Dialectic thinking as a means of understanding systems-in-development: relevance to Rogers's principles

This paper explores the dialectical noncausal category of determination as a method of explaining human development and examines its relationship to Rogers's principles of homeodynamics. The relationships among determinism, causality, and lawfulness are discussed, and the categories of determination are reviewed.

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ACCORDING to Rogers,[1] the focus of nursing science is unitary man or the whole person. Nursing science provides a knowledge base for the practice of nursing; it specifically studies the nature and direction of human development as it relates to the promotion of human health and welfare.

Unitary man, as conceptualized by Rogers, is an open system in a universe of evolving open systems.[1,2] The characteristics of unitary man as an open system include:

- a developmental process that is still growing, evolutionary, and negentropic;
- a field that has pattern, organization, unity, and arbitrary boundaries and is four-dimensional (ie, represents a synthesis of the three space coordinates and time); and
- continuous interaction with the environment.

Rogers's conceptual model has several

key points. As energy fields, humans are intrinsically dynamic, ie, characterized by continual self-movement or activity. As open systems, humans and environment are in continuous interaction, mutually changing each other. Open systems are negentropic, rather than entropic, and the development of human beings is characterized by increasing complexity, diversity, and differentiation. Elements that are uniquely human include feelings, reason, decision making or choice, and goal setting. These elements are manifestations of the whole and emerge from the human-environment interaction; ie, they represent a synthesis (synergism). Changes that take place as a result of the human-environment interaction are creative or innovative, continuous, nonlinear, and rhythmical.

This rhythmical, nonlinear change is represented as an irregular spiral, since the cycles do not repeat in an identical way. The similarity of the cyclic repetitions, however, does allow probabilistic prediction. Pattern and organization identify the field and are manifestations of motion, interaction, rhythmicity, and innovation.

Rogers has rejected the classical model of positivistic science as an inaccurate description of reality, especially with respect to human beings and other living organisms.[2(p333)] Moreover, the traditional world view has emphasized mechanistic materialism, static structure, reductionism, and dichotomies of human or environment, matter or mind: all are inappropriate approaches to knowledge of unitary man. A view of reality that emphasizes process or becoming, relativity, relations, synthesis, and noncausal determination is considered more appropriate in describing unitary human beings.

DETERMINISM, LAWFULNESS, AND CAUSALITY

Bunge[3] examined the problem of causality as a theory of change and its relationship to modern science. Bunge perceived the causal problem to be ontological, with epistemological and logical aspects. Ontology (metaphysics), a branch of philosophy is the study of the most general traits of reality and involves both the study of categories and the analysis of generic laws.[3(p6)] Epistemology involves the study of theories of knowledge, whereas logic is the science of the operations of correct thinking. Bunge concluded that much of the confusion regarding the causal problem is related to an outdated philosophy of science, which confuses determination, lawfulness, and causality. Bunge has proposed an ontological theory of general determinism that includes both causal and noncausal categories of determination.

Determination

Determination is defined as a pattern or way of becoming (act or process) whereby an object acquires a property (either quantitative or qualitative); in another sense, determination refers to a constant and unique connection between events, states, or qualities of things as well as among ideal objects.[3(p7)] The first sense of the meaning is consistent with Rogers's conceptualization of unitary man, whereas the second sense of meaning is the one commonly employed by science.

Lawfulness

Lawfulness, in general, refers to orderly patterns of determination. Bunge distin-

guishes three levels of meaning of laws in the theory of general determinism:

1. $Laws_1$ at the ontic level (existing in reality), are objective patterns of being and becoming (immanent forms) that relate qualities. Thus, there are different laws on different integrative levels;[3(p211,249)]
2. $Laws_2$ at the epistemological level are conceptual reconstructions of the ontic patterns of being and becoming. $Laws_2$ are equivalent to what is generally meant by scientific laws that are actually theories or general hypotheses about patterns of being and becoming;
3. $Laws_3$ are also at the epistemological level and are adaptations of laws to their empirical verification,[3(p249)] which requires the careful use of logical rules and may involve description or prediction.

It is obvious that type 2 and 3 laws are not the equivalent of type 1 laws. It is generally assumed that type 1 laws are absolute and do not change, whereas events and peoples' knowledge of them are relative to the space-time context. The uniformity of nature does not apply to the phenomena, which are relative, but to the *laws of the phenomena,* which are absolute.[3(p249)]

Causality

The concept of causality has a long and complex history since the time of the Greek philosophers, and the term has had varied meanings. There are three main views on causality: causalism (strict causality), acausalism, and semicausalism.

Bunge defines causation as "event generation" and, as such, as having an ontological or metaphysical status.[3(pxix)] It is not coextensive with determinancy; it is a subcategory of determination. The world is not strictly causal but at best only weakly causal. Causation does not have epistemological status. Bunge defends four theses with respect to the concept of causation.

