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Psychology's Reliance on Linear Time: A Reformulation

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The linear advancement view of time is shown to be a very prevalent but relatively overlooked presupposition in psychological theorizing. The past is viewed as indispensable to, if not the determinant of, behavioral and cognitive forces operating in the present. Although some psychologists consider this to be axiomatic, history and physical science teach us that such an assumption is neither a requirement of thought, nor a desirable basis for theory construction. Parallels are drawn between the Newtonian conceptions of unidirectional time and causality and contemporary psychological views. Mach and Einstein's criticism of these conceptions is outlined and their alternative presuppositional base, formal causation, proposed as a more flexible foundation for theorizing in psychology. The viability of this assumptive base is explored in a framework for learning and development, and several theories are cited as trends toward this framework.

When one examines the assumptions upon which the many theories of behavior are based, it is not particularly surprising to find a widespread reliance on the linear perspective of time. In fact, it would be difficult to overestimate the importance of this presupposition because fundamental to nearly all learning theories, from S-R to information processing, is the linear time presumption. Time is viewed as being analogous to a geometric line; it advances continually forward with each point or moment of time considered unique and nonrepeatable. The very meanings of behavior and change, as perceived by these theories, are as a continuous flow over time.

Whether the construct be stimulus-mediation-response, independent-intervening-dependent variable, or input-output, everything seems to fall into line as "before" and "after"—across time. Stimulus is always antecedent to response, whether or not the theoretical formula (S-R) is mediated by an "O". Operant conditioning principles are typically considered linear by psychologists because present behavior is the result of reinforcement history. Even the so-called revolt of many "cognitive" psychologists is not considered revolutionary from this point of view since cognitive constructs, such as expectancy and preference, are viewed as having been originally developed by past associations and experience (e.g., Boneau, 1974). Memory and information processing models, too,

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are based on some variation of input-output directionality. Structural models (e.g., Atkinson & Shiffrin, 1968) with something akin to sensory register, short-term, and long-term memory stages have clearly linear assumptions. Long-term memory is the accumulation of information experienced at previous points in time, while short-term memory maintains information by rehearsal over time. Even the currently influential "levels of processing" and "organization" frameworks also appear to ultimately depend on past associations and images as the determinants of the "level" and "organization" of information (e.g., Craik & Lockhart, 1972, p. 675).

A strong case can be made that a great portion of psychology in general is heavily dependent on linear time as a theoretical presupposition. The past is viewed as indispensible to, if not the determinant of, behavioral and cognitive forces operating in the present. Given such reliance, it is surprising that theorists have so rarely called attention to this fact. The reason for this, however, seems relatively clear. Most psychologists consider conceptualizations of behavior and learning in this manner "natural". Linear time is presumed to be axiomatic and therefore relatively uninteresting. Theorists do not call attention to linear time precisely because it is so pervasive. Indeed, how else can one explain changes in behavior, they might query, except by resorting to past reinforcement, association, or input?

This attitude is not unexpected, given the prevalence of this view in our society. The linear progession of time is without doubt the central mode of all thought in Western culture. "The clock," declares Lewis Mumford(1934), "not the steam engine is the key machine of the modern industrial age" (p. 14). The mass-production of cheap watches in the nineteenth century made it possible for even the most basic functions of living to be regulated chronometrically—"one ate, not upon feeling hungry, but when prompted by the clock: one slept, not when one was tired, but when the clock sanctioned it" (Mumford, 1934, p. 17). Regulation of our lives by the clock meant that the abstract concept of absolute time, as something existing in its own right, came to be endowed with a spurious sort of concrete reality (Whitrow, 1972). In short, a convenient way of organizing events became reified into *the* way events are organized.

Although the tremendous impact of this outlook is undeniable in our society and perception of the world, the question remains whether such a heavy reliance on linear time is a required or desired element in psychological theorizing. Is linear time a necessity of thought and therefore indispensable to learning theory as seems to be contended? Or, have theorists concretized a convenient organization of learning into *the* way learning is presumed to operate? The claim will be made here that the linear assumption of time is neither required nor desired in psychology. As historial evidence reveals, it is far from being a necessity of thought or theory (Whitrow, 1972), and as physical science has learned, it may not be a wanted element in theoretical presuppositions (Cowan, 1975). The modern physical science substitute for this notion will be examined as a possible presuppositional alternative for psychology, and trends in psychology toward this alternative will be noted.

The Rise of the Classical Conception of Time

Throughout the medieval period, there was considerable conflict between two views of time: cyclical and linear. Scientists and scholars, influenced by astronomy and astrology, tended to emphasize the cyclic concept. Utilizing heavenly bodies as cyclical guides, events were viewed not as unique points in time, but as part of a closed ring of repetition. This belief was by far the most influential in antiquity and is presently a prevalent conception in many Eastern cultures (Whitrow, 1961). For humankind to have had such a conception, even if only historically, argues strongly against the contention that linear time is a necessity of thought. But how did the linear perspective of time gain such prominence and hold over our thinking?

