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The Materialistic Theory Of The mind

Abstract. *Materialism answers, among others, the question of the nature of mind, i.e. the mind-body problem. However, so far this answer has been sketchy and inexact, and it has not made full use of contemporary physiological psychology. The aim of this paper is to provide a fuller and more precise answer on the basis of some of the recent work in neuroscience and psychobiology*

We have to remember that what we observe is not nature herself, but nature exposed to our method of questioning.
Werner Heisenberg

1. TEN VIEWS ON THE MIND-BODY PROBLEM

There are two main sets of solutions to the problem of the nature of mind: psychoneural monism and psychoneural dualism. While according to the former mind and brain are one in some sense, according to dualism they are separate entities. However, there are considerable differences among the components of each of the two sets of solutions to the mind-body problem. Thus psychoneural monism is composed of the following alternative doctrines:

panpsychism ("Everything is mental"), neutral monism ("The physical and the mental are so many aspects or manifestations of a single entity"), eliminative materialism ("Nothing is mental"), reductive materialism ("The mind is physical"), and emergentist materialism ("The mind is a set of emergent brain functions or activities"). Likewise the dualist camp is divided into five sects: autonomism ("Body and mind are mutually independent"), parallelism ("Body and mind are parallel or synchronous to one another"), epiphenomenalism ("The body affects or causes the mind"), animism ("The mind affects, causes, animates or controls the body"), and interactionism ("Body and mind interact").

None of these views is too clear: none of them is a theory proper, i.e. a hypothetical-deductive system with clearly stated assumptions, definitions, and logical consequences from them. Every one of the above opinions on the nature of mind has been formulated only in verbal terms and with more concern for obeisance to ideology than for the data and models produced by neuroscientists and psychologists. ***In*** *particular, aIthough there are plenty of arguments pro and con the so-called identity theory, or materialist theory of mind, nobody seems to have produced such a comprehensive theory in the strict sense of the term 'theory'. All we have, in addition to a number of psychophysiological models of a few special mental functions, is a programmatic hypothesis - namely that mind is a set of brain functions. To be sure, this hypothesis has had tremendous heuristic power in guiding research in the neurophysiology of mental processes. Yet it is insufficient, for scientists need a more explicit formulation of the thesis that what "minds" is the brain, and philosophers would find it easier to evaluate the claims of the psychoneural identity "theory" if it were stated with some precision and in some detail.*

The present chapter attempts to accomplish just that with regard to one kind of psychoneural identity theory, namely emergentist materialism. This is the view that mental states and processes, though brain activities, are not just physical or chemical or even cellular, but are specific activities of complex neuron assemblies. These systems, evolved by some higher vertebrates, are fixed (Hebb, 1949) or itinerant (Craik, 1966; Bindra, 1976). This paper is based on another, more comprehensive and formal work which in turn uses key concepts particularly those of system, biosystem, and biofunction. Only the bare bones of the theory are presented here.

2. BASIC CONCEPTS AND HYPOTHESES

A basic concept of our theory is that of a concrete or material

*system, as exemplified by a neuronal circuit, a neuronal minicolumn,
and the entire CNS of an animal. A concrete system can
be characterized by its composition, environment, and structure.
We are of course particularly interested in nervous systems and their subsystems, so we start by proposing:*

*DEFINITION 1. A system is a nervous system if it is an information
biosystem such that*
(i) it is composed of (living) cells;
(ii) it is or has been a proper part of a multicellular animal;
*(iii) its structure includes (a) the regulation or control of some
of the biofunctions of the animal, and (b) the detection of internal
and environmental events as well as the transmission of signals
triggered by such events.*

*DE FINITION 2. A biosystem is a neural (or neuronal) system if
it is a subsystem of a nervous system.*

*DE FINITION 3. A biosystem is a neuron if it is a cellular component
of a neural system.*

*DEFINITION 4. Let v be a neural system and $\varphi_t(v)$ the neuronal
composition of v at time t. Further, call*