1. Causation is a *relationship among events,* not among things, properties, states, or ideas. Thus when A caused B to do C (eg, Joe kicked the ball, causing it to roll), a certain event or set of events in A (Joe kicking) generated change C (the ball rolling) in the state of B (the ball).
2. Causation is a *mode of energy transfer* between events or sets of events and is not external to them, as are the relations of conjunction or coincidence and succession. Thus, Joe kicking the ball involved a transfer of energy generating the effect of the ball rolling.
3. Causes can *modify propensities,* especially probabilities, but they are not propensities. Cause and probability are not interchangeable. Probability is stochastic (involving a random chance component combined with a selective process),[4(p253)] whereas strict causality is not.
4. The causal generation of events is *lawful* rather than capricious. Thus,

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there are causal laws with a certain range.[3(ppxix-xx)]

Causalism

Aristotle (384-322 BC), the Greek philosopher who perhaps has most influenced western thinking, was a strict causalist. He divided causation into four types:

1. material cause (material from which an individual thing is composed);
2. efficient or external cause (the motion or action that began it);
3. final cause (the function or purpose for which it exists); and
4. formal cause (the form it actualizes and by which it fulfills its purpose).[5(p224)]

Of these four causes, modern thought has only retained the efficient cause regarded as an agent or force acting externally. Aristotle also introduced the idea of a succession of causes terminating in an Unmoved Mover.[5(pp229-231)]

Descartes (1596-1650 AD) introduced a philosophical system that rests on metaphysical dualism; ie, reality was divided into thinking substance and corporeal substance, with the former category primordial.[6(p290-301)] Cartesian philosophy greatly influenced the emphasis on mechanism; mathematical deduction; mind-body, human-environment divisions; and isolation of causes characteristic of modern empirical science.

Leibniz (1623-1662 AD), a recognized logician who greatly influenced modern logic, tried to unite Aristotelian and Cartesian thought. In his epistemology, Leibniz equated the causal principle to the principle of sufficient reason: in the judgment of facts, every fact finds its justification in a preceding fact.[6(p320)] Thus, cause was given an epistemological status based on knowledge and experience of things.

Bunge states that the confusion between cause, which has an ontological status, and reason, a rule or procedure in logic, parallels the confusion of material reality and its reconstruction in thought.[3(p230)] Therefore, the principle of sufficient reason cannot be regarded as the mental aspect of causality, since persons do not merely reflect reality but construct it and are influenced by frameworks which form a ground for thought. The laws of nature are not contingent but human knowledge of them is.

The Aristotelian belief that causation is the sole category of determination was carried over to modern empirical science, resulting in the notion held by many scientists that science is coextensive with causality. Some of the characteristics of the modern empirical interpretation of causality include:

- isolation of such factors as cause and effect, human and environment, and content and context;
- examination of relations between fixed "things" based on a philosophy of being, which is static;
- consideration of simple one-way linear cause and effect;
- continuity;
- emphasis on external, physical forces and mechanism as causal factors acting on a passive object;
- assumption of additivity of independent causal factors; and
- emphasis on quantitative relationships and reductive analysis.

These basic characteristics have been

identified by Rogers[1] and Bunge[3] in extensive discussions and critiques. Another trend of modern science, especially positivism, is the prejudice against metaphysics or ontology; it places emphasis on positive data obtained through the senses.[6(p432)]

Acausalism

Acausalism represents the second extreme point of view with respect to the causal problem. The notion of strict causality was increasingly discredited as modern science, especially quantum physics, began to uncover much richer noncausal connections. Some scientists also realized that the perspective of change in terms of separate events had to be replaced by a view in terms of processes.[1,7]

The empirical interpretation of causality (Hume, Locke, and Mill) reduced it to an external, uniform succession of events or, rather, the temporal sequence of experiences.[3(pp57-88)] Einstein's theory of relativity, Heisenberg's uncertainty principle, and the findings of quantum mechanics greatly undermined this notion of causality.[8] Russell declared the law of causality to be a relic of a bygone age.[3(p29)] Indeterminists deny all lawful links between events and qualities and do not recognize that causal connections exist; they assert that events just happen.[3(p29)]

Semicausalism

Semicausalism, the third point of view (represented by Bunge), declares that causality is valid only in restricted domains, whereas other categories of production, such as statistical or holistic, are valid in other domains.[3(p28)]

General determinism

Bunge has proposed an ontological theory of general determinism, which includes eight categories of determination (Table 1). General determinism is the hypothesis that events happen in one or more definite ways; that such ways of becoming are not arbitrary but lawful; and that the processes whereby every object acquires its characteristics develop from pre-existing conditions.[3(p13)] The broad principle of determinancy or lawful production states that everything is determined in accordance with laws by something else; external as well as the internal conditions.[3(p26)] This principle applies to any theory of structure or change.

