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# Co-Genetic Logic

## A Foundation for Behavior Logic [1]

Feelings, desires, intentions and purposes appear to us to constitute part of our subjective experience unrelated, if not opposed, to the structure of logic and the forms in which the world appears to us to be given objectively.

And yet the structures of logic and rational science cannot come into existence independently of our personal intents and purposes which generate the forms in which we come to experience and apprehend the world. For does the infant know in making its first intentional distinction between itself and its surroundings that in this simple act he has generated in its consequences the whole field of logic?

The task of behavioral logic is to trace the relation between our intentions and the conceptual and rational forms in terms of which we perceive and respond to ourselves and the environment back to the point where these have their common origin. I use the term "intention" rather than "purpose" since the resultant consequences of our intentions may not be known by us at the time we act. And also later on, at the time we encounter the consequences of our actions, we may not know who was responsible for them.

### *The Origin of Concepts*

The point of departure is a world which is void of all comprehensible characteristics. Assuming that we now wish to construct a world which may be apprehended in terms of distinctions, such as subject and object, object and environment, finiteness and infiniteness, existence and nonexistence, which is capable of functioning as a dynamic system, and at the same time is structured by a consistent logic, then the question is, what is the minimal requirement which is sufficient for a world of this type to be generated.

There are basically three major theoretical approaches which have been utilized in Western thought to understand the nature of concepts and structures in terms of which the world is apprehended.

[1] Chapter 7 in *Alternatives to Hierarchies*. Leiden: Martinus Nijhoff, 1976.

Platonic theory takes as its point of departure that both concepts and logical and mathematical principles can not be more than approximately realized in the world of phenomena. Since, however, concepts and logic and mathematical principles themselves do not suffer this disability, it is assumed that these exist independently in a rational ideal world. An alternative possibility is to consider concepts not as a given a priori but as part of an independently generated system of constructs.

Positivistic theories take as their point of departure that logical and mathematical principles are empirically discoverable. Therefore these principles exist independently of ourselves in the objective world. Here there are two possibilities. Either these laws exist in a perfect state in the objective world, in which case any observed deviation can be accounted for as being due to experimental or measuring error, or these laws are stochastic and generated by chance factors as an objective fact.

Kantian theory takes as its point of departure that the basic categories of logic, time and space are neither given nor found in the external world. These categories therefore are taken to be inherent constituents of the mind which then apprehends the phenomenal world in terms of these categories.

Each of these theories varies as to where the basic concepts in terms of which the world is organized and structured are located. They may be located in an ideal a priori world or a system of constructs, in the external world or in the internal world, existing objectively or subjectively. However, there is one thing which all the above theories have in common. Each theory starts off with a dichotomy which splits the world into two distinct systems. In Platonic type theories, a distinction is made between the world of phenomena and a world of concepts or constructs. In both materialist and idealist type theories, a distinction is made between an external or objective world and an internal or subjective world.

It is in this context that a discovery by Spencer-Brown (1969) turns out to be a remarkable step forward in the history of Western thought. He finds that the making of a primary distinction, which is the unexamined given in each of these theories, is by itself sufficient to generate the structure of logic. If then the primary distinction, say into an internal and external world, is made and this, by itself, is sufficient to generate the structure of logic, then the structure in terms of which phenomena are apprehended can be located neither in an internal or subjective world nor in an external or objective world and, in this case, both idealist and materialist type theories can be rejected.

The work of Spencer-Brown clearly has ramifications in almost all branches of human thought and is likely in time to lead to basic reformulations of Western philosophies. In the present paper an attempt will be made to take this concept of a primary distinction to a more fundamental and general level. The route taken through this problem is both to explore the common genetic basis of logic and behavior theory and, at the same time, to arrive at a definition of some basic general system concepts.

## *The Primary Distinction*

The form of the primary distinction in shown in Figure 1. The primary distinction is expressible as a cleavage of an empty space and defined as a crossing of the first distinction. It is in crossing the first distinction that what is the form (the inside) and what is not the form (the outside) is generated, together with the boundary which distinguishes the inside and the outside. The Spencer-Brown calculus makes use of only this single operation "cross" denoted by ⏋. This operation leads to the formulation of two axioms. According to *axiom 1*, if the instruction to cross the boundary is repeated, then the end result is no different from a single crossing:

⏋⏋ = ⏋.

However, if the boundary is crossed and then crossed again (in the reverse direction), then according to *axiom 2* the original state, where no form or boundary exists, is reproduced so that

⏋⏋ =

where denotes the empty space in which no distinctions exist. It can then be shown that these two axioms are sufficient to generate the structure which corresponds to symbolic and sententional logic.

Unlike formal logic which starts off with a set of elements and operations as given and links these together to generate different structures, Spencer-

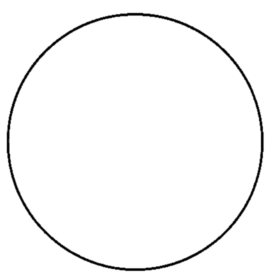


Figure 1. Form of the primary distinction.

Brown provides a more fundamental psycho-logical approach which allows an operational interpretation at successive levels.