C_t: $\varphi_t(v) \times \varphi_t(v)$--->[-1,1]

*The real valued function such that $C_t(a, b)$, for $a, b \in \varphi_t(v)$, is
the strength (intensity) of the connection (coupling, link) from neuron a to neuron b at time t.
Then the connectivity of v at t is represented by the matrix formed by all the connection
values, i.e. $\mathbf{C}_t = ||C_t(a,b)||$*

*DEFINITION 5. A connectivity is constant if it does not change
once established (i.e. if $\mathbf{C}_t$ is independent of time). Otherwise it is
variable.*

*DEFINITION 6. A neuronal system is plastic (or uncommitted,
or modifiable, or self-organizable) if its connectivity is variable
throughout the animal's life. Otherwise (i.e. if it is constant from
birth or from a certain stage in the development of the animal),
the system is committed (or wired-in, or prewired, or preprogrammed).*

DEFINITION 7. Any plastic neural system is called a psycho.

Our initial assumptions are as follows.

*POSTULATE 1. All animals with a nervous system have neuronal
systems that are committed, and some animals have also neuronal
systems that are plastic (uncommitted, self-organizable).*

*POSTULATE 2. The neuronal systems that regulate (control) the
internal milieu, as well as the biofunctions of the newborn animal,
are committed (wired-in).*

POSTULATE 3. The plastic (uncomitted) neuronal systems of

an animal (i.e. its psychons) are coupled to form a supersystem, namely the plastic neural supersystem (P) of the animal.
POSTULATE 4. Every animal endowed with psychons (plastic neuronal systems) is capable of acquiring new biofunctions in the course of its life.
DE FINITION 8. Every neural function involving a psycho (or plastic neuronal system) with a regular connectivity (i.e. one that is constant or else varies regularly) is said to be learned.
Notice that this is a neurophysiological not a behavioral definition of learning, and moreover one in line with the use-disuse hypothesis (Hebb, 1949), which is becoming increasingly popular among neuroscientists.
We proceed now to refine the above ideas with the help of the concepts of state function and state space, welI known to physicists and general system theorists, and which are quickly invading aII of the sciences.
Consider an arbitrary neuronal system, be it a small neuronal circuit (fixed or itinerant), a sizable subsystem of the CNS, or the entire brain of a higher vertebrate. Like every other system, it can be represented by a state function $\mathrm{F} = <F1, F2 ..., Fn,.. .>$, *every component of which is assumed to represent a property of the system. If we let the connectivity function (Definition 4) take care of the spatial distribution, we can assume that is only a time-dependent function whose values may be taken to be n-tuples of real numbers. i.e. we can set* $\mathrm{F} : T \dashrightarrow \mathbf{R}^n$, *with* $T \subseteq \mathbf{R}$ *and* $\mathbf{R}$ *equal to the set of reals.*
Each component Fi of the total state function F *of the neuronal system concerned can be decomposed into a constant (or nearly constant) part* F_i^c *and a variable part* F_i^v *Obviously, either can be zero during the period in question. However, the point is that, while the rate of change of* F^c *vanishes at aII times (i.e.* $\mathrm{F}^c = 0$*), that of*
F^v *does not. The latter may thus be taken to represent the activity of the neuronal system, i.e. what it does. For this reason we make*
DEFINITION 9. Let $\mathrm{F} : T \dashrightarrow \mathbf{R}^n$ *be a state function for a neuronal system v, and let* $\mathrm{F} = \mathrm{F}^c + \mathrm{F}^v$, *with* $\mathrm{F}^c = 0$ *(zero rate of change) for all tin the interval T. Then*
(i) v is active at time t if $\mathrm{F}^v(t) \neq 0$
(ii) the intensity of the activity of v over the time lapse $\tau \hat{o}$ T