Two necessary and sufficient components of the principle of general determinancy are:

1. the genetic or productivity principle, which states that nothing can arise or be created from nothing and
2. the principle of lawfulness, which states that nothing happens in a nonconditional or altogether irregular way (lawless).[3(pp25-26)]

The principle of lawfulness or orderliness does not mean that facts are determined *by* laws but only *in accordance with* laws; ie, the laws act as constraints on freedom. The principle of lawfulness is not committed to a particular form of determinism and does not determine anything. Laws are the *forms or patterns of determination.*

Thus, Bunge is declaring that things, their properties, and the changes of properties exhibit *intrinsic patterns* (objective type 1 laws), which are invariant in some respects. The principle of lawfulness is not

Table 1. Ontological categories of determination or lawful production

Category	Description and comments
1. Quantitative self-determination	Determination of the consequent by the antecedent. Continuous unfolding of states that differ from one another in quantitative respects alone.
2. Causal (ideal of modern science)	Determination of the effect by natural, efficient (external) causes, which it further tries to reduce to physical causes (mechanism). Ontologically objectionable but may be methodologically justified in certain restricted domains.
3. Mechanical	Determination of the consequent by the antecedent, usually with the addition of efficient causes (external force) and mutual actions. Effected through quantitative changes alone.
4. Interaction (functional interdependence, mutual causation)	Determination of the consequent by mutal actions.
5. Statistical	Determination of the end result by the joint action of independent and quasi-independent entities. May emerge from processes on deeper levels in which other categories of determination are involved.
6. Holistic	Determination of the parts by the whole.
7. Teleological	Determination of the means by the ends or goals. Goal-directed structures, functions, and behaviors need not be purposefully planned by anyone.
8. Dialectical (qualitative self-determination)	Determination of the whole process by the inner tension or "strife" and eventual subsequent synthesis of its essential opposing components. Involves qualitative change and has nothing to do with logical contradiction.

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committed to a particular type of determinism, such as causal or mechanical determinism.[3(p23)] The task of science is to discover the intrinsic patterns or type 1 laws of phenomena. These regularities are not generally observed but rather are inferred or reconstructed. Scientific type 2 laws, ideal reconstructions of the intrinsic patterns of structure or process, are generally assumed and then tested by application to classes of objects. To go beyond appearances and into the essence of things, a high degree of abstraction is generally required for the establishment of laws; ie, a theoretical model is necessary.

Causation (Table 1) is only one category of general determination that applies when an event occurs in a *unique way by external* conditions. The other seven *noncausal* categories of determination are quantitative self-determination, mechanical determination, interaction or functional interdependence, and statistical, holistic, teleological (goal-directed), and qualitative or dialectic self-determination. Bunge points out that occurrences or happenings in nature and society undoubtedly involve the intersection of a number of laws (eg, statistical, causal, and interaction laws) from all the categories of determination. Since knowledge of all of these connections is not possible, predictions cannot be certain.

Thus, ontological determinism is consistent with epistemological probabilism.[3(p330)]

The categories of determination or lawful production are seen as a hierarchy of types of increasing complexity with causation (external environmental determining factors) and quantitative self-determination (the dynamic self-motion of things) on the bottom of the hierarchy.[3(p20-21)] No particular type can be assigned to a level of reality to the complete exclusion of the other types, nor does one type reign supreme in all sectors of reality. However, in descriptions and explanations of the world, some categories of type 2 laws may more truly reflect the intrinsic patterns of becoming (type 1 laws) but not to the same extent in all sectors of reality.

Limitations of causal determination

A number of authors have criticized the principle of causation and determinism. Even Bunge's reformulation of causal determination has limitations when applied to human beings.

- The quantum field theory of modern physics has found all physical phenomena to be at least weakly nonlinear, so that, at best, causality can only be a linear approximation in certain restricted domains.[8(p173),9(p271)] Nonlinear connections are noncausal.
- Causality, being one-sided, neglects interaction, which is characteristically synthetic and integrative; it describes inner processes of a living organism, which act as a whole. Interaction is also needed to describe the human-environment relationship. The assumption of independence of causes, isolation of causal chains, and neglect of interaction leads to the erroneous belief that a whole can be described by the addition of parts. Rogers[1] has repeatedly emphasized that human beings (open systems) are dynamic wholes and behavior is synergistic.
- Causality does not account for the purposeful, goal-directed behavior characteristic of all living organisms. The behavior of living organisms is determined by their whole past history (space-time structure) as well as future goals and expectations as there is interaction with the environment. Human behavior is characterized by a high degree of self-determination, purpose, and choice.
- Causality can account for quantitative change but not for novelty, which involves qualitative changes; ie, the transformation that consists of the emergence of things with new properties. Novelty is explainable with the help of all of the categories of determination.[3(pp217-218)] Growth (quantitative change) and development (qualitative change) are characteristic of human functions and those of all living things, so that quantitative and qualitative (dialectic) self-determination should be included in their explanation.
- For a process to be considered causal, either one causal factor or one of the consequences must be selected from a whole constellation of determiners present in real situations. The universe is actually a system of interacting systems, so whenever something is singled out, its complement is neglected.