Linear time, during the medieval period, was fostered by the mercantile class and the rise of a money economy (Whitrow, 1972). As long as power was concentrated in land ownership, time was perceived as plentiful, being associated with the unchanging cycle of the soil. With the circulation of money, however, the emphasis was on forward progress and the accumulation of nonrepreatable moments. But the rise of a mercantile economy alone would not have been enough to wrest humanity from its cyclical moorings. Perhaps the cardinal factor in the linear perspective's hold over present thinking was the spread of Christianity (Whitrow, 1961). Its central events, such as the birth of Christ, were regarded as unique and not subject to repetition.

The great leaders of the scientific revolution of the seventeenth century also were interested in horological questions. Kepler and Boyle rejected the old quasi-animistic, magical conception of the universe, and asserted its similarity to the contiuous flow and mechanism of the clock. Hence, the invention of the clock is said to have played a central role in the formulation of the mechanistic conception of nature (Wessman & Gorman, 1977). With the aid of the nineteenth century biological evolutionists and the invention of cheap chronometers (Mumford, 1934), the linear progression view became reified into *the* way events are organized.

This reification and its influence on how one views the world is perhaps seen nowhere better than in the thought and theory of Isaac Newton. Fundamental to Newton's theory was the assumption of Absolute Time which "from its own nature, flows equably without regard to anything external" (Newton, 1934, p. 6). Here time is viewed as a medium which exists entirely on its own, independent of human consciousness. Newton felt the need of such a conception because he considered motion and causality as change through time and space. Bodies at rest, for example, do not of themselves acquire motion—to acquire motion there must have been some *prior* motion as the cause. Hence, causality itself for Newton was inextricably tied to linear time.

This aspect of the classical conception of causality also provides insight into the accusation that Newtonian physicists "made a metaphysics" of their method (Burtt, 1954, p. 229). That is, Newtonian physicists were criticized for having confounded theoretical presuppositions with their empirical methodology. If theoretical assumptions are thought to be inherent in scientific method, such assumptions can never be falsified. Indeed, through repeated experiments, such confounded assumptions appear to be implicitly confirmed. Newton, of course, based his scientific method on a machine analog. In order to observe the machine in its regularity, he assumed that one tracked the effect of some antecedent (in time) manipulation on its consequent. Therefore, orderly and predictable relationships between experimental variables were ipso facto linear time relationships. The method appeared to confirm the unidirectional flow of cause and effect across time repeatedly, because it could not do otherwise.

The Einsteinian View of Time

Newton's classical view of time and causality utterly dominated physical science until the advent of Einstein's revolutionary theory of relativity—a conception which rejected the previously accepted belief that there exists an absolute frame of reference for observing physical events. Einstein's views were initially rejected out of hand by most scientists (Whitrow, 1972). Absolute linear time was looked upon as axiomatic or intuitive and therefore unchallengable, much like cyclical time years before. However, Einstein's penetrating criticism of Newton's absolute meaning of "simultaneity" eventually precipitated the downfall of the "reality" and unidirectionality of time in classical physics (Baker, 1970; Einstein, 1961; Einstein & Infeld, 1938; Whitrow, 1961).

To aid in understanding this revolutionary perspective of time, Einstein illustrated the relativity of simultaneity be asking us to imagine two observers: one traveling in a moving train and one standing alongside the train on a railway embankment. Just as the two observers coincide at a point along the track (call it *M*), two lightning bolts strike along the track at points on either side of *M* (call them *A* and *B*). Both lighting bolts appear to strike "simultaneously" to the observer standing precisely between the bolts on the embankment at point *M*. To the observers on the moving train, however, also precisely between the two flashes at point *M*, flash *B* is seen "before" flash *A*. Although the observer on the train coincides with the observer on the embankment, the observer on the train hastens toward the beam of light coming from *B* and rides ahead of the beam of light coming from *A*. Consequently, the observer on the train sees light emitted from *B* "earlier" than the light emitted from *A*. Of course, a third observer moving in the opposite direction would experience flash *A* "before" flash *B* (i.e., in "reverse" order).

All three observers in this illustration are correct, yet all three saw different sequences of events. Einstein resolved this apparent contradiction by pointing out that time flow (linear sequence) was not inherent in the events themselves, but rather a result of each observer's frame of reference (Einstein & Infeld, 1938). Thus, Einstein circumvented the medieval debate about which type of time (cyclical or linear) was appropriate, as well as Newton's cumbersome absolutistic assumptions, by removing time and sequence from external phenomena. For Einstein, events simply do not take place in any particular temporal order, since all frames of reference are equally valid. What we commonly think of as "past" events have no objective reality which precede "present" or "future" ones. Einstein would in fact agree (Whitrow, 1961) with Weyl (1949) when Weyl proclaimed that: "The objective world simply *is*, it does not happen" (p. 116).

