J. Theoret. Neurobiol. **4**, 47–58 (1985)
Printed in Australia

MIND AND MATTER MATTER AND MIND?*

JOSÉ PEDRO SEGUNDO
Department of Anatomy and Brain Research Institute
University of California, Los Angeles, Los Angeles CA 90024, U.S.A.

(Received September 10, 1984)

Abstract

It is legitimate to examine the role of the Neural and other sciences in elucidating the important issues that confront us in any field of human endeavor, as, for example, ethics and esthetics, and of course, that of the mind-body relation.

Certain preliminary points are argued. (a) The reality to be considered must include, as starting point at least, the observer himself, an outside world, mental phenomena, and the cultural heritage (art, science, etc.). (b) Strict determinism, intrinsic probabilities and explosive leaps are inherent to, and coexist in, the dynamics of an overwhelmingly complicated reality. (c) Each level within the latter (e.g. , . . . , individual, cellular, molecular, . . .) has defining features and dynamics, some probably emergent and thus irreducible in spite of important two-way between-level interactions.

The contribution of the Sciences is valuable and necessary. Indeed, only answers guided by critical rationalism and compatible with scientific explanations can be accepted. Its successes, however, have been by far more useful and sometimes spectacular manipulations than deeply human insights: hence, it would seem that they are hardly sufficient. Interactions and reciprocities with other disciplines are indispensable, as is the recognition of the limitations of any single approach. Ultimately, faced with interrogations for which no rigorous answers can be demonstrated and many cannot be rejected, human Reason reaches the end of its tether. Then an ideological option arises between remaining perplexed or taking a faith-impelled leap to belief in an all-knowing, all-powerful superior being or science: the variety of such beliefs is quite apparent and striking. Another option arises, and it imposes a gambler's choice between giving up or going on: the decision almost unanimously is an essentially hopeful one.

*The title, but not the spirit, was suggested by a comment, Russellian in the sense of coming, not from the remarkable Bertrand Russell himself but from Lady Russell, his grandmother; she, on discovering his adolescent metaphysical preoccupations, asserted summarily, "What is mind? No matter. What is matter? Never mind" (Russell, 1969).

Introduction

Life is cluttered with interrogations which, like sidewalk billboards, are numerous, stare us in the face and usually receive little heed. It is likely, however, that in spite of such indifference, many have wondered, more or less privately and frequently and with more or less concern as to whether, for example, life has a goal or simply drifts, the noisy and angry story of the poor idiot, as to why the thrill of multicolored sunsets or metallic shapes, as to whence that stern statute that we are convinced our own conduct abides by and that of others should, or as to the relation between our bodies and thoughts. None of this is trivial, naive, forced, or irrelevant, and those who put it aside all the time perhaps do not realize that such postures are but reverse somersaults that entangle irrevocably.

It is pertinent, in any case, to ask how much light is shed by the neural and other sciences into the murky domain of these interrogations. After a period of relatively little interest for physiologists, the topic again becomes fashionable — as in other times (e.g., Brazier, 1979) — and the opinions expressed here join an ever-increasing series of similar efforts by other neuroscientists, not totally irresponsible, for, after all, even inaccurate measures (as such efforts may be) provide more reliable estimates as the sample increases.

This presentation, and a similar one, (Segundo, 1984) discuss the realities that must be considered, the general background that is appropriate in terms of contemporary science, and finally some conclusions.

1. Realities to be considered

First, one must ask (e.g., Popper, Eccles, 1981; Russell, 1948), which are the kinds of entities that are crucial in the sense that, if ignored, the game will start with an incomplete, unjustifiably amputated Universe. It would seem that for me, the writer of these lines, a specific individual with name and surname, social security, etc., who has the intimate experience of living as an independent being, feeling, thinking, deciding, acting, it is admissible to begin by accepting the reality of my own self — the first person singular, "I" — in spite of perhaps reasonable objections to the straightforward acceptance of the Cartesian (and even Augustinian) "I think, therefore I am" (Descartes, 1962).