Psychologically, it implies that the primary distinction made by the infant between himself and his environment may be sufficient to generate the conceptual and logical structure in terms of which he later comes to apprehend the world in which he finds himself. These structures therefore may not need to be assumed to preexist either in the external world or internally, since the distinction between the internal and the external is already by itself sufficient to generate the structure of logic. What the infant learns is then not, as Piaget (1953) assumes, a correspondence between an independent system of logical and the emergent structure of his operations. Instead, what the infant discovers and learns in his operational encounter with his surrounding world will be the consequence of the primary distinction which he has made between himself and his environment.

This then implies that any organism which has come to the stage of making a distinction between itself and its environment will be capable of operating in some form of at least rudimentary logic. Organisms capable of generating a conditioned response to a stimulus appear to lie on this borderline. Human beings are capable of generating far more complex types of logical structure and are able to build these into conceptual logical systems and into isomorphic mechanisms, which may then be believed to have some form of independent existence.[2]

A comprehension of the dependence of logical and conceptual structures on the primary distinction between the self and the environment points at the same time to the possibility of transcending logical and conceptual structuring as the only realizable mode of knowledge.

While derivation of logical and conceptual structure from the primary distinction is demonstrable, the generation of the primary distinction starting off with a world in which as yet no conceptual elements are given remains problematical.[3]

In the following it will first of all be shown that the validity of the concept of a primary distinction can be more easily demonstrated if we reverse the procedure. To do so we willt a different mode of representation than the one introduced by Spencer-Brown. Instead of representing the primary distinction as a single unified operation, we will instead utilize a representation of it as a triadic set of elements

$$[p, q, r].$$

[2]Taken one step further, this can easily lead to the belief that there is no conceivable difference between a mechanical mechanism and a human being.

[3]Spencer-Brown mentions that his procedure initially was in fact to work backward from the principles of logic to the simplest conceivable operational basis which could be identified.

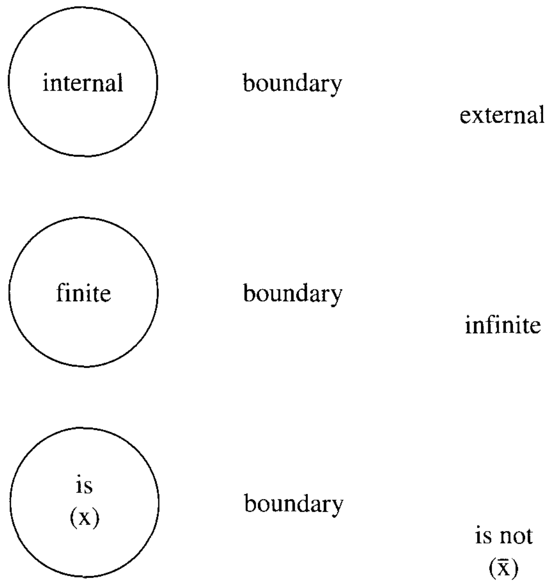



Figure 2. Reversing the primary distinction.

## *Reversing the Primary Distinction*

Spencer-Brown describes the state which is free of any distinctions as an empty space. It may be thought that this state is essentially nothingness or perhaps an infinite space. This, however, is demonstrably not the case. Figure 2 shows three possible triadic sets which in their form are obtainable from a primary distinction at the stage where a specific characteristic can be attributed to the inside and outside of the distinguished form. The first triadic set is given as

[*inside, outside, boundary*].

It is easily seen that if the boundary is removed, then this is sufficient for the original state prior to the existence of a distinction to be obtained. With the removal of the boundary, a distinction between inside and outside is no longer possible. The same result is obtained if either the inside or the outside is eliminated, for then the other two components of the triad also.

Another way of reestablishing the original state is by letting inside and outside become identical and undistinguishable. In this case, the boundary disappears.

The primary distinction thus generates a triad of co-genetic components. That is, the three components come into existence simultaneously. Further, the original state prior to the distinction is reestablished if either

1. one component of the triad is eliminated or
2. two components of the triad (excluding the boundary) become identical.

The second triad in Figure 2 has the form

[*finite region, infinite region, boundary*].

Here again, if the boundary is taken away we return to the original state. The original state can thus not be characterized as being infinite, since the characteristic of being infinite does not come into being without the simultaneous coming into being of that which is finite. The original state can therefore not be defined as being either finite or infinite.

Having on occasion explained to some friends and colleagues the nature of the primary distinction, I found that they have no difficulty in seeing that if the boundary is taken away then both inside and outside disappear. When then asked what is left if the boundary is removed they invariable respond, "Well then, what is left is nothing." In that case it will appear as if the triadic set consisting of inside, boundary and outside has been created out of nothing. This also, however, is not the case.

Consider the triad in the form

[*being, nonbeing, boundary*].

In traditional logic, these would be denoted by $x$ = is and $\bar{x}$ = is not. If again the boundary is taken away, it is clear that what remains is neither something nor nothing since the distinction between "is" and "is not" cannot be made until a primary distinction has been made.

The original state prior to a distinction having been made is thus neither finite nor infinite, neither something that exists nor something that does not exist. It is entirely free of any distinguishing characteristics. However, once a primary distinction has been made, a conceptually apprehendable world comes into existence within which it becomes possible to say that something exists or does not exist. That it is finite or infinite, that it belongs to oneself or somebody else.