If this is the case, where then do we get our very real feeling that time "exists"? Einstein (1961) answered this question regarding the origins of time with the following:

> Everyone has experienced that he has some doubt whether he has actually experienced something with his senses or has simply dreamt about it. Probably the ability to discriminate between these alternatives first comes about as a result of an activity of the mind creating order. (p. 131)
>
> An experience is associated with a "recollection," and it is considered as being earlier in comparision with "present experiences." This is a *conceptual ordering principle* [italics added] for recollected experiences, and the possibility of its accomplishment gives rise to the subjective concept of time, i.e., that concept which refers to the arrangement of the experiences of the individual. (p. 139)
>
> At first sight it seemed obvious to assume that a temporal arrangement of events exists which agrees with the temporal arrangement of the experiences. In general, and unconsciously this was done, until skeptical doubts made themselves felt. [Einstein footnotes here the fact that] the order of experiences in time obtained by accoustical means can differ from the temporal order gained visually, so that one cannot simply identify the time sequence of events with the time sequence of experiences. (p. 140)
>
> [C]onsidered logically, [time and space] are free creations of the human intelligence, tools of thought, which are to serve the purpose of bringing experiences into relation with each other so that in this way they can be surveyed. (p. 141)

Clearly, Einstein viewed time as a "conceptual ordering priciple" which the person uses to organize his/her world. We first begin using temporal organization in order to distinguish between what we think of as "memory" and the "present." Events may look as if they are arranged sequentially in time, but this is only the result of our mind's "unconscious" habit of creating order. One could also speculate that this concretization of time is due to our society having created many conventions about the meaning of certain experences in order to communicate. In any case, Einstein believed that there is no absolute frame of reference or direction for time. The assignment of time and sequence is subjective not objective (Einstein, 1961).

Without time, then, how does the modern Einsteinian physicist organize the universe? In a sense, Einstein felt that the physicist should study the universe as if one were standing on the railway embankment in the relativity-of-simultaneity illustration. The observer on the train saw flash *B* "before" flash *A*, but the same lightning bolts can be seen as a relation of simultaneity in the equally valid frame of reference of the observer on the railway embankment. It is apparent from this illustration that what is time (or sequence) in one frame of reference is only organization (in space) due to the simultaneity of events in another. If one concentrated only on the organization or "spatial" relations of such events, the arbitrariness of time would be avoided.

Minkowski formalized this conception into the space-time, four-dimensional continuum (Einstein, 1961). Although classical, Newtonian physics also localized events by four numbers, space and time were each considered qualitatively different from the other; time was one-dimensional and space was three-dimensional; only the latter contained simultaneous events. Einstein and Minkowski, on the other hand, did not view time and space as qualitatively different entities, but of the same nature (i.e., on a continuum). The resulting conception was neither "time" nor "space" in the classical sense, but the organization or relation of the two, more easily represented in a spatial figure or "time solid" (Whitrow, 1961).

In addition to time, relativity theory altered many other classical notions including causality. With Einstein's train illustration, it is not too difficult to see problems with Newton's unidirectional view of causality. To assign causal status to an event because it is supposedly "first" in temporal order is to assume an absolute frame of reference. Einstein's precursor, Ernst Mach (1959), also held a similar view. He felt that the classical notion of causality was incapable of embracing the multiplicity of relations which exist in nature. Mach viewed events of the world as *functionally interdependent* with no particular event taking precedence over another because it appeared to be antecedent. Measures of time in any case, he pointed out, were based on space (viz., the different positions of the earth or a clock). "We are thus ultimately left with a mutual dependence of positions on one another" (p. 90). All so-called causal relations should be regarded as "mutual relations of simultaneity" (p. 91). Mach illustrated his "functional interdependence" conception with the interlocking gears of a windmill (Feuer, 1974). The cogs of one gear meshing with cogs of another was his protomodel of two classes of phenomena mutally dependent on one another. No particular event held causal status; the perceiver, for Mach, imposed an arbitrary causal primacy on one event (or cog) over another.

Time and Causality in Psychology

The possiblity that a similar arbitary primacy is being ascribed to certain "causal" factors in psychology should also be explored. For instance, it is not sufficiently acknowledged that what is typically construed as causative is only a necessary condition for an effect. Such conditions alone are not sufficient condition for an effect. In fact, a sufficient conditon usually consists of a multiplicity or synergy of many necessary factors, all of which are equally important, because without one the effect would not occur.

In experimentation, an effect results only because many necessary conditions are camouflaged in so-called control factors. "Control" does not mean the absence of a factor; control factors are very much present, they are only held constant. To select one factor from many other necessary conditions and give that factor causal status is inevitably to neglect not only other potentially important factors, but also the factor's total synergy which presumably causes the effect in the first place. Each factor is, in a sense, a part of a greater whole and all parts themselves "functionally interdependent." From this perspective, Mach's position seems to have great import for psychology.