The intuition of this personal "I" involves also a solid body, and different degrees of importance are attributed to its separate parts: most, in fact, are judged dispensable and some almost not altogether belonging. A special feeling of necessity (though perhaps not of sufficiency) is reserved for the head and the central nervous system it contains; with it goes the current belief that a hypothetical head transplant would transfer the person too. It has been said (e.g., Eccles, 1982) that the person is associated exclusively with the dominant hemisphere's cortex — speech areas in particular — through which the activities of the other hemisphere reach consciousness and the latter transmits its motor commands. It is hard, however, to reconcile such a preponderant role with the abundant clinical and experimental evidence pointing to an even more critical participation of central di- and mesencephalic areas; namely,

the facts (i) that consciousness is maintained by a "centrencephalic" system (e.g., Penfield & Jasper, 1954), (ii) that the localized lesions that cause the most spectacular losses of consciousness are those to the reticular nuclei of the brainstem (French, 1952), and (iii) that decorticate or anencephalic humans behave in ways that can be interpreted reasonably as associated with rudimentary feelings (e.g., expressions of pain or pleasure, sighs, smiles and tears, Monnier, 1973).

Secondly, the experience of living as an independent being is associated with — perhaps inseparable, or even arising, from — that of an outside world populated by things and other beings. This world is not apprehended as directly as the "I", but rather through qualities that appear through the senses.

Thirdly, also real probably are mental phenomena outside of me, at least in those entities that resemble me most — I have, or even am, mental experiences — and from whom relatively reliable reports are forthcoming: adult humans, for example. This, of course, leaves open intriguing issues, such as conceding them to infants and other animals (which we are sorely tempted to), as to whether plants also are sentient (though perhaps clumsily so), and even as to whether solid rocks feel at all. This inference, e.g., that there are smells that others smell and passions that others feel, is made automatically by everybody, even if later and upon reflection some may feel it an unwarranted extrapolation beyond direct experience.

Attribution of reality to mental phenomena outside of me is not the anomalous, unaccustomed, scientifically unwarranted concession that it appears to be at first sight. Indeed. modern Physics (as Mythology) accepts the reality of not immediately apparent entities when everyday objects behave as if they existed and acted upon them. Such has been the case with such invisible particles as electrons and their hundreds of peers and anti-peers, and with immaterial entities such as fields and forces (Close, 1984). And who would dare say that more have been face to face with electrons, neutrons or pions than with ghosts, gods or goblins? Hence, the same privilege conceded to Physics *a propos* of electrons and the like must be extended to Psychology and the laity *a propos* of mental phenomena.

There is yet a fourth category to be considered, namely that of the products of the mind which, as technology, science, art, ethics, philosophy and religion, constitute our cultural heritage (Popper, Eccles, 1981): it includes tools, instruments, objects of art, language, theories, systems, etc. For one, such things comply with the requirement that everyday objects behave as if they existed and acted upon them: for instance, a scientific theory (cultural object) starts a train of thought (mental object) that leads to a drug that modifies the internal milieu (physical object).

Much more significantly, such products are ever-present and essential in our daily lives. In fact, beyond those dimensions of brutishness that we share with other species, they form a superstructure that, jointly human, humanistic and humanitarian, constitutes the most specific character of the *Homo sapiens*, each an end in himself to be weighed respectfully in any decision that affects him. It seems, therefore, that to live, indifferently or enthusiastically, happily or angrily, but always anchored firmly to, and rotating faithfully around, the products of the mind, and yet to ostracize them from our studies, demoting them to the second-class citizenship of irrelevant by-products or easily explained-away illusions, is a dishonest sleight-

of-hand, suggestive of a schizoid general attitude and, at best, a myopic, tubular scientific vision.

In short, then, and for a start at least, I must accept the realities of my own self, of an outside world with things and beings, of mental phenomena outside of me, and of the products of the mind.