Starting from the state in which no distinctions exist, the primary distinction creates a co-genetic triad of components. This triad is the irreducible atomic element of any conceptual system. No one or even two of the components can exist independently. It is therefore in no way possible to define a single concept. Nor is it possible to define a pair of concepts in the form of a duality. The triad is the only and minimal form within which definition of its components is possible. Thus the triad generated by the primary distinction represents the minimum definitional unit.

We shall attempt to develop a behavioral logic using as the starting point a triad of undefined components which are definable in terms of one another. It will be shown that this is sufficient to derive as consequences the two principles formulated by Spencer-Brown, together with the basic forms of logic and mathematics. It becomes at the same time possible to derive the basic conceptual structures in terms of which the characteristics of the environment are apprehended and to show that each of these constitutes a dynamic process.

## *The Basic Axiom of Behavior Logic*

The point of departure is a world in which nothing definable exists and which is thus void of any distinguishable characteristics. The characteristics of the primary distinction which, as we have seen, leads to the simultaneous genesis of three distinguishable components can be stated in the following axiom:

*The primary conceptual unit is given as a triad of distinguishable undefined components which are definable in terms of one another.*

We shall investigate whether this axiom is sufficient to generate the basic concepts in terms of which the phenomenal world is apprehended together with the basic structure of logic and mathematics. In order to make derivations from the basic axiom possible we shall first need to define the concept of a pair and of an individual component. This can be done as follows: the triad of undefined components denoted by $m,n,p$ can be represented in the form

$$[m, n, p].$$

This triad is equivalent to a primary distinction. We now make a further distinction within the triad. As shown in the example in Figure 3, in whatever way we do this we shall always arrive at a pair of components and an individual component. For if a pair of components is enclosed then what is excluded is an individual component, and if an individual component is enclosed then what is excluded is a pair of components. If, however, the triad as a whole is enclosed,


Figure 3. Results obtained by making a distinction within a triad.

or if the components have been enclosed, then no distinction has been made which is contrary to the instructions given. The distinction made leads to three possible pairs and three possible single components shown below:

$$\begin{matrix} mn & p \\ mp & n \\ np & m \end{matrix}$$

The distinction made will at the next stage make it possible to obtain a representation of a definitional unit.

If we wish to demonstrate the validity of the distinction made, then we have to show that it has generated a triad of components consistent with the basic axiom. The easiest way to do this is to go back to Figure 3 and in each case to take the boundary away. In this case, both the pair and the individual components which have been created disappear simultaneously. That this is a necessary property of a triadic unit is shown by the theorem discussed in the next section.

## *Conditions for the Existence of Distinguishable Components*

That which has no distinguishable characteristics is denoted by the sign $\phi$. If in a triad of components any two or more components are not distinguishable then this is denoted by the equal sign, =. Thus

$$m = n$$

means that $m$ and $n$ are not distinguishable. Given the triad

$$[m, n, p],$$

Assume that $p$ is not a distinguishable component and thus $p = \phi$. Then the triad takes the form

$$[m, n, \phi].$$

Now assume that in the triad $[m, n, p]$ the components $n$ and $p$ are not distinguishable, so that $n = p$. Then also in this case there remain only two distinct components and the triad takes the same form:

$$[m, n, \phi].$$

However, according to the basic axiom, the condition for any one component to be distinguishable and thus have definable characteristics is that it forms part of a triad of distinguishing components. Therefore in both cases:

$$[m, n, \phi] = [\phi, \phi, \phi] = \phi.$$

The following theorem can then be stated:

*Given a triad of distinguishable components, then a state which allows no distinguishable components to exist will result if either*
*(1) any one component ceases to be distinguishable or*
*(2) any pair of components become identical.*

We have previously given an example of this in the case of the triad

[*inside, outside, boundary*]

where if the boundary is eliminated, the inside and outside also cease to exist as distinguishable entities. Also, if the inside and outside become indistinguishable, then the boundary can no longer exist as an entity. In either case, the original state ** in which no distinguishable entities exist is reestablished.

The theorem can also be stated in another form where its implications are clearer:

*It is not possible for a single entity or a pair of entities to exist alone or to be definable.*

Now, this runs counter both to everyday assumptions and to the assumptions on which traditional theories of logic and mathematics are based. We do normally assume that entities such as, say, a cup, a table, a window and a human being can each exist and be individually defined as independent elements. If we now come to characteristics such as light, then it is more easily seen that this exists relative to what is dark and similarly good is an attribute as distinguished from that which is evil. In fact, however, every distinguishable entity is demarcated and defined relative to what it is not. But even a dual pair is not sufficient to provide a basis for definition unless the distinction made is introduced as a third term, and in this case we come back to the triad as the minimal definitional unit for any form of entities.

## *Types of Definitional Units*

According to the basic axiom, the components of a triad are definable in terms of one another. Given the definition previously arrived at of a pair and of individual components, the definitional unit can be represented in the form

$$\left.\begin{aligned} mn &= p \\ pn &= m \\ pm &= n \end{aligned}\right\} \textit{definitional unit}$$

where each individual component is defined in terms of the remaining pair. No other kind of definitional form is possible since if we set up a definition of the type $m = n$, then, as we have seen, the whole triad of components cease to exist as distinguishable entities.