equals the fraction of the components of v active during τ;
(iii) the state of activity of v at time t is s = $F^{v}(t)$;
(iv) the (total) process (or function) v is engaged in over time interval τ ô T is the set of states of activity of g:
$\pi(v, \tau) = \{F^{v}(t) \mid t \in \tau\}$.
DEFINITION 10. Let $\pi(v, \tau)$ be the total process (or function) of a neuronal system v in an animal b during the time interval $\tau \subseteq T$. The corresponding specific function (activity, process) of v during is whatever v but none of the other subsystems of b does during τ, i.e., $\pi_s(v, \tau) = \pi(v, \tau) - \pi(\mu, \tau)$, with $\mu \neq v$.
(lf A and B are sets then $A - B = A \cap \overline{B}$, where $\overline{B}$ is the complement of B. The union is taken over every subsystem of b, i.e. for all μ ‹b.)
We shall now introduce the hypothesis that the CNS, and every neuronal subsystem of it, is constantly active even in the absence of external stimuli:
POSTULATE 5. For any neural system v of an animal, the instantaneous state of activity of v decomposes additively into two functions: $F^{v} = /A + E$, where /A does not vanish for all $t \in T$, whereas E depends upon the actions of other subsystems of the animal upon v.
DEFINITION 11. Let $F^{v} = /A + E$ be the active part of the state function of a neural system v. Then /A(t) is the state of spontaneous activity of v at time t, and E(t) the state of induced (or stimulated) activity of v at t.

3. *MENTAL STATES AND PROCESSES*

Every fact experienced introspectively as mental is assumed to be identical with some brain activity: this, in a nutshell, is the biological or materialist view of mind. For example, vision is the activity of neural systems in the visual system, learning the formation of new neural connections, intending the activity of certain neuronal systems in the forebrain, and so on. But not all brain activity is mental: we assume that the mental is the specific function of certain plastic neuronal systems (all of which discharge also household functions such as protein synthesis). Our assumption takes the form of
DEFINITION 12. Let b an animal endowed with a plastic neural system P. Then
(i) b undergoes a mental process (or performs a mental function) during the time interval T if P has a subsystem v such that v is engaged in a specific process during T;

(ii) every state (or stage) in a mental process of b is a mental state of b.

Example. Acts of will are presumably specific activities of neuron modules in the forebrain. Nonexample, Hunger, thirst, fear, rage, and sexual urge are processes in subcortical systems (mainly hypothalamic and limbic), hence are nonmental. What is a mental process is ?the consciousness of any such states - which is a process in some subsystem of P.

COROLLARY 1. AlI and only animals endowed with plastic neural systems are capable of being in mental states (or undergoing mental processes).

COROLLARY 2. AII mental disorders (dysfunctions) are neural disorders (dysfunctions).

COROLLARY 3. Mental functions (processes) cease with the death of the corresponding neural systems.

COROLLARY 4. Mental functions (processes) cannot be directly transferred (I.e. without any physical channels) from one brain to another.

DEFINITION 13. Let P be the plastic (uncommitted) supersystem of an animal b of species K. Then

(i) the mind of b during the period r is the union of alI mental processes (functions) that components of P engage in during τ:

$$m(b, \tau) = \bigcup_{x<P} \boldsymbol{\pi}_S(x, \tau);$$

(ii) the K-mind, or mind of species K, during period τ*, is the union of the minds of its members during r:*

$$M(K, \tau) = \bigcup_{y \in K} m(y, \tau).$$

THEOREM 1. The mental functions of (processes in) the plastic neural supersystem of an animal are coupled to one another, i.e. they form a functional system. (The unity of the mind principle.)

Proof:By Postulate 3 the components of P, far from being uncoupled, form a system.

COROLLARY 5. Let b be an animal whose plastic neural system is split into two detached parts, L and R. Then the mind of b during any time period posterior to the splitting divides into two disjoint functional systems:

$m(b, \tau) = m_L(b, \tau) \cup m_R(b, \tau)$, *with*

$m_L(b, \tau) \cap m_R(b, \tau) = \emptyset.$

THEOREM 2. Mental events can cause nonmental events in the same body and conversely.

