Abstract

Newton's conception of time has had a profound influence upon science, particularly psychology. Five characteristics of explanation have devolved from Newton's temporal framework: objectivity, continuity, linearity, universality, and reductivity. These characteristics are outlined in the present essay and shown to be central to psychological theories and methods. Indeed, Newton's temporal framework is so central that it often goes unexamined in psychology. Examination is important, however, because recent critics of Newton's framework--including both scientists and philosophers--have questioned its validity and usefulness.

Newtonian Time and Psychological Explanation

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Perhaps no conception is more fundamental to any science than time. If a science is concerned at all about the order, organization, and measurement of events, then it has to have assumptions of time. Indeed, the notion of "event" itself is wrapped up in temporal assumptions. Even "soft" sciences, such as psychology, must adopt philosophical assumptions about temporal order and measurement. Psychological researchers not only measure time in many of their experiments, but psychological theorists assume certain characteristics of time in virtually all their explanations. What are these assumptions? Why are these assumptions used and not others? The problem is that such questions are virtually never addressed in psychology. With certain rare exceptions,[1] psychologists have ignored the assumption of time. They have studied how people perceive and manage their time, but they have not examined the assumptions of time in their <u>own</u> theorizing.

The reason for this is clear. At the point in history when psychology was conceived as a discipline, time had become reified. That is, time was no longer an "assumption;" time was a property of reality existing independently of our consciousness. Indeed, this was the view of time implicit in our culture. As this article will show, psychologists adopted this cultural view, in part, because it was not recognized <u>as</u> a view. Several historical factors are described below as leading to this reification. Undoubtedly, a prime factor was Isaac Newton's popularization of this reification in the physical sciences. This essay outlines how Newtonian physics--the ideal of sciences during psychology's formative years--became a model for all that early psychologists wished their discipline to become. Much of this model, however, involved

Newtonian assumptions of the world that were accepted uncritically. One of these assumptions, as this essay will show, is Newton's own rendition of time--Absolute Time.

The bulk of the present essay outlines how Newton's conception of time has influenced "scientific" explanations ever since. As we shall see, five characteristics of explanation have devolved from Newton's temporal framework: objectivity, continuity, linearity, universality, and reductivity. The article first describes each of these as it is related to Absolute Time. Then, criticisms of this framework by philosophers and physicists are delineated. The latter group of critics is especially important because many contemporary physicists have abandoned these temporal characteristics (as well as Absolute Time) in their explanations. Nonetheless, contemporary psychology--with its identity now somewhat intact--has not looked back to physics. This essay reveals how psychology currently maintains most, if not all, of these temporal characteristics in its mainstream explanations of behavior, mind, and abnormality.

The Rise of Absolute Time in Western Culture

The view of time held so widely by psychologists is also the view of time held widely in Western society. Time is "out there" flowing like a line from past to present to future. No examination of this linear notion of time is considered necessary, because it is part of reality. An interesting example of that "reality" is our dependence upon the past. All events that occur in the present are thought to be explainable by events in the past. Because the past, present, and future are considered to be consistent with one another--as part of the same "line"--the present and future must be consistent with, if not determined by, the past. In this manner, it is "common sense," both in psychology and our general culture, to explain behavior, attitudes, and personality through past events. The question is: How did this 'common sense' become so common? How has this linear view of time gained such a hold on our culture and such an influence in psychology?

Actually, the predominance of linear time is a relatively recent phenomenon. Ancient peoples did not view time as an objective frame of reference for marking events. They relativized time by making it conform to events, rather than events conform to time. For the Romans, each hour of daylight in the summer was longer than each hour of daylight in the winter. Time was a dynamic and adjustable organization tailored to fit our world experiences. Cyclical rather than linear views of time dominated these cultures because so many aspects of nature seemed cyclical, such as the seasons and heavenly bodies. Plato believed that the order of world events was destined to repeat itself at fixed intervals. Aristotle's students wondered whether Paris would once more carry off Helen and thus again spark the Trojan War (Porter, 1980).