The point of departure was the triad of undefined components $[m, n, p]$. Since at this point the representation of a definitional unit has made use of the definition of pair formation, this definition must explicitly form part of the triad which generates units of this type. The triad then takes the form

$$[m, n, \textit{pair formation}].$$

Pair formation as a defined term itself represents a definitional unit and differs in this respect from the remaining components which will from here on be referred to as elements.

A definitional unit then consists of the three possible pairs *mm*, *nn* and $mn = nm$ that define the two elements *m* and *n*. It is found that there are in this case not more than three possible types of definitional unit. These are shown in Table I.

We are given that *n* and *m* are distinguishable elements, but neither has as

TABLE I Possible Types of Definitional Unit

| | *Defines Element Type* | | | | | |
|---|---|---|---|---|---|---|
| *Pair* | *A1* | *A2* | *B1* | *B2* | *C1* | *C2* |
| *nn* | *n* | *m* | *n* | *n* | *m* | *m* |
| *mm* | *n* | *m* | *m* | *m* | *n* | *n* |
| $nm = mn$ | *m* | *n* | *n* | *m* | *n* | *m* |

yet any identifiable characteristics. The form of a definitional unit is therefore not changed if we exchange the labels $n$ and $m$.

With Type A in the form

$$\left.\begin{aligned} nn &= n \\ mm &= n \\ nm = mn &= n \end{aligned}\right\} \text{Type } A(1),$$

If we exchange the letters $n$ and $m$ we obtain Type A in the form

$$\left.\begin{aligned} mm &= m \\ nn &= m \\ mn = nm &= n \end{aligned}\right\} \text{Type } A(2),$$

The following are the characteristics of each type of definitional unit.

*Type A* distinguishes between pairs composed of identical elements ($mm$) and ($nn$) and pairs composed of different elements ($mn$) and ($nm$). If pairs of like elements are used to define the element $n$, then pairs of unlike elements define the element $m$.

The definitional unit can be shown to correspond to the second principle which applies to the Spencer-Brown cross operation and corresponds in logic to "negation of the statement $P$," in set theory to the "complement of the set $P$" and in algebra to the "inverse of $P$" or the "dual of $P$."

*Type B.* A pair of like elements defines the element included in the pair. That is $n = n$ and $mm = m$ (for instance in algebra, $0 + 0 = 0$ and $1 \times 1 = 1$). Pairs of unlike elements can be used to define either $n$ or $m$. However once a choice has been made then it is always possible for a dual independently definable unit of this type to exist.

This definitional unit can be shown to correspond to the first principle of Spencer-Brown's cross operation. In logic it corresponds to the dual pair:

$P$ and $Q$
$P$ or $Q$

where the statements $P$, $Q$ can be either true or false. If one of these expressions is represented by the form Type B(1) then the other has the form of Type B(2). It should be noted, however, that transformation to the dual form requires that the concept of duality based on definitional unit Type A is given.

In set theory the Type B unit corresponds to the dual pair

intersection of sets $P$ and $Q$
*union of set P* and $Q$

and in the algebra of Boolean rings the Type B unit corresponds to the dual pair

multiplication of $P$ and $Q$
addition of $P$ and $Q$

Type C. Pairs of like elements define the element not included in the pair. That is, $nn = m$ and $mm = n$. Pairs of unlike elements can be used to definite either $m$ or $n$.

This definitional unit does not correspond to any of the expressions which have been used in developing the various basic forms of logic and mathematics. Sheffer (1913) introduced what he called the stroke operation $P|Q$ and went on to show that this single operational symbol is sufficient to express all the various forms of logical operations. This expression does, in fact, constitute a Type C definitional unit.

The cross operation has in sentential logic the corresponding form:

$$P|Q = \text{not } (P \text{ and } Q) \qquad \text{Type C}$$

and therefore,

$$P|P = \text{not } (P \text{ and } P)$$

Then provided

$$P \text{ and } P = P$$

it follows that

$$P|P = \text{not } P$$

It has been claimed that Sheffer's stroke operation $P|Q$ is by itself sufficient to derive the field of logic. This, however, is seen not to be the case since the proof has to make use of the form $P|P$, which corresponds to the "negation of $P$," and this is a Type A unit which has to be independently defined.

## *The Axioms of Logic and Mathematics*

We can now state as a theorem that

*The basic systems of logic and mathematics are derivable from any given pair of definitional unit of Type A, B and C.*

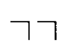
Types B and C can appear in two dual forms and any form can be chosen. Type A can appear in only one and thus self-dual form. There are eight possible pairs, any one of which provides a sufficient axiom set. These are

$$AB_1, AB_2, AC_1, AC_2, B_1C_1, B_1C_2, B_2C_1, B_2C_2$$

The theorem is demonstrable within any of the basic types of logic and mathematics. Table 2 shows the pairs of axiomatic definitions which can be utilized. With the exception of Sheffer's form of logic, the pair of axiomatic principles chosen corresponds to definitional units Type A and Type B. The reason for this is that only the Type A and Type B definitional units are expressible in terms of a single demonstrable operation.