Proof: Mental events are neural events, and the causal relation

is defined for pairs of events in concrete things.
So much for generalities. Let us move on to specifics.

4. SENSA TION AND PERCEPTION

DEFINIT ION 14. A detector is a neurosensor (or neuroreceptor) iff it is a neural system or is directly coupled to a neural system.
DEFINITION 15. A sensory system of an animal is a subsystem of the nervous system of it, composed of neurosensors and of neural systems coupled to these.
DEFINITION 16. A sensation (or sensory process) is a specific state of activity (or function or process) of a sensory system.
DEFINITION 17.
(i) A percept (or perceptual process) is a specific function (activity, process) of a sensory system and of the plastic neural system(s) directly coupled to it;
(ii) a perceptual system is a neural system that can undergo perceptual processes.
We assume that the perception of an external object is the distortion it causes on the ongoing activity of a perceptual system:
POSTULATE 6. Let v be a perceptual system of an animal b, and call $\pi_s(v, \tau) = \{ F^v(t) \mid t \in \tau \}$ the specific process (or function) that v engages in during the period T when in the presence of a thing x external to v, and call $\pi_s^0(v, \tau)$ the specific function of v during τ when x fails to act on v. Then b perceives x as the symmetric (Boolean) difference between the two processes. I.e. the perception of x by b during τ is the process
$p(x, \tau) = \pi_s(v, \tau) \Delta \pi_s^0(v, \tau)$,
where $A \Delta B = (A - B) \cup (B - A)$, i.e. everything in A but not in B plus everything in B but not in A.
We perceive events, i.e. changes of state. And not just any events but those originating in some neurosensor or acting on the latter and, in any case, belonging to our own event space (or the set of changes occurring in us). And our perceptions are in turn events in the plastic part of our own sensory cortex. Normally these are not fully autonomous events but events that map or represent events occurring in other parts of the body or in our environment. To be sure, this mapping is anything but simple and faithful, yet it is a mapping in the mathematical sense, i.e. a function.
Thus we assume
POSTULATE 7. Let b be an animal equipped with a perceptual system c, and call S(b) the state space of b, and S(c) that of c. Moreover let $E(b) \subseteq S(b) \times S(b)$ be the animal's event space, and $E(c) \subseteq S(c) \times S(c)$ its perceptual event space. Then there is a set

of injections (one to one and into functions) from the set of bodily events in b to the set of perceptual events in c. Each such map, called a body schema, *depends on the kind of bodily events as well as on the state of the animal. I.e. the general form of each body map is*

$m: S(b) \times 2^{E(b)} \text{---->} 2^{E(c)}$,

where 2^x *is the family of all subsets of the set* X.

POSTULATE 8. Let $E(e)$ *be a set of events in the environment* e *of an animal* b *equipped with a perceptual system c, and call* $S(b)$ *the state space of* b *and* $S(c)$ *that of c. Moreover let* $E(b) \subseteq S(b) \times S(b)$ *be the animal's event space, and* $E(c) \subseteq S(c) \times S(c)$ *its perceptual event space. Then there is a set of partial maps* k *from sets of external events in* $E(e)$ *to ordered pairs (state of* b, *set of bodily events in* b), *and another set of partial maps* p, *from the latter set to sets of perceptual events. Furthermore the two sets of maps are equally numerous, and each map k composes with one map* p *to form an* external world map *of* b *in* e, *or* $\in$ *i.e.*

$\in: 2^{E(e)} \text{----}^{k}\text{---->} S(b) \times 2^{E(b)} \text{------}^{P}\text{---->} 2^{E(c)}$ •