Aristotle also recognized this aspect of causation when he attempted to classify all types of causal factors or necessary conditions into four categories (Ross, 1937). In describing the causes of a chair, for example, Aristotle noted that: that chair would not have been effected if the carpenter had not had a purpose for it, the *final cause*; the chair would not have had its specific shape without the carpenter having its form or organization in mind, the *formal cause*; the chair would not have held its form without its substance, the *material cause*; the chair would not have been effected unless it had been constructed by the carpenter, the *efficient cause*. Note that the first three causes are not "dynamic" in the traditional sense of that term. They are static or *within*-time concepts, while the fourth, efficient causation, is performed across time (Bahm, 1974; Bhattacharya, 1969; Rychlak, 1977). In other words, the piece by piece construction of the chair "happens" across time, whereas the purpose, form, and substance of the chair just "are." According to Aristotle, these four causes are sufficient for any effect (Ross, 1937). They also provide a convenient conceptualizing frame for discussing time and causality.

For instance, it follows from this conceptualization that the classical conception of causality in the physical sciences is that of efficient causality (Burtt, 1954). Newtonian physicists championed causality and change as happening across time. Their presumption that this was the only type of causality led them not only to confine their investigations to necessary conditons of this general causal classification, but also to interpret all physical phenomena as efficiently caused. Einstein, however, demonstrated the relativity of time and substituted instead a formal causal frame, four dimensional time-space (Wallace, 1974).

> The world of events can be described dynamically by a picture changing in time and thrown onto the background of the three-dimensional space. But it can also be described by a static picture thrown onto the background of a four-dimensional time-space continuum. From the point of view of classical physics the two pictures, the dynamic and the static, are equivalent. But from the point of view of the relativity theory the static picture is more convenient and the more objective (Einstein & Infeld, 1938, p. 208).

Formal causation is an organization of many parts which form a whole on the basis of their relation to one another, independent of time. Change in a time solid is similarly based on the difference in structure of each time slice or part in relation to the entire "solid" independent of time. Einstein was one of the first to view time as merely a function of space and so conceptualized time as organization in "space" or formal causality. It is interesting to note in this regard that Einstein reconceptualized gravity, formally a Newtonian, efficient-casual "force," as space-time curvature (Bunge, 1959). Mach's conception was functional relation without the causal primacy that time gave events and thus also formal causation.

In large measure, psychology, like classical physics, has confined itself to the study of efficient causal conditions, to the exclusion of other necessary conditions. Just as the Aristotelian carpenter constructs the chair, piece by piece, across time, so most psychologists attempt to explain behavior and cognition as "constructed" by the piece by piece accumulation of experience. This, of course, make psychology very Newtonian in scientific outlook, a fact recognized by a great many in recent years (e.g., Bateson, 1978; Overton & Reese, 1973; Rychlak, 1977). Linear time and efficient causal relations are often considered to be "out there" waiting to be "discovered." "Past" events are often reified as the cause of the "present." Moreover, psychology's traditional antimetatheroretical attitude (e.g., Skinner, 1950) is quite Newtonian, leading to many presuppositions, such as that of linear time being held uncritically (Burtt, 1954; Rychlak, 1977).

Aristotle's conceptual frame indicates many other necessary conditions independent of time which are worthy or investigation. In learning, for example, if the final cause or purpose for learning is absent, no efficient causal necessary condition will be sufficient for learning. Rychlak (1977) and his associates have shown the importance of final causal (teleological) conditions in learning. A portion of their research has demonstrated the independence of final cause influences from efficient cause influences. Because of the propensity of many psychologists to consider all causes to be efficient causes, Rychlak has had to demonstrate that final cause factors in learning are not caused by the accumulation of past experience (see Rychlak, 1977, ch. 9, for a review). Rychlak argues that the factors of purpose and intention, which govern the meaningfulness of items to some extent, are not determined by previous inputs. Although it is beyond the scope of the present paper to review Rychlak's theory and research, his investigations do suggest that necessary conditions, other than those associated with linear time, exist and are significant.

Such conditions have already been under investigation in physics as a result of Einstein's theories. Perhaps a fruitful perspective for psychology would be to view the events of learning and development, etc., without linear time assumptions. As long as the theories of psychology employ this presupposition, they will be unduly restricted. Research premised unidirectionally, as Kuhn (1970) teaches, yields only unidirectional findings. Using Einstein's adjustment to Newton's efficient causality as a guide, a more encompassing, formal cause reformulation of methodology, learning, and development is suggested.

Before describing this reformulation, however, two aspects of formal causation should be more fully explicated. First, formal casuation, in a sense, subsumes all necessary conditions. Without the reification of time, all categories of causation must rely on patterning within time. Even the linear time necessary to efficient causality is viewed as merely a convenient organization of events. Second, formal causal "change" does not happen *across* time; change is a realization of a new relation or structure *within* time. There is no piece by piece accumulation or unidirectional advancement as with linear time. Formal causal "change" is merely a new implication of old elements.

Statistics are examples of this type of change. Although the formulation of the statistic appears to "happen" over time as the computer processes the data, the organization of data points already "is" the statistic. Or, the mathematical equation xy/zv already *is* $yx\ 1/z\ 1/v$. One may not realize the possibility of this change or reorganization at first, but it is always there. It is, in a sense, *timeless.* This, of course, is what Einstein and Weyl meant when they agreed that "the objective world simply *is*, it does not *happen.*" The world does not change across time as is traditionally thought; it merely reorganizes. Einstein pointed this out in a most dramatic way, $E = mc^2$, i.e., energy is merely a reorganization of matter!