This also applies to the two principles which were used by Spencer-Brown to generate the structure of logic. What becomes clear from Table 2 is that *each of the definitional units which have been derived correspond to an operation on a set of elements.*

TABLE 2 Correspondence of Axioms of Basic Logics and Mathematics to Pairs of Definitional Units

| | *Definitional unit* | | |
|---|---|---|---|
| *Basic axioms of* | *Type A* | *Type B* | *Type C* |
| Sentential logic | Opposite of *P* | *P* or *Q* | |
| Set theory | Complement of *P* | Union of *P* and *Q* | |
| Algebra of Boolean rings | Inverse of *P* | Addition of *P* and *Q* | |
| Scheffer's stroke operation | $P \mid P$ | | $P \mid Q$ |
| Spencer-Brown's cross operation |  |  | |

We have arrived at the end of the demonstration that, given a triad of undefined elements which are definable in terms of one another, then this is sufficient to generate the logical structure in terms of which the world is apprehended. However, we are still at the stage where the components of the structures evolved are undefined elements. The next step is to investigate to what extent the definitional units make it possible to derive some of the basic system concepts which we utilize to identify specific characteristics of the phenomenal world.

It will be shown that this becomes possible if we make use of an operational interpretation of the three types of definitional unit. To do so we need, however, to show that the concept of an operation is derivable from the basic axiom.

## *Operations, Directionality and Time*

The triadic form which defines the concept of an operation is

$$[\textit{preceding state } (S_n),\ \textit{subsequent state } (S_m),\ \textit{operation } \pi]$$

so that if the operation $\pi$ is applied to the state $S_n$ what results is the state $S_m$. This can be put in the form

$$\pi(S_n) \rightarrow S_n$$

We note that an operation generates a specific direction which takes us from one distinguishable form to another. Also an operation generates the concept of time, since it creates a distinction between a state which lies or was before and a state which lies or comes to be after. Any triadic form which has these characteristics of directionality will then have the characteristics of an operation unit.

It was shown to begin with how a primary distinction in the form of a boundary creates a triadic set $[m, n, p]$. Next it was found that if a further distinction in the form of a boundary is made within this set then we obtain pairs and individual elements as follows:

$$[m,\ n,\ p] \begin{array}{l} \nearrow [(mn)\ p] \\ \rightarrow [(mp)\ n] \\ \searrow [(np)\ m] \end{array}$$

What has been produced at this stage is an operational unit. Direction is uniquely defined, since in this way we can only go from the triad to sets of pairs and individuals. As a result, what is generated is a preceding and a subsequent state. This initial state is the triadic set, the operation is that of introducing a boundary within the triadic set and the subsequent state are possible pairs and individual elements. The conceptual characteristics of an operation are thus derivable from the basic axiom.

We note that a directional property is found also within each definitional unit. For instance, a Type A unit has the form

$$\begin{matrix} nn \searrow \\ mm \nearrow \end{matrix}\; n \qquad \begin{matrix} nm \searrow \\ nm \nearrow \end{matrix}\; m$$

The characteristics of each element in the triad are in this form uniquely defined consistent with the basic axiom. A definition of the form $nn = n$ can in this case be interpreted as an operation on an initial state which leads to a subsequent state as an outcome.

## *Types of Operational System*

Up to this stage, the elements $n$ and $m$ of the basic triad have remained without definable characteristics. We shall now show that each of the definitional units constitutes an operational system and that, within each system, the elements acquire specifiable characteristics. This is not the case, however, for the Type C unit, which accounts for the fact that this unit has not normally been made use of in the development of logic or in the construction of scientific theories.

## *Type A System*

The Type A definitional unit can be put in the form of a table:

| | *nm* |
|---|---|
| *n* | *nm* |
| *m* | *mn* |

The properties of this operational system become more clearly visible if this is put in the form of a diagram (Figure 4). If we start off with element $n$ and apply $n$, then we come back again to the element $n$. As long as we do this, the element $n$ will be produced over and over again until the element $m$ is applied and as

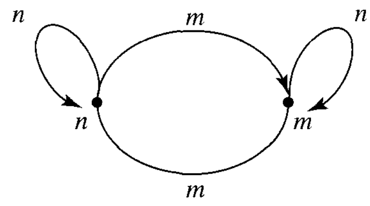



Figure 4. State transition diagram for operational system, Type A.

soon as this happens, a transition will occur to the element *m*. If we now apply *n*, then as often as we do this the element *m* is reconstituted. However, if we again apply *m*, then a transition to element *n* occurs. Since the elements *n* and *m* can be interchanged without affecting the properties of the system, *n* and *m* constitute *dual elements*.

Inspection of the diagram in Figure 4 makes it clear that

*n* is a *state maintenance operator.*

To whatever element this operator is applied, this maintains the element in existence.

*m* is a *state transition operator.*

To whatever element this operator is applied, the element ceases to exist and the dual element is created. If we continue to apply this operator what results is an oscillation between the two elements similar to what happens in an alternating current or in figure-ground reversal.

If we denote the two elements by 0 and 1, the repeated application of the state maintenance operator leads to sequences

1, 1, 1, 1, 1, . . . or 0, 0, 0, 0, 0, . . .

where a form is maintained.

Repeated application of the state transition operator leads to the sequence

1, 0, 1, 0, 1, 0, 1 . . .

Each of these processes can be found in both material and behavior systems.

MATTER AND WAVES

The Type A system restricted to repetitive sequences of the state maintenance and state transition operation generates the basic attributes in terms of which we apprehend the material world. The material world is apprehended by us either in the way of form-maintaining objects, that is, entities which are perceived as maintaining an identical form, or in the form of wavelike oscillating phenomena. What we classify as constituting the physical world are those phenomena which are apprehended as matter, that is identity-maintaining entities or as wave phenomena. Restricted to these two possibilities, matter and waves constitute dual forms in terms of which the structure of the physical world comes to be apprehended.