DIALECTIC APPROACH

Bunge's formulation of the causal problem is in many ways consistent with Rogers's conceptualization of unitary man. However, it is probable that causal determination plays a minor role in most human situations. The task of science is to look for some type of lawful genetic connection or principle of determinancy to make the world intelligible and understandable. Nursing science studies the development of human beings (wholes or open energy systems) as it relates to health. Human beings are systems in development who are inextricably connected to the environment and participate in a universal evolutionary process.

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The dialectic category of determination and a dialectic explanation may afford a truer account of human development, thinking processes, and evolution than causation. The dialectic pattern of lawful production can account for the rhythmic nature of change and the qualitative leaps characteristic of creative emergence (discontinuities), and it is also applicable to open systems, which behave as wholes. The dialectic explanation presented should not be confused with Marxian (materialistic) dialectic[10] with its denial of metaphysical reality and accompanying political ideology nor with Hegelian (idealistic) dialectic.[11] Rather, it is related to the Rogerian conception of unitary man.

Meaning of dialectic

Original meaning

The term *dialectic* is as old as western philosophy, dating back to at least the Greeks. Through the centuries, it has taken on many meanings. The original meaning of dialectic (Greek, *dialego*) was to discuss or debate.[12] The Greek philosophers believed that the best method of arriving at truth was to discuss a question from all sides, allowing different one-sided points of view to oppose and contradict each other during the debate.

The essence of the Socratic method of teaching is the use of a dialectic technique. When anyone claimed to have a formula that was the final answer to a question (eg, the meaning of justice), Socrates would enter a discussion with the person, and by forcing consideration of the question from different angles, would compel the person to make contradictory statements and so to admit that the formula was false. Socrates considered this method to be the most effective way of teaching and arriving at truth. Numerous examples of this technique of argument are found in *Plato's Dialogues*.[13] If the notion of dialogue is broadened to include self-dialogue, then dialectic becomes a method of thinking. Thus, dialectic in the original sense of the term is concerned with both epistemology (knowledge development) and logic (development of correct thinking).

An ontological category of determination

A second broad meaning of the term dialectic refers to a pattern of determination, of lawful production, or existential change. In this sense, dialectic refers to an objective pattern of becoming in the very nature of reality, so it is ontological (metaphysical). The basic notion is that of tension, strife, or opposition, which develops between different parts or features (complementarities) of whole systems and which is enhanced (or dampened) by external determiners to the point of a radical or qualitative change in the object. A synthesis of the essential components is involved in the working out of the opposing trends.

The opposing tendencies or complementarities are not independent of one another but are inseparable parts of the whole (ie, they form a unity of mutual dependence); they come into opposition on the basis of the contradictions inherent in the process and because of its self-dynamic nature. The opposing tendencies are heterogeneous and asymmetric, and in the process of interacting, they interpenetrate one another so that each modifies and is modified by the other.[3(p19),14-17]

Bunge notes that some authors have equated interaction (mutual causality) with dialectic.[3(pp164-165)] However, Bunge believes that not every interaction results in a qualitative change, a criterion of dialectical determination.

Wald lists four features accounting for the dialectic or complemental nature of the various pairs of categories forming such units. They are:

1. opposite because a third fundamental property is impossible;
2. inseparable, since each is a function of the other;
3. asymmetric because one is primordial and the other is secondary; and
4. self-dynamic, since they steadily interpenetrate and develop without any action from the outside.[17(p226)]

External factors, however, do modify and provide some of the conditions of the changes, which are basically the result of inner processes. A few examples of dialectic patterns of relations in the world that might be called necessary are: quality (pattern)/quantity; structure (form)/function (process); necessity/chance; differentiation/integration of parts in living organisms; organism/environment; subject (knower)/object (known); and content/context.

Specific meanings

Dialectic also has many more specific meanings when used by various philosophers. Many persons in contemporary society misunderstand the meaning of the term dialectic and consider it synonymous with the philosophies of Marx[10] and Hegel.[11] Hegel's philosophy was that of a thoroughgoing idealism, and Marxist socialism represents complete materialism. Both philosophers used a dialectic method.