2. General background

A second fundamental question asks which is the overall conceptual context against which these issues must be examined? Two general attitudes are contraposed: Physics — the queen of the sciences, and the object of much envy from its peers — illustrates them well. One, that of classical Physics and largely abandoned by specialists, lingers on unhealthily in the Neurosciences and in everyday life. Classical Physics believed that a scientific theory had to be valid universally, applicable always and everywhere. Nature was essentially stationary, since even varying situations departed relatively little from some point of reference; it was also homogeneous, and what was valid here would be valid there too. Everything could be explained by causally deterministic laws. Furthermore, these would be expressed by relations between variables that at each instant had precise values: it was legitimate to use probabilities, of course, but this was imposed by the coarseness of measuring devices and the ignorance of influential issues.

And, continued classical Physics, because the parts explain the whole exhaustively, any scientific theory should wind up appealing to basic events. The parts fluctuated, it is true, but particulate variations were negligible compared with those that counted in the whole; they were, moreover, uncorrelated, and from statistically independent disorder at one level arose orderliness at the next. If, in fact, a complexity were chopped up into its components, all its mysteries would fade under the simple, majestic radiance of the ultimate particle, the indivisible "atom" that holds the clue that unravels the Universe. Laplace's demon (Brillouin, 1967), aware of the positions and velocities at a particular instant of all masses, could reconstruct the entire history of the Univere from beginning to end. Indeed, then, "With Earth's first Clay they did the Last Man knead, /And there of the Last Harvest sow'd the Seed: /Yea the first Morning of Creation wrote /What the last Dawn of Reckoning shall read" (Fitzgerald, 1952).

Contemporary Physics and Thermodynamics (Cereijido, 1978; Prigogine, Stengers, 1979) confront classic views, often appalling naive intuitions and self-satisfied common senses. A scientific theory, they claim, must adjust itself to a Universe that is multiple and ever-changing, less a set of objects that one of events where there is no permanent invariant essence. Stability and uniformity are but useful idealizations that provide references and make thinking and calculations easier. What does exist are trends, and it is only from them and applying pragmatic criteria that periods at best acceptably stationary can be extracted.

There are, too, explosive crises of instability: on arrival at critical "threshold" or "crossroad" points, the system performs leaps that, in a literally catastrophic manner,

carry it to entirely different states (Thom, 1972). On reaching such a threshold, a particular microscopic deviation becomes significant relative to the whole: it imposes, so to speak, upon other parts its operational regime which is magnified and blown out of proportion when between-part correlations appear, as if each knew what the others were doing. The whole behaves as a macroscopic unit, achieving a macroscopic event that cannot be explained by the microscopic ones, even though the latter allowed it.

The neuronal membrane provides an example when, in the macroscopic event called "action potential", it leaps from the resting to the excited state, and the electromotive force across it passes from, say, 70 mV negative inside the cell to 40 mV positive. In an iron-wire model of a nerve, current pulses produce small active patches that the naked eye sees as spots; when the fraction of the surface in this condition reaches a critical value, the entire surface becomes activated. In the living membrane, the catastrophe is explained as follows (Tasaki, 1981). The membrane is formed by microscopic units of molecular order whose state is characterized by the proportion of intact calcium bridges: only two states are stable, one called "compact" (or "resting"), the other "swollen" (or "excited"), and they are separated by many unstable ones. Adjacent units associate in sets called "domains", such that all units in a given domain are in the same state and jump synchronously from one stable state to the other; when neighboring domains are in dissimilar states, small micro-currents circulate between them. In the membrane at rest most domains are in the compact stable state. Extraneous outward-through-the-membrane currents increase the proportion of domains in the swollen stable state and with it the sum of the microcurrents; when that sum achieves a threshold value, the abrupt tidal wave of excitation that constitutes the action potential floods the entire membrane. Consequently the whole cannot be deduced always from its parts.

Laws cannot be universal since each situation, bounded by inescapable constraints, is specific or "local". Moreover, expressing a parameter at a particular instant by precise values is just another useful idealization: it is not simply clumsiness and ignorance that impose probabilities but also a character inherent to reality whereby variables can have several values, each with a certain probability. In short, the reduction to atoms has failed, as each level has its peculiarities and interactions. Quantum mechanics dispelled the appealing mirage of a unique conceptual scheme serving across the board for the entire Universe (Guillemin, 1968).