DEFINITION 18. Let b be an animal with perceptual system c in environment e. *Moreover call* $S(b)$ *the state space of* b *and* $E(e)$ *the set of events in* e. *Then* b, *when in state* $s \in S(b)$, perceives *external events in* $x \in 2^{E(e)}$ *if, and only if, these cause bodily events that are in turn projected on to the sensory cortex c, i.e. if* $k(x) = \langle s, y \rangle$ *with* $y \in 2^{E(b)}$ *and in turn* $p(s, y) \in 2^{E(c)}$. *Otherwise the events in* x *are* imperceptible *to* b *when in state s i.e. imperceptible events either do not cause any bodily events or cause them but do not get projected on to the perceptual system .*

5. BEHAVIOR

We turn now from perception to motor outputs, i.e. behavior, starting with

DEFINITION 18. For any animal b,

(i) the behavioral state *of* b *at time* t *is the state of motion of* b *at t ;*

(ii) the behavior *of* b *during the time interval* τ *is the set of all behavioral states of b throughout* τ.

DEFINITION 19. A behavior pattern is a recurrent behavior.

DEFINITION 20. Let b be an animal of species K, and let A be the union of all animal species. Then

(i) the (possible) behavior of type i of animal b, or $B_i(b)$, *is the set of all(possible) behaviors of b associated with the ith biofunction (in particular neural biofunction) of b ;*

(ii) the behavioral repertoire of animal b, or B (b), is the union

of all (possible) behavior types of b, i.e.

$B(b) = \bigcup_{i=1}^{n} Bi(b)$,

(iii) the (possible) behavior of type i of species K, or $B_i(K)$, is *the union of all the (possible) behaviors of the members of K, i.e.*

$B(K) = \bigcup_{x \in K} B_i(x)$;

(iv) the behavioral repertoire of species K, or B(K), is the union of all (possible) behavior types of K:

$B(K) = \bigcup_{i=1}^{n} B_i(K)$;

(v) the specific behavioral repertoire of species K is the behavioral repertoire exclusive to members of K:

$B_s(K)=B(K)- \bigcup_{X \subset A} B(X)$, *with* $x \neq K$;

(vi) animal behavior is the union of the behavioral repertoires of all animal species, I.e. $B = \bigcup_{X \subset A} B(X)$,

We assume that behavior, far from being primary, is derivative:
POSTULA TE 9. The behavior of every animal endowed with a nervous system is produced ("mediated", "subserved") by the latter. I.e. for every behavior type B_i of animals endowed with a nervous system, the latter contains a neural subsystem producing the motions in B_i

COROLLARY 6. Any change in (non redundant) neural systems is followed by some behavioral changes.

THEOREM 3. No two animals behave in exactly the same manner.
Proof: By Postulate 9 and the general ontological principle that there are no two exactly identical things.

THEOREM 4. The behavioral repertoire of an animal endowed with plastic neural systems splits into two parts: the one control/ed by the committed (or prewired) part of the NS of the animal, and its complement, i.e. the behavior controlled by the plastic components of the NS.
ProoF: By Postulates 1 and 4 together with Definition 20.

DEFINITION 21. The part of the behavioral repertoire of an animal that is controlled by the committed part of its NS, is called its inherited (or instinctive, stereotyped, modal, or rigid) repertoire, while the one controlled by the plastic part of its NS, its learned repertoire.

COROLLARY 7. The behavior of an animal deprived of plastic neural systems is totally stereotyped.
POSTULATE 10. Provided the environment does not change radically during the lifetime of an animal, most of its inherited behavioral repertoire has a positive biovalue for it.
POSTULATE 11. Some of the inherited capabilities of an animal endowed with plastic neural systems are modifiable by learning.
So much for our general behavioral principles. Now for motivation.