Dialectic in scientific explanation

Although dialectical explanations are not common in science, one notable exception is Prigogene,[18] who won the Nobel prize in 1977 for the theory of dissipative structures. A typical dialectic explanation consists in the disclosure of the inward and outward conflicts that maintain certain processes or bring about

the emergence of entities endowed with new qualities.[3(p305)]

Theory of dissipative structures

Prigogene's theory of dissipative structures bridges the gap between the physical, biological, and social sciences and offers an explanation of how evolution may proceed toward increasingly higher orders of complexity and diversity from inert matter, to living organisms, and finally humans.[18] Prigogene's theory applies to open systems, structures that are maintained by a continuous dissipation or consumption of energy. All living things and some nonliving systems are dissipative structures. One example of a dissipative structure studied by Prigogene is the Zhabotinskcy reaction.[18,19] When this chemical solution is put into a shallow dish and touched with a hot wire, a reaction is initiated. Scroll-like waves unfold in an orderly spatial and temporal pattern, changing from red to blue at regular intervals.

The pattern of a dissipative structure is that it is in continuous flux as energy moves through it and forms it at the same time. When the fluctuations in this nonequilibrium system reach a critical level, the whole system may escape its steady state and shift into a pattern that is more ordered and coherent. The change to a more complex structure is a sudden event, and it is nonlinear, since multiple factors act on each other simultaneously. When a system is perturbed by fluctuations, these fluctuations increase the number of interactions by bringing elements of the system into contact with each other in new ways. The interaction is thus said to be self-organizing.

Prigogene believes that the nonequilibrium in dissipative structures is the source of order and suggests that evolution itself may represent a process leading toward increasingly complex and diversified biological and social organisms through the emergence of new higher-order dissipative structures.[18] Prigogene's theory is widely applicable in explaining many levels of reality in which there are transformations: chemical phase shifts, thought changes, social changes, and evolution itself.

Unity of mind and nature

Bateson[4] has demonstrated another example of dialectic explanation. Bateson's thesis is that mental processes, epigenesis, creativity, and evolution are all similar processes that depend on double increments of information (double description). These double descriptions provide news of a difference, nonsubstantial and related to negentropy, which triggers interaction of parts. Transforms or codes are the effect of differences and form a pattern or information.

Some examples demonstrate double description or combination of information that generates a higher dimension or metapattern.

- The difference between the information provided by one retina and the other is itself information of a different logical type, and from this new sort of information, an extra dimension is added to seeing.
- The difference between the information from several sense organs provides metainformation so that imaginary experiences may be differentiated from actual ones.

- The combination of two sources of genetic information in sexual reproduction both limits genetic variability and increases phenotype variety, which have superior survival value for a species; ie, if the differences between two corresponding strings of DNA are too great in the process of fusion, then fertilization cannot take place.
- The combination of two different frequencies produces a third frequency (beat phenomena), and any two of the three patterns can serve as the basis for description of the third.

The general rule in all of these examples is that information of a new logical type is generated by juxtaposing multiple descriptions. Context is characteristic of all interaction, providing all meaning and shaping all communication. Growth and development, mental processes, and creative evolution all depend on information in the very shape or pattern of phenomena. Thus, mind (news of a difference) in its broadest sense is part of all nature.

Although these authors have not labeled their theories dialectical, they clearly are according to Bunge's description of a dialectical explanation. They also focus on process or becoming and on cyclical change. Ballard[14] notes that dialectical systems are cyclical or rhythmic and develop in the direction of increased complexity.

PRINCIPLES OF HOMEODYNAMICS

The principles of homeodynamics are derived from Rogers's conceptual system of unitary (synergistic) man and postulate the nature and direction of change during human development. The term *homeodynamic* denotes the dynamic nature of the processes that continually occur within the human energy field and between the human energy field and the total environment. There are three principles of homeodynamics: complementarity, resonancy, and helicy.

There is a "biological metabolism" between humans and environment characterized by the exchange of matter-energy. This relationship is constant and necessary. There is also an "epistemological metabolism" between humans, the subjects and the objects. Similarities and differences or information are immanent patterns in the object. However, the knowing subject provides the receiving context of the patterns, so that knowledge is always subjective and relative. The world consists of processes, which are always becoming. The principles of homeodynamics as formulated by Rogers (type 2) are assumed to correspond to the intrinsic patterns in the very nature of processes in reality (type 1 laws).

The principles are lawful patterns of becoming that not only describe individual development but also, in a more general form, describe all evolutionary processes in nature and society. The objective patterns or laws (type 1) are metaphysical and absolute, whereas human knowledge development is subjective and relative. Logic or thinking processes are also subjective. Thus, the objective laws (type 1) are primordial and it is important that persons reflect these patterns in their thinking. Although knowledge does *develop* in accordance with ontological laws, *developed knowledge* may not reflect reality, ie,

there is no *necessary* connection with things as they seem and things as they are. Knowledge is not mere reflection of sense data, and truth is not self-evident. Rather, humans strive to make the world intelligible by building cumulatively through correspondence and coherence and by scientific testing. The principles of homeodynamics are believed to provide the proper framework to guide thinking processes. These principles are dialectical and explanations must follow the same pattern.