Our Western view of time arose primarily as a result of three historical developments: the spread of Christianity, the industrialization of society, and the invention of cheap watches (cf. Porter, 1980; Morris, 1984, chs. 1 and 2; Whitrow, 1980, section 2.3). Pre-Judaic religions complemented the cyclical view of time. They either portrayed time as infinite and possessing no beginning or end, or as a cycle of rebirth and future life with time forever repeating itself. The spread of Christianity brought to bear a "stunning" new conception (Porter, 1980, p. 13). Christians considered their God to be the creator and ultimate destroyer of the universe. Hence, the world had a beginning and an end, and important Christian events, such as the birth of Christ, were unique and nonrepeatable. The spread of these conceptions resulted in a competition between the cyclical and linear views during the medieval period (Whitrow, 1980, section 2.3).[2]

The temporal tide began to turn in the favor of linearity--at least for our Western culture--when industrial economies arose. As Lewis Mumford concludes, "The clock, not the steam engine, is the key machine of the modern industrial age" (Mumford, 1934, p. 14). When power stemmed from the ownership of land, time was considered plentiful and cyclical, being associated with the unchanging cycle of the soil. However, with the rise of a mercantile economy and the mechanism of industry, emphasis was placed on the scarcity of time and "forward" progress (Whitrow, 1980, pp. 58-59). "Time is money" was the byword; time could now be "saved" or "spent."

The coup d'état for the linear view was the increased availability of cheap watches. The mass-production of watches in the nineteenth century made it possible for even the most basic functions of living to be regulated by time. "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 assumption of linear time could be endowed with a type of concrete reality (Morris, 1984, ch. 3). People now seemed to be able to "see" and "feel" time (the clock). Time also appeared to be one of the causes of psychological factors, because the thoughts and behaviors of individuals seemed to turn on what time "told" them. In short, a convenient (linear) way of organizing events became reified as <u>the</u> way events were organized.

Psychology was conceived and developed during this temporal zeitgeist, when time was a concrete actuality rather than a point of view. The spread of Christianity, industrialization, and the invention of cheap clocks, all coalesced to make linear time a "reality." Before this coalescence, many scientists, including Newton, felt it necessary to make their assumption of time explicit. Several views of time were possible,[3] and so one view had to be identified and supported. On the other hand, psychologists were not called upon to articulate their temporal assumptions. Linear time had become a given and required no discussion or defense. Time existed as a line, independently of us, and virtually everyone accepted this reification without awareness.

<u>Newtonian Time</u>

Psychology was not the only discipline that reified time. Einstein described a similar state of affairs in his own discipline at the turn of this century:

> Concepts which have proved useful for ordering things easily assume so great an authority over us that we forget their terrestrial origin and accept them as unalterable facts. They then become labeled as "conceptual necessities," "a priori situations," etc. The road of scientific progress is frequently blocked for long periods by such errors. It is therefore not just an idle game to exercise our ability to analyze familiar concepts, and to demonstrate the conditions under which their justification and usefulness depend. (as quoted in Holton, 1973, p. 5)

Einstein's point here, of course, is that sometimes the very pervasiveness of an idea leads to its anonymity. Certain ideas can be so commonplace and so widely accepted that they go completely unrecognized. Yet it is these very ideas that are often the most influential for thinkers in a discipline.

Part of Einstein's immense contribution to knowledge was the realization that time played an unrecognized role in physics. Indeed, linear time was seen as an absolute truth--an unquestioned part of reality--during the preceding three hundred or so years of physics. This led to a curtailment in the number of new ideas in physics (cf. Burtt, 1954, Ch. VII, sections 3-4). Acceptable ideas about reality had to be compatible with time's supposedly linear properties. Einstein's theory of relativity, however, was in large measure based upon his examination and eventual rejection of this traditional view of time.[4] He proposed an alternative view that ultimately revolutionized the discipline of physics in the twentieth century (to be discussed later).

Still, this revolutionary view has had little impact upon the lay culture. Except for parts of physics and philosophy, the Newtonian picture of the world remains dominant in Western culture (McGrath and Kelly, 1986, p. 26-30). This is not to say that this "picture" was totally original to Newton. When it came to crucial aspects of his metaphysic, Newton often accepted the view of the world handed down by his predecessors (Burtt, 1954, p 231). In regard to time, his most immediate forerunner was Isaac Barrow (1735), who regarded time as "passing with a steady flow" (p. 35). Aristotle is also viewed as one of the primary philosophical precursors of Newton's view of time (Faulconer and Williams, 1985; Williams, 1990). Nevertheless, Newton rightly deserves the credit for assembling their ideas into the current package our culture calls "time." Let us therefore examine Newton's views in more detail.