6. *MOTIVATION*

DEFINITION 22. A drive (or motivation) of kind X is the detec. tion of an imbalance in the X components(s) of the state function of the animal. (More precisely: the intensity $D_X(b, t)$ of drive X in animal b at time t equals the absolute value of the difference between the detected and the normal values of X for b at t.)
POSTULATE 12. For every drive in an animal there is a type of behavior of the animal that reduces that drive (Le. that decreases the imbalance in the corresponding property and thus tends to bring the animal back to its normal state).
We come finally to values:
DE FINITION 23. Let S be a set of items and b an animal. Further, let $\succ_b$ be a partial order on S. Then the structure $V_b = \langle S, \succ_b \rangle$ is a value system for b at a given time if
(i) b can detect any member of S and discriminate it from aU other items in S;
(ii) for any two members x and y of S, b either prefers x to y i.e ($X \succ_b Y$) or conversely ($Y \succ_b X$) or both ($X \approx_b Y$) at the given time.
POSTULATE 13. All animals are equipped with a value system, and those capable of learning can modify their value systems.
DEFINITION 24. Let $V_b = \langle S, \succ_b \rangle$ be a value system for an *animal b at a given time, and call $A \subset S$* a set of alternatives open *to b, Le; belonging to the behavioral repertoire of b at the time. Then b chooses (or selects) option $X \in A$ if*
(i) it is possible for b to pick (i.e. to do) any alternative in A (i.e. b is free to choose);
(ii) b prefers x to any other options in A ; and
(iii) b actuaIly picks (i.e. does) x.
Note the difference between preference and choice, obscured by the operationalist doctrine: preference underIies and motivates choice, which is valuation in action.

7. *MEMORY AND PURPOSE*

Many systems besides animals have memory, so the foIIowing definition is quite general:

DEFINITION 25. A system at time t has memory of (or memorizes) some of its past states if the state of a at t is a function(al) of those past states.
POSTULA TE 14. AII animals have memory of some of their past states, and none of aII of them.
DEFINITION 26. CaII P a kind of event or process in a neural system of an animal b involving a plastic subsystem, and S a kind of stimuli (external or internal) which b can detect. Then b has learned p ϵ P in the presence of s ϵ S during the time interval [t 1 , t 2] if
(i) p did not occur in b in the presence of s before t1;
(ii) after t2, P occurs in b whenever b senses s [i.e. b has memorized p] .
Since aIl behavior is controIIed by some neural system (Postulate 9), the previous definition embraces the concept of behavioral learning, Le. acquisition of new behavior patterns in response to new environmental situations.
DEFINITION 27. The experience of an animal at a given time is the set of all it has learned up until that time.
So far we have dealt with non-anticipatory systems. We now introduce anticipation, an ability only few species possess:
DEFINITION 28. Animal b expects (or faresees) a future event of kind E when sensing an (external or internal) stimulus s while in state t, if b has learned to pair s and t with an event of kind E.
Animals capable of anticipatory behavior can act purposively:
DEFINITION 29. An action X of an animal b has the purpose or

goal Y if
(i) b may choose not to do X;
(ii) b has learned that doing X brings about, or increases the chance of attaining, Y;
(iii) b expects the possible occurrence of Y upon doing X;
(iv) b values Y.
The conditions of purposiveness are then freedom, learning, expectation, and valuation. Since machines do not fulfil all four conditions, they cannot be goal-seeking except by proxy.
DEFINITION 30. An action X of an animal b is a suitable means for attaining a goal Y of b if in fact b's performing X brings about, or increases the probability of occurrence of, Y.

8. THINKING

Let us now tackle concept attainment and proposition formation.
We assume that forming a concept of the "concrete" kind - i.e. a class of real things or events - consists in responding uniformly to any and only members of the given class:

POSTULATE 15. Let C be a set of (simultaneous or successive) things or events. There are animals equipped with psychons whose activity is caused or triggered, directly or indirectly, by any member of C, and is independent of what particular member activates them.

DEFINITION 31. Let C be a class of things or events, and b an animal satisfying Postulate 15, Le. possessing a psycho that can be activated uniformly by any and only a member of C. Then b attains a concept θ_b (C) of C (or conceives C, or thinks up C) if the activity (process, function) stimulated by a C in that psycho of b equals θ_b (C).

