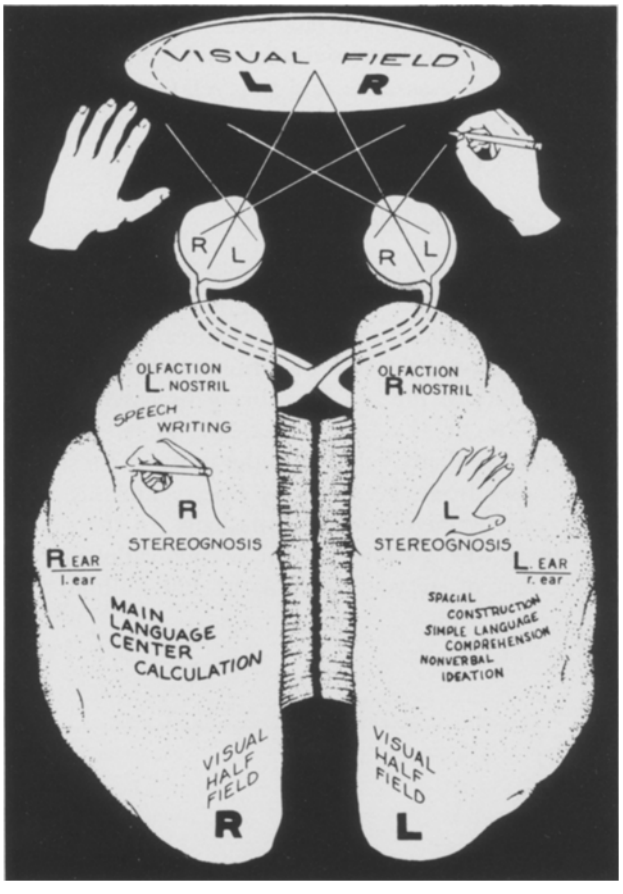

Figure 4. Schema showing the way in which the left and right visual fields are projected onto the right and left visual cortices, respectively, due to the partial decussation in the optic chiasma. The schema also shows other sensory inputs from right limbs to the left hemisphere and that from left limbs to the right hemisphere. Similarly, hearing is largely crossed in its input, but olfaction is ipsilateral. The programming of the right hand in writing is shown pictorally to come from the left hemisphere. Sperry, R.W.: Lateral specialization in the surgically separated hemispheres. In: The neurosciences: third study program, pp. 5–19. Eds F.O. Schmitt, and F.G., Worden. MIT Press, Cambridge (Mass), 1974.

6. The uniqueness of each self

It is not in doubt that each human person recognizes its own uniqueness, and this is accepted as the basis of social life and of law. When we enquire into the grounds of this belief, modern neuroscience eliminates an explanation in terms of the body. There remain two possible alternatives, the brain or the psyche. Materialists must subscribe to the former, but dualist-interactionists have to regard the psyche of World 2 (cf. fig. 2) as being the entity with the experienced uniqueness. It is important to disclaim a solipsistic solution of the uniqueness of the self. Our direct experiences are of course subjective, being derived entirely from our brain and self. The existences of other selves are established by intersubjective communication.

If my experienced uniqueness is attributed to the uniqueness of my brain that was built by the unique genetic instructions provided by my genome, one is confronted by the infinitely improbable genetic lottery from which my genome was derived as has been argued by Jennings[12], by Eccles[4–6] and by Thorpe[28]. There is further the impossibility of accounting for the experienced uniqueness of each identical twin, despite the identical genome. A frequent and superficially plausible answer to this enigma is the assertion that the determining factor is the uniqueness of the accummulated experiences of a self throughout its lifetime. It is readily agreed that my behavior, my memories, and in fact the whole content of my inner conscious life are dependent on the accummulated experiences of my life; but no matter how extreme the change that can be produced by the exigencies of circumstance, I would still be the same self able to trace back my continuity in memory to my earliest remembrances at the age of 1 year or so, the same self in a quite other guise.

Since materialist solutions fail to account for my experienced uniqueness, I am constrained to attribute

the uniqueness of my psyche or soul to a supernatural spiritual creation. To give the explanation in theological terms: each soul is a new divine creation which God attaches to the growing foetus at some time between conception and birth. It is the certainty of my inner core of unique individuality that necessitates the 'divine creation'. I submit that no other explanation is tenable, neither the genetic uniqueness whith its fantastically impossible lottery nor the environmental differentiations which do not *determine* one's uniqueness, but merely modify it.

An appealing analogy is to regard the body and brain as a superb computer built by genetic coding that has been created by the wonderful process of biological evolution. On the analogy, the soul or psyche is the programmer of the computer. Each of us as a programmer is born with our computer in its initial embryonic state. We develop it throughout life. It is our life-long intimate companion in all transactions. It receives from and gives to the world, which includes other selves. The great mysteries are in our creations as programmers or experiencing selves and in our association throughout life with our computers, as is diagrammed in figure 2, across the frontier.

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The regulation of order in cell communities

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The recognition of the difference between self and non-self is an essential feature of life within any system – whether the system be a single cell, a multicellular organism, a coral reef, or the largest ecosystem of which we have any knowledge, the biosphere of this planet. Every living creature is marked, in one fashion or another, as its own self, different from all other creatures of the same species and widly different from all other species. In effect, the life of the earth is made up of unique individuals. Uniqueness, if associated with mechanisms for the recognition of signals indicating individuality, makes a certain kind of biological sense. If you are going to set up a living system, with the implication contained in the term 'system' that the various members must relate to each other one way or another, as collabora-