Such timeless change need not be restricted solely to "external" entities. An alteration in one's perspective or a sudden realization or insight is also formal causal change. Time is not needed in order for one to change one's outlook or way of structuring incoming information. The "ah-ah" of insight occurs suddenly, often with no prior determinants. This is probably most readily seen in logic where the conclusion or relation between major and minor premises of a syllogism is determined (or formally-caused) before time has operated (Whitrow, 1961). That is, once the premises (or parts of the syllogism) are understood, their relation (or whole) is immediately comprehended. Formal causation, then, takes place through the organization of parts which determine the whole, whether in cognition or the environment. The elements of the whole never change, but the parts of the whole can be restructured to cause a change in the meaning of the whole.

Methodology without Time

A formal cause reformulation of psychology must begin with its methodology. Methodology has been particularly impacted by the reification of linear time. Paul Meehl (1971) notes some of the many misconceptions which can arise in research due to "causal arrow ambiguity." He specifically criticizes the common assumption that so-called nuisance variables (e.g., social class) are potential confounding causes and therefore should be controlled in non-experimental research. Such assumptions, according to Meehl, hinge upon the experimenter's "prior causal framework" rather than any requirement of method. What Meehl seems to have detected as a poor research practice is the traditional assumption that factors observed earlier in time should be considered causal to factors observed later. As with any nonexperimental research, however, the causal "arrow" can actually run the opposite direction from the way in which the experimenter happens to observe each variable in time. An experimental approach has been assumed to be necessary before one can validly infer that one variable causes another.

This generally accepted notion is further testament to the serious distortions brought about by psychology's reliance on linear time. Experimental method itself has been miconstrued by many researchers. The terms "independent and dependent variable" were originally coined by the 19th century mathematician, Dirichlet, who was attempting to enlarge upon Leibniz' concept of function (Eves, 1969; Rychlak, 1977). Dirichlet stipulated that a variable y is a function of x when some numerical value, arbitrarily assigned to x, determines the value of y. The x variable is "independent" because the value assigned to it is arbitrary and the y variable is "dependent" since its value is fixed by its mathematical relationship to x. Note that the IV-DV relationship here does not involve time; it is a formal causal construction. Mach realized this when he observed that $y = f(x)$ could as easily be written (and interpreted) as $x = f(y)$ (Feuer, 1974). In other words, IV and DV are functionally interdependent; designation of one variable as the IV does not give it "causal" status with significant results. Although Meehl actually discusses his "causal arrow ambiguity" in terms of "nonexperimental" or correlational research, there is no reason why his position could not also be applied to "experimental" research. With experimental method devoid of time biases, the IV, even under ideal circumstance (i.e., no confoundings), cannot be said to be the unidirectional "cause" of the DV.

Perhaps the best examples of this unidirectional causal bias in methodology come from the operant conditioning literature. Consider, for instance, a study in which the experimenter positively reinforces the subject for saying personal pronouns in an interview. Results show that subjects do indeed utter more personal pronouns following their reinforcement. A typical explanation of such findings is that the IV (pronoun reinforcement) causes the DV (number of pronouns uttered). The assumption is that the reinforcement was antecedent and therefore causal to the utterances. However, the IV-DV relationship is formal causal and only indicates the functional interdependency of the two variables. It is just as tenable to infer from the findings that the subject was purposely increasing personal pronoun utterances in order to increase the number of reinforcements. This, of course, is the final cause explanation of the results. Indeed, the research on the need for subject awareness in such conditioning (Brewer, 1974) supports the viability of this interpretation. But in any case, the method and therefore the data itself do not make such causal distinctions.

Unfortunately, the fact that method does not indicate causal primacy is not generally acknowledged in psychology. One example of this is described by Rychlak (1977) as the "S-R bind." That is, the time dependent S-R (or S-mediation-R) theory is often identified with the IV-DV of scientific method, the IV being the stimulus and the DV the response (e.g., the dictionary English and English, 1958, commits this error). With the "S-R bind" in effect, S-R theorists cannot help but "confirm" their own theory and linear time. This situation is analogous to that of the

Newtonian physicist making "a metaphysic of his method" (Burtt, 1954, p. 229). Many psychological scientists likewise confound theoretical assumptions with methodology, thereby biasing an otherwise neutral tool of inquiry. The reification of linear time, common to both contemporary psychology and classical physics, seems a cardinal factor in such confoundings.

Even if two events are observed repeatedly in sequence, the same two events can be observed in a reverse sequence from an equally valid frame of reference, as Einstein demonstrates. Meehl's "causal arrow ambiguity," as applied to both correlational and experimental designs, analogously implies that there is no absolute frame for the causal arrow. Causal status, as Meehl and Mach point out, is a result of a theorist's arbitrary causal framework. It is suggested, then, that we reject such arbitary frames of reference and follow Einstein's lead in studying the two variables as a relation in simultaneity.