We now conjecture that forming a proposition is the chaining of the psychons (possibly cortical columns) thinking up the concepts occurring in the proposition:

POSTULATE 16. Thinking up a proposition is (identical with) the sequential activation of the psychons whose activities are the concepts occurring in the proposition in the given order.

POSTULATE 17. A sequence of thoughts about propositions is (identical with) the sequential activation of the psychons whose activities are the propositions in the sequence.

We can now characterize the various modes of knowing:

DEFINITION 32. Let a be an animal. Then

(i) if b is a learned behavior pattern, a knows how to do (or perform) b if b is in the actual behavioral repertoire of a;

(ii) if c is a construct (concept, proposition, Of set of either), then a knows c if a thinks up (or conceives) c;

(iii) if e is an event, then a has knowledge of e if a feels or perceives e, or thinks of e.

9. DECISION AND CREATIVITY

We can use the concept of knowledge to elucidate that of decision:

DEFINITION 33. Let x be an arbitrary member of a set A of alternatives accessible to an animal b with the value system V_b =<S, $\succ_b$ >Then b decides to choose x if

(i) b has knowledge of some members of A;

(ii) $A \subset S$ (i.e. b prefers some members of A to others);

(iii) b in fact chooses x.

The ability to make decisions is then restricted to animals capable of knowing. And rational decision is of course even more restricted:

DEFINITION 34. A decision made by an animal is rational if it is preceded by

(i) adequate knowledge and correct valuations, and

(ii) foresight of the possible outcomes of the corresponding

action.
DE FINITION 35. A rational animal is one capable of making some rational decisions.
Finally, a few words about creativity, a characteristic of all higher vertebrates.
DEFINITION 36. Let a be an animal of species K with behavioral repertoire B (K) at time t. Then
(i) a invents behavior type (or pattern) b at time t' > t if a does b for the first time, and b did not belong to B (K) until t';
(ii) a invents construct c at time t' > t if a knows c for the first time at time t';
(iii) a discovers event e at time t' > t if a has knowledge of e for the first time at time t';
(iv) a is creative if a invents a behavior type or a construct, or discovers an event before any other member of its species;
(v) a is absolutely creative (or original) if a creates something before any other animal of any species.
POSTULA TE 18. Every creative act is the activity, or an effect of the activity, of newly formed psychons. [New connections, not new neurons.]
POSTULA TE 19. All animals endowed with plastic neural systems are creative.

10. SELF TO SOCIALITY

We start by drawing a sharp distinction between awareness and consciousness:
DEFINITION 37. If b is an animal,
(i) b is aware of (or notices) stimulus x (internal or external) if b feels or perceives x - otherwise b is unaware of x;
(ii) b is conscious of brain process x in b if b thinks of x - otherwise b is unconscious of x .
POSTULATE 20. AlI animals are aware of some stimuli and some are also conscious of some of their own brain processes.
DEFINITION 38. The consciousness of an animal b is the set of alI the states of the CNS of b in which b is conscious of some CNS process or other in b.
POSTULATE 21. Let P be a subsystem of the CNS of an animal b engaged in a mental process p. Then the CNS of b contains a neural system Q, other than P and connected with P, whose activity q equals b's being conscious (thinking) of p.
DE FINITION 39. An animal
(i) has (or is in a state of) self-awareness if it is aware of itself (i.e. of events occurring in itself) as different from alI other entities;
(ii) has (or is in a state of) self-consciousness if it is conscious