Newton postulated Absolute Time which ". . .of itself, and from its own nature, flows equably without relation to anything external. . ." (Newton, 1687/1990, p.8). Newton needed this assumption for two main reasons. First, his conceptions of motion and causality required an absolute frame of reference (Burtt, 1954, p. 249). Motion, for example, could not be detected or measured without an objective "past" and "present." The rolling ball begins its roll at some point in the past but is "now" at some point in the present. Second, his mathematics required the continuity of events (flowing "equably"). He regarded moments of absolute time as a continuous sequence like that of real numbers, believing that the rate of this sequence was independent of events (Whitrow, 1980, pp. 185-190).

For these reasons, absolute time became the standard by which all scientific explanations were judged. The order (and directionality) of the world was thought to be synonymous with the absolute and linear organization of events. Characteristics of Newton's absolute time became the "rules" for acceptable scientific explanation for nearly three centuries and still form the rules for many disciplines such as psychology. It is thus important that we explicate these rules and their modern criticisms and then check the specific role these rules play in psychological explanation.

Newtonian Temporal Framework for Explanation

Newton's approach to time left science with a legacy of five somewhat overlapping implications or characteristics for "scientific" explanation. These include objectivity, continuity, linearity, universality, and reductionism. Some of these characteristics are the properties of time itself, as envisioned by Newton, and some are the necessary properties of the events to be explained, because they are in absolute time.

The assertion that events are "in" time is itself an implication of a temporal characteristic. Newton viewed time as **objective**, existing "absolutely" and independently of consciousness. Time is conceived as a medium in which and against which events occur and can be related to one another. Motion, causation, and change are seen to exist "out there," and so an absolute framework for evaluating these conceptions must also exist "out there," separate from them (and our consciousness). If time were subjective--Newton might argue--distinctions between the temporal dimensions (past, present, and future) would be left up to the perceiver, and an objective science would be in jeopardy. Indeed, the notion that cause and effect require succession in time occurred with the advent of absolute time (Bunge, 1959, pp. 62-64).

This view of causality was bolstered by another property of Newtonian time, its **linearity**. Newton was a highly religious man whose theology guided much of his scientific work (Burtt, 1954, pp. 256-264). God, for Newton, was the First Cause of the world, and thus time has a beginning point (unlike cyclical time), and properties akin to a geometric line, with no gaps or spaces. Time begins in the past and advances into the present on its way to the future.[5] This places the greatest weight upon the past (or the "first" in a sequence), because it is the temporal entity which supposedly starts this process. The metaphor of the line means that the present and future must remain consistent with the past. Moreover, the past is the temporal entity with the most utility. The present is less useful because it is just an evanescent "point" on the line of time, and the future is less useful because it is not (yet) known with any certainty. Only information from the past is thought to be substantive and certain enough to be truly known and understood.[6]

Newton also considered time to be **continuous**, proceeding smoothly and "equably," as he put it (Newton, 1687/1990, p. 8). Actually, this characteristic of time has two properties worth separating out: consistency and uniformity. Consistency is the well-known Newtonian notion that events which happen at one point in time will be consistent with events occurring later in time--the past is continuous with the future. This is the origin of

Newton's conviction that the world is predictable. If enough is known about the present situation (or the past), then future events or states can be predicted. Uniformity, on the other hand, is the notion that time is homogeneous. Although the events in time can move at different rates, time does not itself slow down at some points and speed up at others--it "flows" at a constant, never-changing pace. This uniformity provides the perfect frame of reference for measuring events.

Time's continuity has also had significant implications for change. In Newton's metaphysic, change could not be discontinuous or instantaneous, moving abruptly from one state into the next.[7] Change had to be continuous and smooth, much as a flower gradually blooms, because Newton conceived of time as infinitely divisible--like a line. No matter how small the interval of time, there is always a line of time (points in time) that spans the interval. This means change can only be incremental. Whatever change occurs, it is assumed to have intervening levels that correspond to intervening points in time. Change can occur at different rates, and motions can proceed faster or slower. However, change cannot occur through sudden jumps from one stage into another--such as a flower bud jumping to a full bloom--without some points of time (and levels of change) falling in between the two stages.