A Framework for Learning Theory without Time

With variables properly construed, it now becomes possible to consider the viability of formal causal assumptions in the study of learning. The movements toward the "organization" of information and the "levels of processing" framework can be viewed as trends toward a formal causal approach. However, in most cases the organization capacity itself is "shaped" over time, and the "level" to which an item is processed depends upon its triggering of "associations, images, and stories on the basis of the subject's past experiences" (Craik & Lockhart, 1972, p. 675). This means that these frameworks are still, in principle, efficient causal. To formulate a learning framework without time, one must begin with the Einstein-Weyl assumption that the world is and does not happen. The first traditional learning assumption which is rejected from this perspective, at least in part, is the law of contiguity. Events which are contiguous in time are thought to be associated together by conventional learning theories (Misiak & Sexton, 1966). But if the world does not happen and the contiguity of time does not occur, upon what is learning based?

Mach (1959) suggests that what may seem like temporal sequence may actually be difference in attention.

> We feel the work of attention as time. During any severe effort of attention time is long to us, during easy employment time is short...When attention is completely exhausted...in dreamless sleep, the sensation of time is lacking. (p.250)
>
> The sensations connected with greater expenditure of attention appear to us to happen later. Since the attention cannot be fixed upon two different sense-organs at once, the sensations of two organs can never occur together and yet be accompanied by an absolutely identical effort of attention. Hence, one appears later than the other...(p. 251)

Mach is suggesting that the person actually extends time or temporal contiguity *to* events. Contiguity associations are not "out there," controlled by the events themselves. It is rather the perceiver which selectively attends to, and associates as simultaneous or successive, certain relations of perhaps an infinite number in the situation which are meaningful. The plausibility of this conception is perhaps most readily seen at the level of science, where learning is most systematic. Despite an infinite possibility of necessary conditions, the scientist selectively attends to certain variables considered meaningful. The variables themselves (as noted in the preceding section) are only formal causally related, but the selective designation of one as the IV and one as the DV makes it appear as if one precedes the other. The scientist in this sense is analogous to a person attending to one gear of Mach's windmill and calling it the IV and then attending to the other gear and calling it the DV.

It is contended that learning in general occurs in a similar fashion. Temporal contiguity is used as any other cognitive organization of environmental input. Contiguous associations are extended to the world via the selective attention to what is meaningful. Presumably the next question is, "What controls the meaningfulness?" In other words, how was the temporal-contiguity, conceptual organizaton formed? It cannot have been from past experiences or across time, since the present framework is independent of such accounts. The answer to these questions entails a look at the relation between cognition and the environment.

The Formal Causal Relation between Cognition and the Environment

A formal causal trend has recently manifested itself in that several theorists regard this relation as interactive. Bandura (1978), for instance, specifically rejects the "generally favored unidirectional models" which emphasize either the environment or cognition as the first cause of behavior (p. 334). He proposes, instead, a "reciprocal determinism" whereby both entities have the power to influence each other, presumably with neither as "first" cause. However, merely labeling the cognition-environment connection as "interactive" or "reciprocal" does not fully explicate their relation. Recognition of this description's formal causality, however, provides some explanatory power of which these theorists have perhaps been unaware.

One could conceptualize the nature of this interaction by framing each as a premise of a logical syllogism or a part of a whole, the structure of the environment making up one part and the schema of cognition the other. The relation between the two premises or parts becomes the formally caused meaning for the person. The meaning of any situation, then, depends upon both structure of the stiuation and the meaningfulness of certain aspects as controlled by the idiosyncratic conceputal schema of the person. Both sets of causes, the efficient and material causes of the environment and the final and formal causes of cognition, reciprocally determine meaning and behavior. The findings of the operant conditioning study mentioned above, then, were the result of *both* the reinforcement (environment) and the subject (cognition), as sources of causal determinancy, interacting moment by moment with neither as "first cause."

As philosophers of whole-part (formal) causation point out, to say that parts interdepend is to assume that each part is independent of one another to some extent (Bahm, 1974). As applied to the formal causal relation between cognition and environment, this means that each source of influence must be independent of each other to some extent. That is, in order to "reciprocally determine" each other, each entity should have some determining or *causal* power of its own. The environment's ability to reorganize or formally cause its own structure has rarely been challenged. The present framework, however, demands a less recognized determining power—that of cognition's capacity to change its own organization, *independent of the environment.*

This point has been largely ignored by theorists espousing interactionism or reciprocal determinism. However, one theorist, Rychlak (1977), has proposed what appears to be a viable candidate for the formal cause reorganizer. He proffers a process called the dialectic which is an innate capacity to change (or reason) independent of the environment via the "oppositional alteration of the pattern" of events (Ibid., p. 501). The importance of such a capacity to an approach devoid of unidirectional time and causation can be illustrated by drawing on Mach's windmill metaphor once again.