The process generated by the two operations is shown in Figure 5. We tend to perceive objects which retain their form as having static characteristics, while processes of change are easily recognized as constituting dynamic processes. However, it will be seen at this stage also that identity-maintenance of objects, which we conceive to be located in our environment, is a continuous and dynamic process in which throughout our waking life we are ceaselessly involved.

The two dynamic processes which generate waves and identity-maintaining forms are similar in their structural form. A wave form is a process moving continuously between alternative states. A material form can be looked at as a special case of such a wave form which, as a process, is continuously restricted to a single state. The form in which we have discovered the identity- and form-maintaining process is shown in Figure 6.

This can be looked at as a wave which is, so to say, locked into itself. That is, a continuously cyclic process which revolves around itself until it is disrupted, when the form disappears and it then turns into a wavelike oscillating process until it is again bound into an identity maintaining form. During the intermediate period when no stable identification is possible we are faced with a situation of uncertainty, which is essentially one of oscillation between alternatives, until the process again becomes locked into a single form and uncertainty is removed.

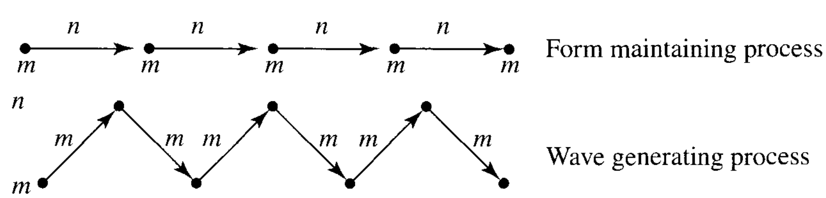



Figure 5. Two basic processes.

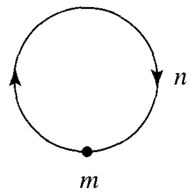



Figure 6. Form maintenance as a cyclic process.

We are familiar with representations of this type for matter at the atomic level. The derivation, however, shows that the same type of process is involved in the generation of all kinds of identity-maintaining forms. That is, the generation of the ordinary objects around us insofar as these appear to be unchanging and of those permanent characteristics which we attribute to persons and organizations. Also, we ourselves, insofar as we seek to maintain a stable identity, constitute ourselves as a continuously repetitive self-enclosed and self-maintaining process which, when it becomes disrupted, leads to a state of uncertainty which may be experienced as intolerable. It is possible also to remain in this state of uncertainty for some time unable or unwilling to lock oneself into a self-repetitive form. It is to the extent that behavior is restricted to these two types of processes (which, however, it does not need to be) that its structure becomes analogous to the structure of material entities. This is the case since the process which generates the perception of identity-maintaining objects in the environment generates in the same way the enduring and permanent characteristics which we attribute to ourselves, to other persons and to social organizations.

The dynamic system which has been discussed is generated by a statement of the "take the opposite or the inverse of an element *P*." We are here able to confirm Piaget's (1953) theory that identity-maintenance depends on an operational system which has the property of reversibility.

## *Type B System*

The Type B definitional unit can be put in the form

| | *nm* |
|---|---|
| *n* | *nm* |
| *m* | *mm* |

Given the element *n* and applying *n* we arrive back at *n*. In every other case we arrive at *m*. A diagram showing the operational system which is generated is

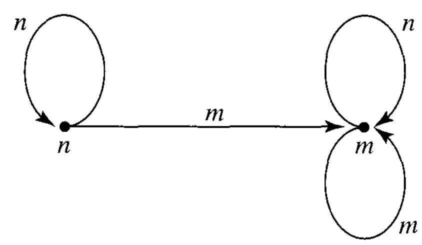



Figure 7. State transition diagram for operational system, Type B.

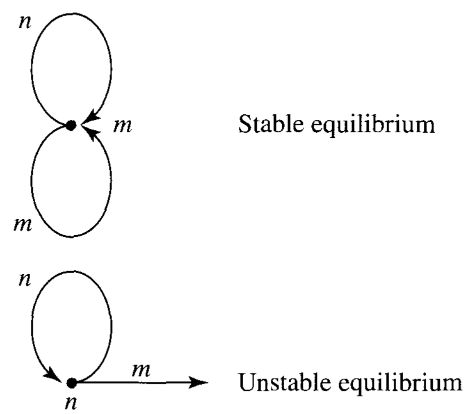



Figure 8. Separation of Type B system.

shown in Figure 7. As before, *n* is an identity-maintaining operator. Starting with state *n*, if *n* is applied, then the state *n* is maintained in existence. Starting with state *m*, if *n* is applied, then state *m* is maintained in existence; *m* is a *displacement operator*. However, a state transition occurs only if this operator is applied to the state *n*, not if it is applied to the state *m*.

While the basic characteristic of the Type A system is that its processes are reversible, the basic characteristic of the Type B system is that its processes are *irreversible*. Once we have left state *n* there is no way in which we can come back to it again and once we have arrived at state *m* there is no way in which we can come out of it again.