There are lessons to be learned from this and there are lessons to be learned as well as attitudes to be un-learned, a process with amazing inertia: hence, their acceptance may not be smooth. Some refer to universal evolution. The physical one, starting from early states with simple and few elements, is spattered by creative leaps, each exhibiting a miniscule *a priori* probability, and thus quite unexpected even to the sharpest of present-day scientists: such, the emergence of heavier elements, of different isotopes of the same element, and of Life itself. The argument is often made that any possible event is bound to happen sooner or later, regardless of how unlikely it may be. It is insightful when aimed at countering the opinion that Life cannot arise without some special design. It is far less, and even not at all, so when aimed at down-playing the unexpectedness of a certain event — forty "heads" in succession or some

evolutionary leap — and at invalidating feelings of surprise and curiosity about its genesis.

Life does not comply with the conditions required for, and therefore escapes from, Bolzmann's irreversible drift to the most likely macroscopic state, uniform, inert and unchanging (Cereijido, 1980; Prigogine, Stengers, 1979). It arises in open systems and far from thermodynamic equilibrium, where organization literally feeds on that aperture, where linearity coexists with non-linearity, where acceptable stabilities subject to conventional determinisms coexist with unpredictable instability crises, and where dissipation becomes the source of a structured macroscopic order. The evolution of living matter confronts us with creative leaps, builders of macroscopic organizations with increasing complexities, veritably miraculous, and almost unbelievable: such, the emergence of sensitivity, consciousness, language, science, art, ethics and religion. The former (e.g., sensitivity, science) are justified in a straightforward manner within the framework of natural selection since their survival value (so far at least) is clear. The others, as the arts, philosophy, and research without practical connotations, are less comprehensible, unless they too are ends in themselves, as prominent and meaningful vitally as preservation of individuals and species (Segundo, 1973).

To be learned also is the lesson that what exists after each leap cannot be reduced to what preceded it, having features, principles and dynamics that differ from standing ones (Mac Kay, 1978; Sperry, 1980): the latter, though respected scrupulously and remaining inviolate, are used and superseded. The whole, thus much more than a simple juxtaposition of parts, is a complex of masses and energies that absorbs its components physically and conceptually, filling in in space and time whatever between-part gaps remain. Any reduction destroys the distinctive idiosyncrasies of the whole, in effect dismantling it. Macduff, on emerging from Duncan's chamber, announces the confusing, horrifying happening by screaming simply, "murder and treason": even if he'd known about them, it is just unthinkable that he would have uttered instead a list of discharging neurons, liberated transmitters, sliding filaments or ruptured and spilled tissues.

Exhaustive reductions, if any, are few and far between (e.g., Popper, Eccles, 1981). In Physics, for instance, commonplace phenomena such as turbulence and storms are largely not understood, and the reduction of Chemistry to Physics is minimal. That which concerns Socio-psycho-biology faces special difficulties. An immediate one arises from the finding that, even ignoring pathology and aging, "the outward appearance of individual stability is an illusion" (Young, 1982): indeed, any living being renews incessantly all of its molecules (with few notable exceptions). This uninterrupted anabolism and catabolism, that occurs essentially within the cells where it is the main consumer of metabolic activity, opposes the entropic destruction of spatial and energetic inhomogeneities and thus delays death. Contrastingly, the genetic material DNA is stable, for it is synthetized exclusively prior to mitosis, and, privileged among all molecules, enjoys mechanisms that repair any local damage. (Histones also are stable nuclear proteins but lack repair mechanisms.)

Thus, two entities persist in each individual. First, a set of particular molecules of DNA (and histones) is distributed spatially throughout all cells and outlines the

individual's shape. In the second place, and interlaced in that discontinuous phantasm, is a set, not of particular molecules, but of particular molecular types. The individual is, in a sense, like an army camp or prison, with a permanent staff and with invariant categories of recruits that are renewed individually. This is pertinent to the intimate conviction of being a lasting individual capable, say, of evoking memories about oneself: indeed, if it relates to DNA (or histones), it can do so on the basis of the individual merit of particular molecules; if, on the other hand, it relates to other compounds, it must do so on the basis of their representing certain types or serving certain processes. In either case, it tolerates the evanescent nature of most molecules (and atoms).