Complementarity

The principle of complementarity explains the fundamental dynamics of change or self-development in a universe of open systems, interacting as wholes. This principle is actually subsumed under the principle of helicy and states that the interaction between human and environmental fields is continuous, mutual, and simultaneous.[2(p333)] The principle of complementarity has been stated by Wald[17] as the law of the unity of contraries and of internal contradiction.

Humans strive to make the world intelligible by building cumulatively through correspondence and coherence and by scientific testing.

All manifested reality in the universe behaves according to the principle of complementarity. It is the inner contradictions or tension field in the complementarities that provide the driving force of evolution or development. The most general properties of any system must be expressed in terms of complementary or contradictory sets of that system, which are joined as complements to each other.[20(p139)] The complementary sets are not dichotomies but are inextricably bound to each other, each mutually influencing the other in their opposition, thus forming a unity. The opposition between the complementarities has sometimes been referred to as a tension field or ontic (existential) stress.

Complementarities describe not only the inner processes of an open system but also its relationship with the environment. The contradiction within a system is considered the fundamental cause of its development, whereas its external relationships are the conditions of change and only modify or trigger inner processes.

A necessary condition of open living systems and their environment is a constant exchange of energy. Both Rogers[1] and Prigogene[18] assert that living open systems (dissipative structures) cannot be described in terms of equilibrium. A state of nonequilibrium within and between living systems and the environment is absolutely necessary for the flow and transformation of energy. Otherwise, it would not be possible to maintain the life processes and to evolve and grow. The asymmetry present in the complemental sets provides the dynamic tension necessary for the continual dance of energy characterizing the human field or any other field in reality.

The principle of complementarity may be expressed as the unfolding of dynamic potential and the combination of energy with many different levels of the environment. The complementarities involved in any process are not isolated pairs but many

different sets. The working out of a whole constellation of complemental sets that interact with each other is involved. The combination of energy involved in the process is called synergy. Thus, Rogers refers to human beings as unitary or synergistic, since a synthesis results from the working out of the contradictions, and energy exchange is involved.[1(p93)]

The human-environment interaction occurs on many different levels simultaneously. In a metaphysical sense or in reality, biological, psychological, and social interactions do not exist, as these are epistemological categories. There is only the exchange of energy and the generation of knowledge from the patterns immanent in the forms, which are actually the interconnections of events.

According to the principle of complementarity, there is a hidden complemental aspect to every experience.[20(p139)] The level of understanding can be increased by identifying these complementarities. Usually, a few contradictions or complemental sets play a key role in a constellation. To understand the laws of the development of a process, there must be understanding of the basic contradiction of the process at each stage of development, as well as the principle "force" for working out the basic contradictions and carrying the process forward to the next stage.

Fundamental complementarities include the following.

- *Human (organism)/environment* illustrates a necessary relation of any entity considered.
- *Space-time structure (form)/function (process)* illustrates a fundamental strategy of how a living entity can maintain its identity and change at the same time. Rogers describes structure as a slow process and function as a more rapid process.[1(p62)] Interacting processes define temporary structures, and structures define new processes, which in turn give rise to new structures that are temporary. Thus, structures allow the focusing and acting out of energy, whereas process carries the momentum of the energy unfoldment.
- *Integration/differentiation* describes two fundamental processes characteristic of development; these constitute the two moments of the overall process.
- *Continuity/discontinuity* illustrates how processes may be perceived on different integrative levels.
- *Quantity/quality* mirrors the dialectics of things as far as their measure is concerned. Quantity is measurable, but quality is not.
- *Difference/identity* illustrates the categories in point of repetition. Difference is never repeatable, whereas identity always is.
- *Chance/necessity* represents the two sides of an object as far as the possible is concerned. A chance may materialize or not, but necessity cannot fail. An organism is captured, preserved chance, reproduced by the mechanism of invariance, and thus converted to order, rule, and necessity. Thus, chance turns to necessity, and necessity is rendered manifest through chance, since between chance and necessity there is a dialectical unity.[17(p227)]
- *Individual/general* illustrates the complemental parts with respect to space. The individual is somewhere; the general is everywhere.

- *Phenomena/essence* illustrates dialectics in point of depth. The phenomenon is the superficial side, whereas essence is the deep side.[17]

Since everything is part of a complemental set in some of its aspects, many more complementarities could be identified, which are relevant in describing human development or evolution. Dialectic thinking requires consideration of the complemental aspects of whole systems and their relationships. The opposing trends or contradictions inherent in the nature of things do *not* constitute logical contradictions.