of some of its own past conscious states;
(iii) has a self at a given time if it is self-aware or self-conscious at that time.
POSTULATE 22. In the course of the life of an animal capable of learning, learned behavior, if initially conscious, becomes gradually unconscious.
DEFINITION 40. An animal act is voluntary (or intentional) if it is a conscious purposeful act - otherwise it is involuntary.
DEFINITION 41. An animal acts of its own free will if
(i) its action is voluntary and
(ii) it has free choice of its goal(s) - i.e. is under no programmed or external compulsion to attain the chosen goal.
THEOREM 5. All animals capable of being in conscious states are able to perform free voluntary acts.
Proof :By Postulate 20 and Definitions 40 and 41.
DEFINITION 42. If b is an animal endowed with a plastic neural system capable of mentation (i.e. with a nonvoid mind), then
(i) the personality of b is the functional system composed of an the motor and mental functions of b ;
(ii) a person is an animal endowed with a personality.
Finally we face sociality:
DEFINITION 43. An animal engages in social behavior if it acts on, or is acted upon by, other individuals of the same genus.
POSTULATE 23. The behavioral repertoire of every animal inc1udes types (patterns) of social behavior.

11. CONCLUDING REMARKS

The greatest merit of the psychoneural identity theory is that it takes it for granted that mind can be investigated scientifically, while the greatest sin of psychoneural dualism is to deny this or at least to make things difficult for the physiological psychologist who investigates the brain in order to understand mentation and behavior.
If we wish to approach the study of mind in a scientific manner we must start by identifying the concrete system in question, be it a neuron, neuron assembly, or entire nervous system. Now, physiological psychology, psycho endocrinology and psychopharmacology tells us that the thing in question, that which does the minding and controls the behaving, is the CNS, in particular the brain. In this approach the mind is not an entity apart from the brain, paralleI to it or interacting with it. In the psychobiological approach mind is a collection of activities of the brain or some multimillion neuronal subsystem of it. For example the felt intensity of a stimulus (the subjective experience we have of it) is conjectured to be identical with the frequency of firing of certain neural

systems (including the corresponding cortical area).
All this can be stated clearly with the help of the state space formalism, which is not just a formal trick but a method used, or utilizable, in all factual sciences because it fits in with the ontology of lawfully changing concrete things. The dualist cannot adopt this method because there is no way of merging properties of the brain with properties of an immaterial substance to form a single vector spanning a single state space. So, if the dualist attempted to speak a mathematical language - which he does not - he would be forced to split the state space of a person into two different and separate spaces, one of which would be ill-defined for it would be characterized in verbal and non physiological terms.
The rejection of psychoneural dualism does not force one to adopt eliminative materialism (or physicalism). Psychobiology suggests not only psychoneural monism - the strict identity of mental events with brain events - but also emergentism, or the thesis that mentality is an emergent property possessed only by animals endowed with a very complex plastic nervous system. This ability confers its owners such decisive advantages, and is related to so many other properties and laws (physiological, psychological, and social), that one is justified in asserting that the organisms endowed with it constitute a level of their own - that of psychosystems.
But of course this is not saying that minds constitute a level Of '''world'' of their own, and this simply because there are no disembodied (or even embodied) minds, but only minding bodies.
In other words, one can hold that the mental is emergent relative to the merely physical or chemical without reifying the former. That is, one can hold that the mind is not an entity composed of lower level things - let alone an entity composed of no entities whatever - but a collection of functions (activities, processes) of certain neural systems, that individual neurons do not possess. And so emergentist (or systemist) materialism, unlike eliminative materialism, is seen to be compatible with overall pluralism, or the ontology that proclaims the qualitative variety and mutability of reality
Our espousing emergentist (or systemist) materialism and proposing a general framework for handIing the mind-body problem does not entail claiming that the latter has been solved. It hasn't and it won't, except in very general terms, for emergentist materialism is a philosophy providing only a scaffolding for the detailed scientific (empirical and theoretical) investigation of the many particular problems lumped under the rubric 'the mind-body

problem'. It behoves neuroscientists and psychologists to attack these problems - as scientists, not as amateur philosophers, let alone theologians. They won't do so if told that mind is a mysterious immaterial entity best left in the hands of philosophers and theologians.