In short, the reduction of Socio-psycho-biology is trifling, as it stands and in spite of meritorious advances. It is quite obvious that we are very far from understanding the neurogenesis of innumerable current events, let alone that of, say Poe's "Raven" or of how the uneasy workers in one place simply are being manipulated from the other geographic longitude. A metaphor from athletics may be illustrative: running the 100m dash in close to 10s is admirable, and efforts to improve that mark are commendable, but there still is an abyss between that and moving at the speed of light.

Yet another lesson to be learned is that of two causalities (Popper, Eccles, 1981). One we are well aware of and "ascends" from the part to the whole. The other "descends" from the whole to the part and, though used pervasively, tends to be neglected when examining these matters. It is apparent when atoms in a certain molecule and not otherwise have some behaviors imposed and others interdicted, when molecules in a purposive gadget — wedge, wheel or whistle — push, turn or shake because of the overall design, or when the cells of any individual are carried upstairs, downstairs, shopping, to work, and finally to the grave because of some local but lethal failure.

Our daily coming-and-going is thought, felt, and performed at the human levels of physically macroscopic behavior, intellectual categories, emotions, etc., the things Man lives by. Attempts to manipulate at those levels certainly can be initiated by detours through the microscopic level of basic components that trip ascending causalities; examples abound in everyday life, technology and science. Other such attempts start with maneuvers at macroscopic, intellectual or emotional levels. This occurs endlessly in the dialectical give-and-take of current life, psychotherapy (professional or amateur) and propaganda that appeal to logical exhortations, more or less sibylline insinuations, and so forth. Also often, however, there are attempts at human level whose goal is precisely to trip descending causalities: such are, for example, medical recommendations to avoid aggravating frustrations in the prevention of hypertensive crisis and the vibrant harangues by the leader — Henry V, Winston Churchill, the coach — prior to forthcoming competitions. The laboratory too provides hints (Diamond *et al.*, 1981), for the cerebral cortex is thicker in rats exposed since birth to an increasing series of alerting novelties, than in those reared in a practically unvarying environment. The former go through what objectively is just "a succession of not-previously-presented, exploration-provoking stimuli", but that, as soon as anthropomorphic implications are considered, can be described

legitimately as "a life enriched by surprising, interesting and challenging events". Hence, features defined at the mental level and relative to the individual's history act downwards upon the CNS.

The essential lesson is that one can know only within bounds. These are imposed, of course, by the impossibility of talking about the simultaneity of distant events, by the use of instruments orders of magnitude different from the objects they study, etc. But in addition, and above all perhaps, by the opulence of a reality that exceeds any verbal description or intellectual categorization. Strict determinism, by referring effects to causes, is a supposition necessary for understanding. A totally undetermined and random Universe where any event could follow any other with equal probability, one with which God played dice, would be unacceptably incomprehensible and unpredictable. Determinism covers a broad aspect of reality that includes much of technology, science, and everyday life. The persuasion that this is so is implicit in the repeated "why" of children and in the conviction that each act triggers a cascade of causally concatenated events. Even complete determinism, however, is far from providing a secure guarantee of predictability, and the trajectories of deterministic differential equations may wind up wandering in a largely unpredictable manner in the vicinity of chaotic attractors, though they appear simple and can be followed step by step as far into the future as one may wish to (Geisel, 1982): they could perhaps be fathomed by the exquisite omnipotent reason of some Laplacian demon. Determinism is but one side of the coin, and shares the stage with the uncertainty of the inherently probabilistic and with the capricious whims that direct traffic at crossroads. This second side reigns, not just at quantum level, but also in the innumerable situations that are unexplained and unpredictable in the macroscopic sciences and in everyday life. In short, Laplace's demon has been exorcised (Brillouin, 1967).