The Type B system is separable into two distinct process structures as shown in Figure 8. Just as previously identity-maintaining entities and waves were found to be generated as dual forms, so here in the same way stable and

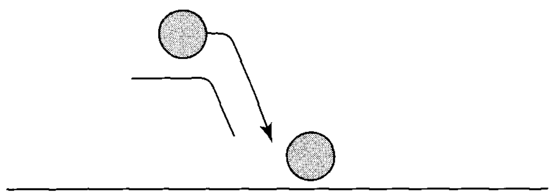


Figure 9. Transition from unstable to stable equilibrium.

unstable equilibrium states are generated as dual forms in terms of which the dynamic characteristics of the environment, and also of ourselves, come to be apprehended.

In the case of unstable equilibrium, a form is maintained in existence until an operation is applied which leads out of the form which then ceases to exist and there is no way back to it. In the case of stable equilibrium no matter what operation is applied there is no way out of the state once it has come into existence. An example might be a stone on a hilltop which stays there until it is displaced. Once this happens it rolls down until it comes to rest on a limitless plain. Once there, whether it stays in the same spot or is displaced, there is nowhere else it can move (Figure 9). The two definitional units thus not only generate the basic types of logic and mathematics but apparently also the basic concepts sufficient for building a theory of physics.

If we wish to show how these operational systems also generate a psychological theory then what we need to do is to change our perspective. Instead of attending to the output, we need to look at the process which generates the conceptual structure in terms of which the apparently objective characteristics of the environment are apprehended. It is the same process which, as a consequence of the initial distinction between the self and the environment, generates and constitutes what we take to be the enduring structure of ourselves.

## *Review*

Going back to the beginning, we now see that what was called the original state is not originally the original state but only becomes this *after* a primary distinction has been made. Also, this state, which was said to be void of characteristics and thus undefinable, is in fact defined relative to the state in which definable elements exist.

What we now find is that the *primary distinction between self and environment does not create a single triad but a triad of triads* as shown in Figure 10.

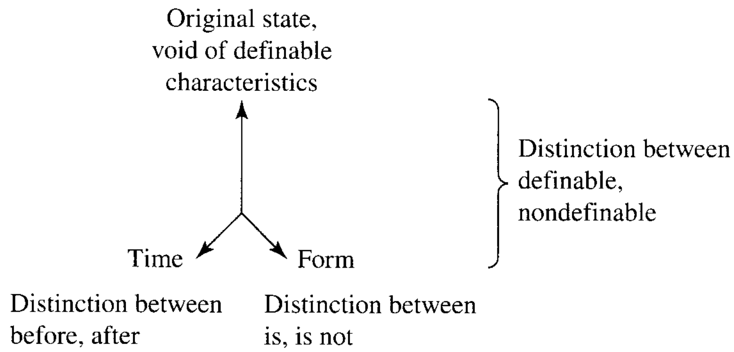



Figure 10. Proceeding from the "known" to the "unknown."

A primary distinction having been made, the state void of characteristics, conceived of as a distinct and separate object, is generated *together with* the state in which definable elements exist. Thus, a world in which definable characteristics exist is not, to begin with, created from a *prior* state void of characteristics.

When to begin with we conceived of a state void of characteristics which became subject to a primary distinction resulting in a world of definable elements, the primary distinction had already been made and the state void of characteristics which is apprehended at this stage is only one of relative void.

As long as we are concerned with before and after, the existing and the nonexisting, the nondefinable as opposed to the definable, then we are in the realm of the primary distinction. Also, if we conceive of something outside this realm, then we are still within the realm of the primary distinction.

The primary distinction of inside, boundary and outside constitutes the identification of the inside with its boundary as a self and of the outside as the environment. The maintenance of the primary distinction is the maintenance of a self as a distinguishable and enduring entity perceiving itself as confronting the environment as an object.

When a triadic set of elements is generated, then characteristics of each of the elements, such as inside, boundary and outside, become manifest in their mutual dependence on one another.

Apart from a triadic definitional unit and by itself, there are no elements with distinguishable characteristics. And so, that which manifests itself as elements with specific characteristics within a triadic set is and remains in its nature not different from that which is void of characteristics.