This characteristic of continuity has led to another major feature of scientific explanation, labeled by some authors as "universality" (Schrag, 1990, p. 65), "atemporality" (Faulconer and Williams, 1985, p. 1180), or "symmetry" (Ballif and Dibble, 1969, p. 32). This characteristic of **universality**, as we shall here call it, assumes that natural laws are universal and unchangeable, regardless of the period of time in which they are observed. Natural processes are still thought to unfold across time in the continuous manner just described. Nevertheless, the principles behind the processes are considered to be independent of the events and particular period of history in which the events unfold. The laws of planetary motion, for example, are the same laws at one point in earth's history as they are at another point in earth's history. This universality is only possible if time is uniform in the Newtonian sense. If time changes its rate or quality, then the temporal relations between planetary events would not be consistent from one period of history to the next. Scientific laws, in this sense, would not be lawful.

The notion that lawful processes take place across time has had another implication for explanation--**reductionism**. Reductionism results from the fact that any one moment in time contains only a reduced portion of the process. That is, if a process begins at time 1, proceeds through time 2, and culminates at time 3, only a portion of this process can be studied at any point in this sequence. This is tantamount to saying that the process as a whole literally never exists, because only a piece of the process is occurring at any one moment in time. The only way in which the pattern or "wholeness" of such processes can be recognized at all in Newtonian physics is through a recording device (e.g., an observer's memory). Recording devices permit each piece of the process to be "photographed" and juxtaposed with the next moment's piece and the next moment's piece until all the process is viewed at the same time. Nonetheless, no direct access to the whole of any process is possible, given the separation of its pieces in time.

Newton brilliantly coalesced all five of these characteristics of explanation into a coherent package by calling upon **mechanistic metaphors**. He felt the universe--with its motions and chains of causation across time--was directly analogous to the great machine of his day: the clock. Through his writings and discoveries, he combined the implications of absolute time just described--objectivity, linearity, continuity, universality, and reductionism. He represented them all with machine metaphors that embodied these characteristics.[8] Machines seem to objectively operate through a continuous and linear sequence of events. This sequence is universal, because it appears to be repeatable, regardless of the period of time in which the repetition occurs. Machines also seem to evidence temporal reductionism in their functioning; their sequentiality provides no direct access to the whole of their processes at any given moment in time.

When the universe is presumed to possess these five temporal characteristics, explanations that are properly "scientific" also possess these characteristics. "Mechanistic" explanations of data are, of course, preferred because they naturally embody these characteristics. The reverse is also true--those processes that manifest linear and lawful properties are considered "mechanisms" and thus accorded appropriate scientific status. Newton even carried his temporal approach to explanation into his method. He assumed that in order to observe parts of the machine universe in its mechanistic regularity, a scientist should track the effect of some antecedent (in time) experimental manipulation on its consequent. Orderly relationships between variables can thus be observed and cataloged until all of the universe is understood.

Criticisms of Newton's Framework

As undeniably brilliant and influential as this temporal framework for explanation has been, it has not avoided criticism. Indeed, Whitrow characterizes Newton's conception of time as the "most criticized, and justly so, of all Newton's statements" (Whitrow, 1980, p. 33). Newton's conception of time has been called into question on theoretical, practical, and empirical grounds, primarily by subsequent philosophers and physicists. For example, Whitrow (1980) himself notes that the "equable flow" of time is problematic on purely theoretical grounds:

> If time were something that flowed then it would itself consist of a series of events in time and this would be meaningless. Moreover, it is equally difficult to accept the statement that time flows 'equably' or uniformly, for this would seem to imply that there is something which controls the rate of flow of time so that it always goes at the same speed. However, if time can be considered in isolation "without relation to anything external," what meaning can be attached to saying that its rate of flow is not uniform? If no meaning can be attached even to the possibility of non-uniform flow, then what significance can be attached to specifically stipulating that the flow is "equable?" (p. 33)[9]

Some have questioned the practical utility of Newton's conception of time as a frame of reference (e.g., Burtt, 1954, pp. 256-264). Because Newton regarded time as uniform and infinite, any position that an object might take <u>in</u> time is not discernible from any other position. One portion of time is identical (and uniform) to another. Wherever the object resides (in time), there is no distinguishing feature for that period of time. There is also a similar quantity of time surrounding it in the past and future (infinity). It is therefore impossible to locate an object in absolute time and establish whether it is in motion. Temporal position and motion can only be discerned with reference to another body (e.g., a clock), and Newton's conception of absolute time is unnecessary. Indeed, Newton's conception seems useless for the main reason he formulated it--as a standard for temporal position and motion.