Dialectic logic

Wald[17] has developed epistemological principles and principles of logic, which he believes reflect the dialectical, ontological principles. According to Wald, knowledge develops between tautology and paradox. A tautology represents minimum information. Thus, when the judgment is made that "stone is stone" (A = A; the law of identity in elementary logic), the meaning is that "a stone has the characteristics of a stone." A tautologic judgment is akin to a pointing process and it is the beginning of knowledge.

Language is only a tool used to assist thinking and communication. On the other hand, a judgment such as, "Light is both a wave and a particle" is a paradoxical or dialectical judgment. A paradox *may* represent the maximum amount of truth or knowledge about a subject and does not represent a reversal of reason. The two predicate terms (*wave* and *particle*) ascribed to the single subject term (*light*) represent the two complemental aspects of the reality.

The dialectical judgment represents the motion of things, the becoming or the *developing* contraries and not the *developed* contraries, which are static and based on being. A dialectical judgment attempts to mirror the real (ontologic), mutual, simultaneous interaction between the complementarities in the motion or process of becoming. The simultaneity referred to by Rogers in the principle of complementarity is real, even though one can ascertain complementarities only successively and relatively. The becoming or developing process itself is described by Rogers as transcendent or four-dimensional.

Wald's system of dialectic logic (based on becoming) assumes the laws of elementary (Aristotelian) logic (based on being) but transcends them. The former is concerned with the logical laws of the development of dialectical ideas and judgments, whereas the latter is concerned with the identity of things. Wald believes that human reason first mirrors the identity of things through elementary thinking and then through dialectic thinking, the contradictory unity between the relative identity or stability of things and their absolute self-differentiation or self-motion.[17(p109)]

Since the realm of knowledge and thinking is always subjective and relative, dialectic logic and thinking is not a panacea for revealing objective or ontological truth; however, it may help uncover some of the complementarities and thus attain the maximum knowledge of which human beings are capable. The dialectical or process thinking recommended by Wald is similar to Bateson's method of double description. Bateson asserts that relationship (the pattern that connects events) should or could be the basis for definition, rather

than the usual method based on what a thing is in itself, ie, its essence. [4(p18)] The epistemology of Bateson and the epistemology and dialectic logic of Wald seem to be consistent with Rogers's theoretical framework of unitary man.

Resonancy

The principle of resonancy postulates that change in pattern and organization of the human and environmental field is propagated by waves.[1(p101)] Change is continuous from lower-frequency, longer wave patterns, to higher-frequency, shorter wave patterns.[2(p333)] This principle expresses the manner in which things self-develop, ie, change is rhythmic or cyclic in nature. The principle of resonancy follows from the fact that the entire universe is characterized by wave phenomena, which vary in wavelength, frequency, and amplitude. The energy is proportional to the frequency, so that the lower the frequency (long wavelength), the lower the energy, and the higher the frequency (shorter wavelength), the higher the energy.[21(p57)]

When energy waves interact, the resulting wave interference pattern is manifested as form. Pattern represents the interconnections of qualities.[4(pp53-59)] There is a rhythmic flow of energy waves between human and environment. The interaction of energy waves may be manifested as beat phenomena or rhythmic vibrations of the field.[22(pp68-69)] All developments in nature and human situations show cyclic or rhythmic patterns in the cycle of change.

Rogers has defined health as a rhythmic pattern of energy exchange that is mutually enhancing and expresses the full life potential.[1(pp122-123)] An increasing number of nurse researchers and clinicians are beginning to study and take account of rhythmic phenomena as they relate to human health and functioning.[23-25]

The principle of resonancy can explain the sudden changes or qualitative leaps that characterize transformation or creative emergence in evolution or the stages in human development. Rogers's principle of resonancy corresponds to Wald's laws of transformation of quantitative change into qualitative change[17] and Prigogene's description of the behavior of dissipative structures.

According to Wald's description, the passage from a quantitative to a qualitative change is determined by the working out

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of the contradiction inherent in the process (internal changes) and by external accidental causes, but the character of change always depends on the internal processes. Thus, the contradiction within a thing is the fundamental cause of its development, whereas its relationship with other things is a secondary cause. The external changes are the conditions of change, whereas the internal processes are the basis of change; the external factors only become operative through the internal factors. The particular quality on which the old quality was based determines the new quality that emerges. The external factors only affect the quantitative changes of things: the times and

places of their beginnings and the rate at which the change proceeds.