3. Conclusions

These conclusions will not be conclusive in the sense of providing a definitive answer to the light shed by the neural and other sciences in the domain of those interrogations, let alone to the interrogations themselves. Tentatively, however, one may assert that the contribution of the natural sciences and the light projected into those domains have been important and necessary, and will continue to be. In fact, once we have accepted the validity of the induction principle — which Hume (1963) proved, probably for all time, cannot be inferred from experience or deduced from other premises — the only admissible roamings about and within these interrogations are those guided by the compass of critical rationalism and along routes compatible with explanations in force in the sciences, including those of the nervous system. Any other meandering, abiding exclusively by metaphysical or religious conjectures, will by definition be less self-critical, consistent and reliable. This is no more nor less than an affirmation of our faith in what we have come to call the scientific method. If certain facts are added to this affirmation, the vogue of the reductionistic opinion that the laws of the inanimate are all that is required to explain Life, becomes understandable. Those facts are (i) that the chronology wherein physical and

chemical phenomena preceded Life is compatible with the former causing the latter, and (ii) that the many times confirmed validity of physico-chemical laws in living matter is compatible with their being the only ones.

The contribution of the neural and other natural sciences is not sufficient. As noted, whereas exhaustive reductions are few and far between, incomplete ones are innumerable. It is possible, of course, that these will be achieved someday: this is simply a matter of opinion, however, and an affirmative answer is but a prophecy about the future based upon an act of faith. Hence Reductionism is not the only interpretation compatible with present-day facts, an inescapable logical deduction. Its vogue is understandable, as pointed out, but not as justified is the wooden, simple-minded, impatient attitude of many proponents, too close to the blind, untroubled, smug faith of explicitly religious groups and too remote from the mistrustful, worried, modest skepticism that is at the core of true science, and that in fact provides the purest fuel to its motivation.

In the last decades of the 20th century, around 1984, the Neurosciences find themselves at the surface of issues with deep human connotations and, emboldened by justified hopes of spectacular manipulations, abandon earlier attitudes of detached austerity (Segundo, 1983). Shed too with these should be all traces of the arrogant negligence that stifles sobriety, self-criticism and broadmindedness. Indeed, the Neurosciences by themselves, lacking reciprocity in terms of aid, guidance and supervision with the other branches of knowledge — Logic and Mathematics, Linguistics and the Humanities, Philosophy and Theology — will more and more ramble artlessly and pretentiously around increasingly sophisticated and decreasingly meaningful technical trivia.

This is not a plea for a Renaissance Man, in the sense of one with almost exhaustive knowledge of many fields: obviously the sheer mass of contemporary information, not just in any discipline but also in each nook and corner, renders that unattainable. Any discipline that is relevant to *Homo sapiens*, however, after shaking off what essentially are either minute details with only local worth or the pirouettes and contortions of the specialists' crafts, can and should be distilled into sentences expressed in everyday language and comprehensible to non-specialists. Strength in the former with weakness in the latter have led the thinking community to a labyrinth of forking and ever-diverging tunnels, to a Babel's tower with each vanguard trapped by its own jargon and no more than occasional misgivings about its insularity. Many, and particularly those in the sciences, have experienced the difficulties of such distillations, but they are indispensable, and it is at their level that the Renaissance character can be recuperated.

In any case, at the very core of the thinking, emotional, willful, believing medley of forces that each experiences within, rests a fulcrum formed by the primitive irreducible certitudes of one's own existence, of the reality of an outside world and of the significance of ethical, esthetic and other values; with them stands the conviction that one can know and that logic, though admittedly somewhat mercenary and permeable, provides the not-to-be appealed censorship to which all of the rest must submit (e.g., Segundo, 1983). The whys and wherefores of these certitudes may well remain unclarified enigmas. The Sciences, exceedingly reticent in the past, cannot

remain marginal; if they did, then they would be guilty of the omission against which our most intimate self reacts unfavorable under any circumstances, judging it a demeaning neglect that slights our very essence and saws the pillars of our personality. Indeed, if the banality of all this were accepted, what sense would there be in searching for truth and admiring beauty, why the notions of merit and demerit, and the strivings toward or away from them? And what of the hard-to-please demiurge proclaiming an unforgiving ethics and an unshakable belief in a will that is free?