Other criticisms of absolute time are long-standing, and convince most analysts that Newton was "mistaken in several different respects" (Morris, 1984, p. 209) or "uncritical, sketchy, inconsistent, even second-rate" as a theoretician (Burtt, 1954, p. 208). The ancient philosopher Zeno, for instance, provided an penetrating critique of the infinite divisibility and continuity of time (Ariotti, 1975; Harris, 1988, pp. 48-51). Other critics have focused upon Newton's confounding of linear flow (his theory) and temporal sequence (his data) (e.g., Morris, 1984, ch. 1). That is, the existence of temporal sequence--"time's arrow"--does not necessarily imply the existence of linear flow. There are other ways to explain the data (Slife, 1993, p. 5). Newton, though, considered all physical events to be influenced by the temporal medium in which they supposedly occurred. Therefore, any sequence of related events supposedly involved all the characteristics of absolute time described above.

The trouble is that a sequence of physical events does not <u>have</u> to involve these characteristics. Consider the sequence of hydrogen and oxygen gases becoming water. Although this particular set of events has a very definite and predictable relationship, this relationship does not have to be viewed as linear. Its predictability is not derived in classical Newtonian fashion from its "past." The past properties of hydrogen and oxygen gases do not permit us to predict the qualitatively different, future properties of water (cf. Polkinghorne, 1983, 136-137). The predictability of this relationship stems from our repeated observations of this sequence, <u>not</u> from its continuous unfolding from a past state. Indeed, this particular change (gases into water) can be construed as <u>dis</u>continuous in nature--from one qualitatively different gestalt to another. The point is that the directionality or sequence of natural events does not require linear or continuous characteristics (or any of the other characteristics of Newton's framework).

Newton also confounded his linear theory with his method. Some philosophers, for example, have criticized him for "making a metaphysics of his method" (e.g., Burtt, 1954, p. 229). That is, Newton confused his metaphysical theory of the universe (being a linear and continuous machine) with his scientific method (observing the natural order of variables). He experimentally intervened in antecedent events in order to observe their later effects in time, all the while assuming that linear flow was involved in this sequential relation. In this way, his metaphysics could not be proven wrong. His method (sequential observation) made it seem that his assumptions of time were constantly being affirmed. If, on the other hand, a crucial event for explaining a phenomenon were simultaneous, Newton's linear method would be unable to discover it. This type of nonlinear explanation would be overlooked due to the institutionalization of linear explanation in his scientific method (see discussion in Slife, 1993, chapter 4).

The most significant criticisms of Newton's notion of time have come from his fellow physicists. Einstein's precursor, the physicist Ernst Mach, criticized the reductive implications of Newton's conception, focusing particularly upon what absolute time did to causality. Mach felt that a linear conception was incapable of embracing the multiplicity of relations in nature. He viewed events of the world as functionally interdependent, with no particular event taking precedence over the other just because it occurred "prior" to the other in time. He noted that measures of time were themselves based on space, such as the spatial positions of clock hands or heavenly bodies. "We are thus ultimately left with a mutual dependence of positions on one another" (Mach, 1959, p. 90). In this sense, our dimensions of reality are not time and space, but space and space. There is no separate temporal entity against which to measure the "past" or "future" of even causal events (see also DeBroglie, 1949).