Picture two interlocking gears, one symbolizing the organization of the environment and one the structure of cognition. As mentioned previously, an observer watching them in motion cannot determine which has causal primacy. If however, the observer looks "behind" the gears and sees that the environment gear is powered by a variable speed motor while the cognition gear merely loosely bolted, the observer knows that their motion is not as mutual as it appears. Without the cognitive gear's own "power" and capacity to vary its own speed independent of the environment motor, the two gears' motion and variance of motion cannot be said to be functionally interdependent or reciprocally determined.

Given the need, then, of a cognitive organizing capacity such as the dialectic for the formal causal theorist, how is such a capacity manifested? At this point, Einstein's proposal seems plausible: time itself could be one aspect of the conceptual organization extended to the world. The philosopher, Immanual Kant (1966), advanced a similar proposal of which many aspects are implicitly accepted by Einstein (Callahan, 1977). Such a temporal ordering principle would likely be manifested through the selective attention to and retention of experience. Although the temporal contiguity of environmental relations is in some sense purely cognitive (i.e. time does not exist in events), learning is the meaningful relation between both the structure of the environment and the organization of cognition. Learning, then, can be explained entirely within a "slice" of time-space, without resorting to the unidirectionality and arbitrariness of time-dependent causality. Learning depends upon the "present" structure of the two organizations, which includes the selected "past" (made present through memory) and selected "future" (*made* present through purpose). To maintain this continually "present" and reciprocally determined "whole," however, a cognitive reorganization capacity, which transcends both the environment and time itself is required. In other words, an individual must be able to select from the "past" and "future" without the "past" determining that selection.

Discontinuous Change in Development

An important implication of a theory based on formal causal presuppositions is its subsumption of discontinous change. With the preceding conceptualization, any shift in the meaning organization of either part, cognition or the environment, could result in a *cataclysmic* change of the meaning organization of the whole. Because such change could occur in one "slice of time," it would not appear as a smooth, continuous transition but an abrupt jump into perhaps a completely different state. Any theory dependent on linear time requires continuity of change since transition happens across time. Time flows uniformly (or "equably" as Newton (1934) put it) and change is expected to occur through a smooth and orderly unfolding (Feuer, 1974). A formal cause approach, however, does not require continuity of transition. Indeed, change can occur *discontinuously* or by leaps into a different state, within time. Cataclysmic change would not always be required of a formal causal theory, of course; differences in time slices could be slight and change would appear smoothly incremental.

The fact that change is not always smoothly continuous was observed in physics by Niels Bohr when he discovered that electrons leap from one orbit to another through abrupt, inexplicable transitions (Feuer, 1974). This phenomenon was dubbed the "quantum leap" and eventually led the way to the development of quantum mechanics. Bohr realized that such discontinuous change departed from the continuous world as viewed by Newton and therefore advocated that physics wholely renounce the classical notion of causality (Feuer, 1974). Bohr knew that the quantum leap he observed among electrons could never be accounted for by efficient causality (Wallace, 1974). He knew also that discontinuous change meant a "radical revision" of explanatory constructs not just at the atomic level but at all levels, since the classical conception of causal explanation was *in principle* excluded (Shilpp, 1951).

Discontinuous change analogous to the quantum leap, also has been recognized in individual and scientific development, and it is contended that a revision of classical efficient causality is again called for. In the development of science, Kuhn (1970) observes that many scientists view their discipline as the cumulative historical record of their research activities. It is held that such a linear advancement view of knowledge is related to, if not a direct manifestation of, a traditional linear view of time. Kuhn cogently shows, however, that science does not progress by the linear accumulation of its empirical studies; rather, it progresses by the conceptual change of its scientists, called paradigmatic revolution. This latter change is precisely what is meant by formal causal cognitive change. Change is a sudden shift in perspective or gestalt, an "ah-ah" or an insight. Paradigmatic change, according to Kuhn, is also the result of empirical anomalies (the environment organization), but anomalies are not the "first cause" of paradigmatic revolution since they are themselves not recognized without some accompanying change in perspective (cognition-environment interaction). When anomalies are recognized, however, the switch in scientific paradigm is abrupt, as the sympathies of individual scientists shift. Suddenly, other meaningful relations are seen and other variable (or necessary conditions) are selectively attended to. Conceptual ordering principles like time and causal arrows are placed onto functionally dependent variables in a different manner. In short, paradigmatic revolution for Kuhn is formal causal change requiring a conceptual shift in the gestalt of scientists as well as research anomalies. Scientific development is *not* simply "caused" by the accumulation of antecedent research (i.e., efficient causation).

Many researchers view the development and growth of the individual in a similar manner (Bransford, Nitsch, & Franks, 1977; Overton & Reese, 1973; Reigel, 1973). Bransford, Nitsch, and Franks (1977), for instance, contend "that growth is not simply and accumulation of 'pieces of knowledge'...Growth seems to be better viewed as a 'remodeling' of a structure of the whole" (p. 47). Overton and Reese (1973) would concur with this view as "there is a basic discontinuity of development" (p. 73). In fact, they propose an "organismic" as opposed to a "mechanistic" model of development. The former is conceptualized explicitly from a formal and final causal frame, while the latter they feel is derived from dependence on efficient causal constructs. Thus, unlike time models which rely exclusively on continuity of transition, models independent of time can readily subsume both "smooth" transition and the "quantum leap" into different stages which are observed in individual development.