The qualitative change is always sudden: At a certain critical point of quantitative change a new quality emerges, and this change is abrupt. Although the qualitative change begins suddenly, the rapidity with which the new replaces the old depends on the nature of the process and the conditions under which it occurs. The quantitative aspect of the qualitative change is the power and speed with which it completes itself.[17]

When two rhythmic wave patterns are superimposed, the results depend on the conditions. If the two wave patterns are of equal amplitude and in phase (ie, crest corresponds with crest and trough with trough), the result is a reinforced wave of twice the amplitude of either wave; this is resonance. The amplitude represents the degree or quantity of fluctuation, which is enhanced by resonance. All bodies have natural periods or frequencies of vibration. Thus, the phenomenon of resonance is very important, since it can be readily activated if a force acts on it periodically with the body's own natural frequency.

An example of resonancy is that of a child pumping a swing. The child learns that the swing can be given a vibration of considerable amplitude if the impulses are timed in accord with the natural period of the swing.[22(p56)] On the other hand, if the interacting waves are of a slightly different frequency, the result is a third pattern (beat phenomenon), with the frequency exactly equal to the difference between the original frequencies.[22(p69)]

The phenomenon of resonance provides an explanation of how external rhythmic processes resonating with internal processes may enhance fluctuations until, at the critical point, a new level of organization or sudden qualitative change occurs. The nonlinear sudden emergence of new qualities may be thought of as a continuous motion in space-time.

Helicy

The principle of helicy indicates that the direction of change in the evolutionary and developmental processes is toward increasing complexity and diversity of the human and environmental field patterns. The change is always irreversible, probabilistic, and innovative.[2(p333)] The developmental or evolutionary process has been illustrated as an irregular, ascending spiral bound in the curvature of the space-time continuum to illustrate the nonlinear progression.[1(p100)] The cyclic rhythmic similarities of change allows probabilistic goal setting and prediction of the developmental process. Prediction of behavior becomes less accurate higher on the phylogenetic scale, since there is increased flexibility in the interaction with the environment, ie, human beings manipulate the environment to enhance the life process.

The principle of helicy is represented by an irregular spiral, because although development takes place by the working out of complementarities and these are cyclic in nature, they do not work themselves out in such a way that an earlier stage of development is repeated at a later stage. Features of the past can appear in the future but have always been changed and transformed. Thus, regression is not possible. The increased complexity and differentiation follows because past experiences become preserved in the space-time structure and each new level of integration

includes more interactions. The increased differentiation results because all change and processes grow out of prior processes. Wald has expressed the principle of helicy as the law of the negation of the negation.[17]

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The classical causal model of positivistic and empirical science has been judged to be inappropriate as an approach to the study of unitary man, the focus of nursing science. Rather, a view of reality emphasizing process or becoming, relations, relativity, synthesis, and noncausal determination is considered to be a more appropriate ontology and epistemology applicable to the complex human being acting as a whole. The Rogerian model of unitary man may be classified as a model of systems in development.

The dialectic noncausal category of (qualitative) determination was explored and found to be particularly applicable to systems in development. The theoretical models of Rogers, Prigogene, and Bateson have a number of similarities, since they are all developmental and all use dialectical explanations. Although all of these theoretical models use dialectic as an ontological category of determination and as a method of explanation, none are combined with materialism.

In the exploration of the appropriateness of the application of the dialectic category of determination to unitary man, the related problem of causality was analyzed. The causal problem was judged by Bunge,[3] a philosopher of science, to be largely ontological, with epistemological and logical aspects.

Some of the confusion in modern science regarding causality relates to a philosophy based on being rather than on becoming or process; the rejection of ontology or metaphysics; and the confusion between ontic, epistemologic, and logical aspects of reality. Thus, causality has been equated with determination and lawfulness; it is, however, just one category of determination, and causal laws are just one type, very few in number, and never strictly true. Causality, an ontological category of determination, has also been wrongly equated with the principle of sufficient reason (a rule of procedure in logic), which is in the epistemological realm of reality.

Causal determination is particularly inadequate in explaining human development, and the interaction of all the categories of determination is assumed to be involved in the creation of novelty. However, causal determination does play a role, although it may be minor compared to that of the other categories, so it should not be completely dismissed. The theory of general determinism and the semicausalist position is judged to be consistent with a model of systems in development such as unitary man.

The dialectic category of determination, being the most complex, is judged to be particularly appropriate in explaining the development of complex human beings. The principles of homeodynamics are essentially dialectical principles or laws. Dialectic principles may be particularly helpful in assisting to discover and identify complementarities, which provide the basis for self-development. However, dialectical descriptions and explanations of events

should not be considered a panacea for revealing objective truth.

The purpose of nursing science is to render reality intelligible as it relates to human health and development. This is accomplished with the help of theories and scientific laws or principles, which are constructed from the patterns and order understood as reality. The principles can then serve as hypotheses, which can be tested for correspondence. Explanations, for the most part, involve several categories of determination and are largely noncausal. The ultimate goal is to uncover the intrinsic patterns or objective laws basic to human beings and the environment.

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