Einstein, too, was highly critical of Newton's temporal framework. In what follows, Morris (1984) summarizes the effects of relativity theory upon absolute time:

> Time is not absolute, it is relative. As the special theory of relativity shows, time measurements depend upon the state of motion of the observer. Time is not a substance that "flows equably without relation to anything external" [Newton's assertion]. According to the general theory of relativity, the presence of matter creates gravitational fields that cause time dilation. Finally, if time does "flow," . . .the movement of the "now". . .seems to be a subjective phenomenon. . . .At best, one can only say that time moves onward at the rate of one second per second, which is about as meaningful as defining the word "cat" by saying "a cat is a cat." (pp. 209-210)

Central to Newton's view is the notion that events which are simultaneous for one observer are simultaneous for all observers, regardless of their frame of reference. In other words, a particular instant of time is the same instant of time everywhere in the universe, and hence absolute or universal. Einstein, however, demonstrated through his special theory of relativity that this is not true. Avoiding Newton's linear methodology, he used <u>gedanken</u> (or thought) experiments to show that two or more observers in relative motion do not necessarily agree that two independent events are simultaneous. When events A and B are simultaneous in one inertial frame of reference, A can be observed to occur before B in another inertial frame of reference. In still another inertial frame of reference, B can be observed to occur before A.

If one assumes an absolute temporal frame of reference, the next question is "which observer is really correct?" This query implies that only one (objective) interpretation of events is correct, because there can be only one temporal measure of events. The same events cannot occur in opposite sequences when observed at the same time. Nonetheless, Einstein held that all observers are correct within their own inertial frames of reference, and no observer is more correct than any other.[10] In short, there is no absolute truth about the matter. Einstein resolved the apparent contradiction between these observations by noting that time flow is not totally a result of the events themselves. The apparent flow of time is due, at least in part, to each observer's inertial frame of reference (Nicolson, 1980).

Modern physicists have not only disputed the reductivity, linearity, and objectivity of time, they have also challenged the continuity of events across time. Many quantum physicists, for instance, contend that electrons move from one orbit to another instantaneously, i.e., without time elapse (Wolf, 1981, pp. 83-84). Electrons simply disappear from one quadrant and reappear in another. Similarly, changes between various stationary states are considered to be discrete and discontinuous (Bohm, 1980, p. 128).[11] Discontinuous change, as mentioned above, is akin to a flower growing from a bud to a full bloom instantaneously--one instant it is closed, the next instant it is fully opened. This seems to fly in the face of our linear notions of common sense. Our usual notion of time implies that one instant has to be connected to the next with a line, and thus there is always a small interval of time in which the change must occur. Nevertheless, quantum physicists have demonstrated that change can truly be discontinuous--not just faster rates of change, but change without temporal duration.

Psychology's Newtonian Framework

These challenges to Newton's temporal framework for explanation have not been widely recognized. Linear time continues to reign supreme in our lay culture and most disciplines other than physics and philosophy. Linear time certainly rules mainstream psychology. After psychologists modeled physics, prior to Einstein's "revolution" at the turn of the century, they never looked back. Because of the historical factors described above, early psychologists never concerned themselves with assumptions of time. Linear time was part of reality. Criticisms of Newton's temporal assumptions prompted no reexamination in psychology, because no temporal assumptions were recognized. Psychology's reliance upon Newtonian assumptions, therefore, remains undeterred in virtually every important respect.

Consider psychologists' objective view of time as existing independently of human consciousness. As Ornstein (1972) notes, "most psychologists, in considering time, have taken for granted that a 'real' time, external to our construction of it, does exist, and that this time is linear" (p. 79). Faulconer and Williams (1985) also discuss psychology's "objectification" of time (p. 1182), and McGrath and Kelly (1986) observe that most research on time is "done on the premise that there is a singular, and known or knowable, objective time" (p. 24). Many psychological experiments, for example, have been conducted to discover how accurately such "real" time is perceived. Time is treated as if it consists of its own stimuli for perception, though real time is always identified with clock-time. The clock, of course, only marks or measures time; the clock is not time itself. To call the clock "real time," as Ornstein (1972) points out, "is somewhat like calling American money 'real money:' it is parochial at best" (p. 81).

Second, time is viewed as <u>continuous</u>. Psychological events are seen as continuous in the sense of later events being consistent with earlier events. Abrupt "discontinuous" shifts that are incongruent with previous events are thought to be improbable, if not impossible. As the developmentalists Emde and Harmon (1987) have observed most researchers have "expectations for connectivity and continuity" (p. 1), presuming a "linkage from early behavior to later behavior" (p. 3). People in general are presumed to be continuous with their upbringing. Personalities and attitudes are traditionally thought to be consistent with the person's past experiences. Any behaviors or thoughts that appear to be exceptions to this rule (sometimes deemed "abnormal") merely indicate that some of the person's past is not known. If it were known, then we would see its continuity to the "exceptional" behaviors and thoughts in question.