A view of the Universe restricted to the flatness of what is ordinary and inert has little place for beings that are human, i.e., that enjoy and suffer the cognitive, esthetic, ethical, religious features that identify them as a species and as individuals (Kung, 1979; Mac Kay, 1978, 1980; Popper, Eccles, 1981; Sperry, 1980). An opinion which, for example, disqualifies the norms of rational thinking as meaningless and shrinks them to epistemological non-significance automatically abrogates any ideology, including itself. If left at that without further ado, it implies that no knowledge is possible, the absolutely skeptical conclusion that can escape from the flagrant contradiction of expressing or suggesting knowledge only by refraining from making statements or even thinking (Hessen, 1939).

Few who judge factual evidence critically and rationally, i.e., according to the scientific creed, escape the conclusion that it was against the background of the private fidgeting of an inanimate world that Life, Sensibility and Consciousness raised their heads and prospered (Cereijido, 1978; Prigogine, Stengers, 1979). Nevertheless, the crucial interrogations mentioned, including the mind-body relation, are susceptible of several answers, whose truth or falsehood cannot be demonstrated rigorously because conclusive evidence is missing (and, in fact, may simply be unobtainable thus sparing us from an eventual loss of what indeed is the salt of the earth).

Ultimately, then, at a point where rational thought reaches the end of its tether, at the non plus ultra beyond which it can advance no more, unarmed, astonished, fascinated, perhaps anguished, we face crucial indecipherable interrogations. An ideological option arises at this critical dead end: i.e., that of whether to remain perplexed or to gamble on a faith-impelled leap. Those who do gamble may place their money on a deity, an original intent and a final goal that, they claim, confer meaning to our norms and some majesty to the human race (Kung, 1979). Others, apparently more modest, bet on a Universe existing by and for itself whose private squirmings are hare-brained, where thought and consciousness arose simply because of some unreason or another, erratic perhaps, devoid of rules and hierarchies and lacking insight, intents or goals, but in any case godlike. It is likely that any bet will soothe whatever roughness is inherent to unanswerable interrogations.

The critical dead end raises also a behavioral option, that which cannot be sidestepped, of whether to give up or live on. Contrary to the multiplicity of outcomes to the ideological one, this decision is overwhelmingly unique; indeed, neither the ideological choice nor the not-always-taken-lightly burden of serious problems blocks the ongoing flurry of everyday life. Even though in a half-light and balanced precariously on the crest of about-to-collapse breakers, inexorably a point is reached where further discussion ceases to make sense, where the will to live on becomes

dominant, and as compulsive gamblers we bet on a particular route and follow it without harping on its essential uncertainty. Some might agree with Jason Compson III that man is conceived by accident, that every breath is a fresh cast with dice already loaded against him, and that even despair, remorse or bereavement are not important to the dark diceman, but few would, like his unhappy son, carry this through to self-slaughter (Faulkner, 1946).

We live and act, therefore, without major complications or after-thoughts, as if knowledge were desirable and possible, as if there really were values to be aspired to or shunned, as if choosing between them were indeed in our hands, and as if rationalism were fully trustworthy. The common behavioral choice is, therefore, in a sense confident and optimistic, and it was not for nothing that the kindly Titan was condemned to eternal shackles and daily eviscerations, less because of giving to Man that which will warm him (and may burn), than because of placing in his heart a Hope that springs eternal, blind as a bat and gullible like a fool.

And so Hume (1963): "Thus the Observation of human Ignorance and Weakness is the Result of all Philosophy, and meets us, at every Turn, in spite of our Efforts to conquer, or avoid it." And Camus (1949): "I am for the plurality of opinions. If it were possible to organize the party of those who aren't sure of being right, that would be mine." But Pascal (1971): "Nature rallies to aid impotent reason, and prevents it from wandering too far astray."