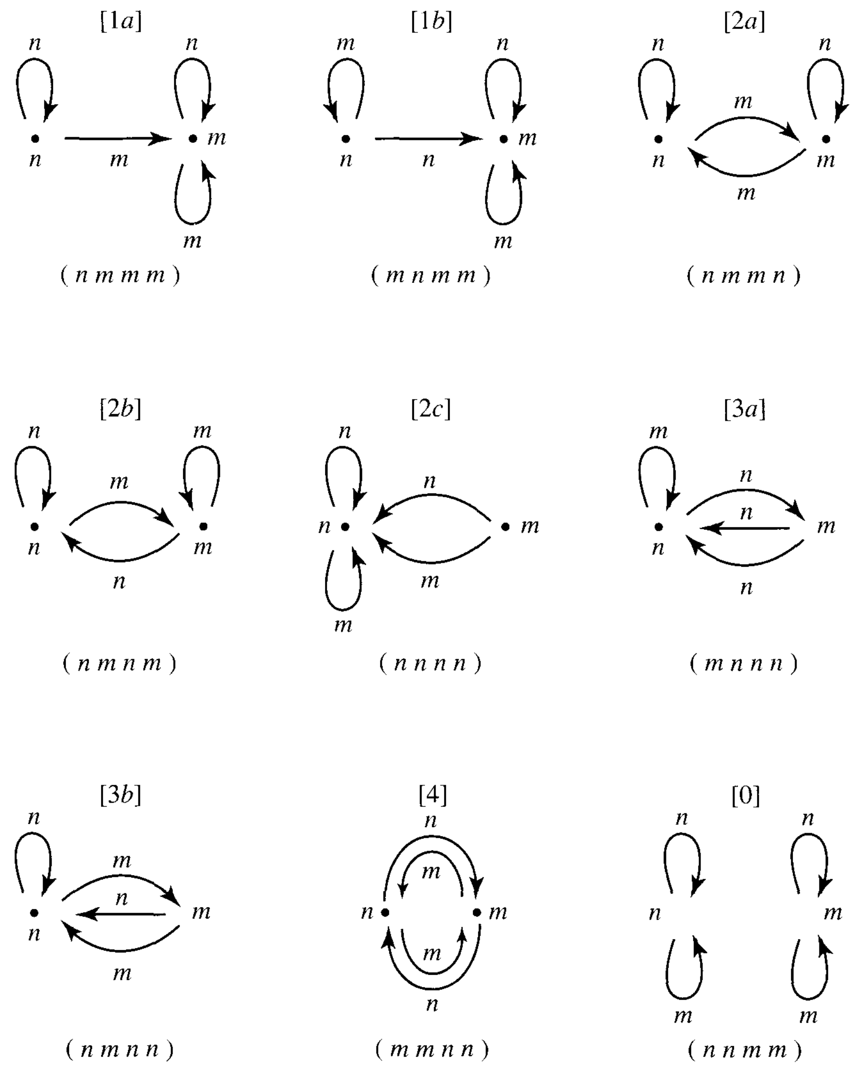



Figure 11. The eight process networks.

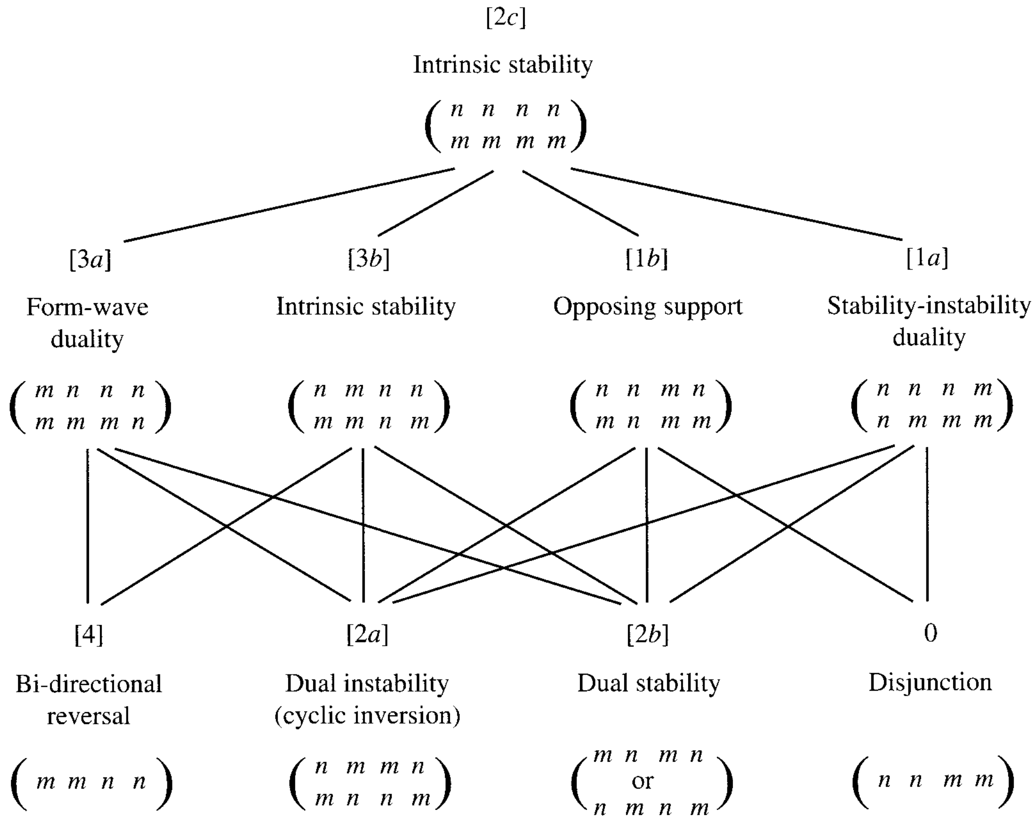



Figure 12. Map of metamorphic transformations resulting from change in one outcome element.

## *Editor's Note, 1994*

Paul Rasmussen (1986) suggested that Herbst might map all the outcome conditions in their Boolean form (corresponding to the 16 possible Boolean connectives). Herbst (1987:12) responded to this suggestion with his paper on "Co-Genetic Logic: The Eight Process Networks." The question he posed in this paper was "whether all of these (outcome conditions), when the elements *n* and *m* are undefined, might have identifiable characteristics."

Before he died David Herbst spelled out the framework for this search for identifiable characteristics. Figures 11 and 12 present this framework. He appears to have achieved little beyond this.

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