Temporal continuity is also used to explain change in psychology. Indeed, in accordance with Newton, change and time are considered almost synonymous--both being smooth and gradual. Change from one psychological stage to another must occur through intermediary states (or moments in time). "Spurts" of change are possible, but <u>some</u> amount of time must occur <u>between</u> changes. For example, changes that researchers consider "discontinuous" are often observed in child development (Kagan, 1984). Still, these are normally viewed as rapid continuous changes--changes across a short span of time--rather than changes with no time or transition between events (e.g., Fischer, 1984). A child cannot move from one stage of development to the next without passing "in between." Continuity implies that one instant is connected to the next with a line, and thus there must always be a small interval of time in which change occurs.

Virtually all mainstream psychological explanations are <u>universal</u> (Faulconer and Williams, 1985). Psychologists have long sought general "laws" of behavior that are independent of the particular historic situation in which they are embedded (cf. Rakover, 1990, ch. 2). Examples are Fechner's law of sensation strength and Skinner's principles of reinforcement--both presumably still applicable, despite their having been formulated many years ago. Most psychologists attempt to look "behind" their data to find the universal principles that underlie them (Fuller, 1990, ch. 1). In their study of memory, for instance, cognitive psychologists expect to glean universal principles that can be applied uniformly under specified experimental conditions (cf. Ashcraft, 1989). These psychologists implicitly assume that time itself will remain uniform from situation to situation.

The <u>linearity</u> of explanation in psychology is also readily apparent. Time is considered to "flow" between psychological events like a line and to function as a medium for the sequence of events (Ornstein, 1972, p. 82-84). This is most clearly observed in the "causal" explanations of psychologists. Any event observed "before" is automatically considered for, if not awarded, causal status over events observed "after" (Rakover, 1990, ch. 2). The time interval--the points on the line--between cause and effect must be filled with causal process (McGrath and Kelly, 1986, p. 128-131). From this perspective, it is easy to see why so many psychologists place so much emphasis upon the past. The present is an effect of the past. Moreover, the present is only one point on the line of time, and a durationless and fleeting point at that. A person's life, therefore, consists of the past almost exclusively. It seems only logical that the most theoretical and therapeutic attention is paid to the past.

The fact that psychological processes supposedly take place across time has the same implication it had in Newtonian physics: reductionism. No process--whether it be mental, emotional, or behavioral--can exist as a whole at any point in time. A reduction of the process is all that is directly available for study. Consequently, it is only natural to conceptualize processes as component parts that are separated by linear time. Consider, for example, some models of family therapy. Although family therapists typically wish to conceptualize the whole of the family system, their theorizing often depicts this system as occurring piecemeal along the line of time. This type of linear explanation has overlooked reductive ramifications. Because the system-as-a-whole is never present at any one point in time, the therapist is necessarily resigned to interventions that directly affect only a portion of the system. No truly systemic intervention--at least in the sense of affecting all parts simultaneously--is possible.

Similar to Newtonian physicists, psychologists also seem to favor machine metaphors for explaining psychological processes. Aveni (1989) rightly declares, "Machinery is, for us, the power tool of metaphor" (p. 36). Just as Newtonian explanations relied upon the clock, psychological explanations have historically relied upon a host of different machines. The human mind, for instance, has been analogized to whatever mechanism was prominent in that historic period, from the hydraulics of the steam engine to the relays of telephone switchboards (Martindale, 1981, p.3). Today, of course, the computer is the ascendant machine, and true to form, computer metaphors abound in theories of the mind. Even families are understood through computer metaphors (e.g., Nichols, 1984, p. 421). Computers, no less than their mechanistic predecessors, operate across time in temporal stages that minimally included input and output (Dreyfus, 1979, ch. 10). In this sense, Newtonian time and mechanistic models have each served to catalyze the popularity of the other.