REFERENCES

Brazier, M. A. B. (1979). Challenges from the philosophers to the neuroscientists. In: *Brain and Mind.* Ciba Foundation Series 69 (new series). Elsevier, North Holland.

Brillouin, L. (1967). *Science and Information Theory.* Academic Press, New York.

Camus, A. (1949). Cited by Vargas Llosa, M. (1948), *Entre Sartre y Camus.* Ediciones Huracán, Puerto Rico.

Cereijido, M. (1978). *Orden, Equilibrio y Desequilibrio.* Nueva Imagen, México.

Close, F. (1984). Particelle. Le analogie in fisica harono portato alla scoperta di particelli elementari subatomiche, al mondo colorato dei quark. *Prometeo,* anno 2 numero 5, 62–69.

Descartes, R. (1962). *Discours de la Méthode suivi des Méditations.* Union Générale d'Edition, Paris.

Diamond, M. C. and Connor, J. R. (1981). A search for the potential of the aging brain. *In, Brain Neurotransmitters and Receptors in Aging and Age-related Disorders.* Aging series, Vol. 17, (Enna, S. J., Samorajski, T. and Beer, B., Eds.), Raven Press, New York.

Eccles, J. C. (1982). *Mind and Brain. The Many-Faceted Problem.* Paragon House, Washington.

Faulkner, W. (1946). *The Sound and the Fury.* Vintage Books, New York.

Fitzgerald, E. (1952). *Rubaiyat of Omar Khayyam.* Garden City Books, New York.

French, J. D. (1952). Brain lesions associated with prolonged unconsciousness. *Arch. Neurol. Psychiatr.* **6**, 727–740.

Geisel, T. (1982). Chaos, randomness and dimension. *Nature* **298**, 322–323.

Guillemin, V. (1968). *The Story of Quantum Mechanics.* Charles Scribner Sons, New York.

Hessen, J. (1939). *Teoría del Conocimiento.* Editorial Losada, Buenos Aires.

Hume, D. (1963). *An Enquiry Concerning Human Understanding and Other Essays.* Washington Square Press, New York.

Kung, H. (1980). *Does God Exist? An Answer for Today.* Doubleday, Garden City, New York.

Mac Kay, D. M. (1978). Selves and brains. *Neuroscience* **3**, 599–606.

Monnier, M. (1973). Response repertoire of the anencephalic infant. In: *Early Human Development.* (Hutt, S. J. & Hutt, C., Eds.). University Press, Oxford.
Pascal, B. (1971). *Pensées.* Mercure de France, Paris.
Penfield, W. and Jasper, H. H. (1954). *Epilepsy and the Functional Localization of the Human Brain.* Little Brown & Co., Boston.
Popper, K. R. and Eccles, J. C. (1981). *The Self and Its Brain.* Springer International, New York.
Russell, B. (1948). *Human Knowledge, Its Scope and Limits.* Allen and Unwin, London.
Russell, B. (1969). *The Autobiography of Bertrand Russell.* Bantam Books, New York.
Segundo, J. P. (1973). How much is basic research worth really? *Perspect. Biol. Med.* **16**, 329–331.
Segundo, J. P. (1983). Rationalism in an age of reason. *J. Theoret. Neurobiol.* **2**, 161–165.
Segundo, J. P. (1985). *La Neurofisiología: algunas Bases y Supuestos, Implicancias y Recovecos. Universidad Nacional Autónoma de México*, México D.F.
Sperry, R. W. (1980). Mind-brain interaction: mentalism, yes: dualism, no. *Neuroscience* **5**, 195–206.
Tasaki, I. (1982). *Physiology and Electrochemistry of Nerve Fibers.* Academic Press, New York.
Thom, R. (1972). *Stabilité Structurelle et Morphogenèse.* W. A. Benjamin, Inc., Massachusetts.
Young, R. (1982). Biological renewal. Applications to the eye. *Trans. Ophthal. Soc. UK* **107**, 42–75.