Summary and Conclusion

Linear time has been shown to be a very prevalent but relatively overlooked presupposition in psychological theorizing. Although many psychologists might consider it as axiomatic and unchallengable, history and physical science teach us that such a presumption is neither a requirement of thought nor necessarily a desirable basis for theory construction. Parallels can be drawn between problems inherent in Newtonian time-dependent theories of physical science and contemporary psychology. The roots of "mechanism," methodological distortions, emphasis on "antecedents" as primary, activating factors, and many conceptions regarding individual and scientific development are all traceable to the metaphysical presupposition of linear time and its concommitant, efficient causation. Mach and Einstein sought to remediate problems such as these through a critical analysis of metatheoretical assumptions. With the advent of relativity theory, linear time and efficient causality were supplanted with a less arbitrary notion conceptualized as formal causality.

A similar critical analysis and remediation is herein proposed for psychology. Instead of giving status to certain factors over others in functional dependencies, such dependencies can be viewed as relationships within a larger organization, or parts of a greater whole. Unfortunately, much of psychology has relegated itself to only one part of the necessary conditions which comprise the whole through its confinement to theories based on linear time. There is, in fact, no empirical justification for this confinement. Because the logic of science is a neutral tool of inquiry, it reveals only relations between variables and does not validate any form of "causal arrow" or temporal sequence. Thus, the restriction to empirical relations and theoretical interpretations pertinent only to efficient causation is unjustified.

A formal causal framework, however, allows flexibility of causal inference such that all forms of causation can be utilized in interpretation. Efficient causality itself remains a viable theoetical option as long as linear time is not reified as "reality" and causality across time thereby made the only interpretive mode. Final cause presuppositons have been used successfully by Rychlak (1977) to formulate and empirically support a theory of learning. Trends toward the use of formal cause presuppositions in learning seem particularly apparent in the "cognitive" movement. Bransford, Nitsch, and Franks (1978), for instance, seem to be attempting such a conceptualization. In fact, they specifically question the assumed dominance of practice and frequency of exposure (i.e., learning over time) in skill acquisition. However, most theorists in this movement still rely on the "past" as the ultimate determiner of meaningfulness and cognitive organization.

A thorough-going, formal causal approach is presently proposed which requires the capacity for formal causal change of both the environment and cognition, to some extent independent of one another. As whole-part causation implies, a part must have some existence of its own or it cannot be discriminated from other parts or the whole. Likewise, the person in reciprocal determinism cannot be distinguished from the "effects" of the environment if some transcendental capacity of the mind is not presumed. Kant (1966) recognized the necessity of such a capacity when he proposed the "transcendental dialectic." This conception has been revived and modified somewhat by Rychlak (1977) and seems a good candidate for the "reorganizer" or cognition. The assumption of such an innate capacity is no less tenable or arbitrary than the typical assumption of conventional learning theories that the person is born with the capacity to remember. And, the presence of a dialectic capacity in no way obviates the limitations placed onto it from the changeable structure of the environment, as both parts interdepend to form the person.

The "unconscious" manifestation of this cognitive capacity, as suggested by both Einstein and Kant, may be time itself! In the same sense that Einstein challenged the assumption that time is inherent in the events of physics, the formal causal theorist challenges a basic principle of associationism, temporal contiguity, as being inherent in events that are learned. Contiguous associations can be viewed as extended to, rather than received from phenomena. The plausibility of this conception is perhaps most readily seen at the level of science, where learning is most systematic. Variables are selectively chosen and entered in to the experimental paradigm in an order meaningful to the experimenter, thereby dictating "temporal" and "causal" order. The selection and ordering of these factors are for the most part a result of the cognitive organization (theory) of the experimenter, whereas the experimental data are for the most part a result of the environmental structure. Analogously, the individual selectively attends to certain aspects of his or her environment—extending contiguous associations—and learning and developing in a similar fashion. This type of interaction begins from birth and continues moment by moment with neither the environment nor cognition as "first cause."

It should be noted that the objective of this paper has not been to advocate the total abandonment of theories which rely on time. The intent, rather, has been to show that time is not the fundamental given that many psychologists seem to view it as. Time is *an* organization not *the* organization of events. Other equally valid and viable theory organizations are available. These theories deserve more attention than psychology has been willing to devote to them thus far. As with Einstein's "revolution" of physics, a change in our assumption (or recogniton that such assumptions can be changed) could provide new understanding and insights into human behavior. The conception of freewill in behavior, for instance, has always been hampered by the temporal regression of causes. The person has been considered the end-product of a cause and effect chain stemming from the past. If, on the other hand, the person is viewed as producing time rather than being a product of it, theories encompassing freewill can be formulated more readily. The issue of freewill is, of course, a complex one, but discussions of this concept and other like it will proceed more fruitfully unfettered by the reification of time.

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