Finally, many contemporary psychologists and Newtonian physicists view scientific method with similar temporal assumptions (Rychlak, 1988, p. 47-49; cf. Slife, 1987). Psychological scientists view themselves as intervening experimentally, and then observing the consequences of this intervention later in time. This view is aided by psychology's decidedly linear approach to causation. Temporal sequence is so conflated with causation that the two are often indistinguishable in research. Psychological experimenters have rarely been accused of "making a metaphysics of their method"[12] (as has Newton), but this may be because psychologists have not made their own assumption of time explicit. Without an awareness that linearity is a part of psychology's metaphysic, psychological researchers cannot be accused of confounding this assumption with their method. Yet, their method may incorporate linear time in a way that prohibits any true test of its validity.

Conclusion

It is important, then, that we identify the linear view of time in all of its manifestations. Temporal assumptions cannot be discerned through the use of a method that assumes them. Thus, in this essay, the process of identification has begun with a brief cultural and historical analysis. Our cultural analysis finds psychology's temporal conception to be a product of modern Western culture to some degree--likening time to a continuous line that is independent of the events it supposedly measures. Still, it is unlikely that psychology would have adopted this conception without reputable scientists also endorsing it--hence, the significance of Isaac Newton. Newton, to his credit, made his conception of time explicit. However, there is no indication that early psychologists (particularly those pressing for natural science methods) did likewise. Instead, methods and modes of explanation were adopted that contained temporal assumptions implicitly.

Five of those implicit temporal assumptions are described in this essay: objectivity, continuity, linearity, universality, and reductivity. These five characteristics have served historically as an important guide to scientific explanation in general. Should the recent criticism and abandonment of these characteristics--in physics and philosophy--give psychologists pause? There is no question in the mind of the present author that it should. This is not to say that the issues of psychology are identical to those of physics or philosophy. However, one is struck by the almost total lack of examination of the Newtonian temporal framework in psychology. How can psychologists <u>know</u> if the problems of physics and philosophy are relevant when most psychologists have no idea they even endorse the framework in question? This, then, is the importance of recognizing the "Newtonian legacy."

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Footnotes

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[1]For exceptions, see Rychlak (1981, 1988), McGrath and Kelly (1986), and Slife (1981, 1987, in press), Williams (1990).

[2]Christian doctrine may have been interpreted historically as supportive of a linear view, and thus led to its rise in Western culture. Nevertheless, it is debatable whether Christian doctrine implies linear time. Biblical revelation points to the directionality of events, but it does not necessarily point to a linear interpretation of this directionality. The past, for example, is not necessarily primal in Christian theology. The present (e.g., the indwelling of the Holy Spirit) and the future (e.g., Christ's Second Coming) seem to be as important as the past. Moreover, God is often thought to transcend time, and sinners are viewed as being "reborn" and thus transcending their pasts.

[3]Not only was cyclical time possible, but Newton also differentiated his "absolute time" from "relative time" (Newton, 1687/1990, p. 8). Moreover, Leibniz opposed Newton's conceptions with his notion of "relational time." From Leibniz' perspective, time does not exist in its own right, independently of events. Time is the successive order of the events themselves (Whitrow, 1980, p. 36-39).

[4]This is not to imply that Einstein eliminated time. As Whitrow (1980, section 6.5) has noted, modern notions of "cosmic" time are not incompatible with relativity theory.

[5]This linear characteristic of absolute time may seem in contradiction with Newton's contention that natural processes are "reversible." Newton believed, for example, that celestial mechanics were consistent with his mathematical laws whether they were run "forward" or "backward." This would seem to imply that time itself can run forward and backward (e.g., Coveney & Highfield, 1990, p. 30; McGrath & Kelly, 1986, p. 29). However, Newton made clear distinctions between natural change processes and Absolute Time. Absolute Time flows "without relation to anything

external," and is independent of these natural processes. Natural processes may be reversible, but their temporal medium--absolute time--is not. How else could we know, Newton might ask, whether natural processes of change are forward or backward, unless we have some absolute standard by which to judge this directionality? As Newton (1687/1990) described it, ". . .the flowing of absolute time is not liable to any change. . .the order of the parts of time is immutable" (pp. 9-10). For the purposes of this book, reference to Newtonian time is a reference to Absolute Time which has definite linear properties.

[6]Of course, whenever the past is fully understood in a Newtonian framework, the present and future are also considered to be illuminated (and predicted) as well.

[7]An interesting exception to this was Newton's conception of gravitation. For him, gravity was a force which acted instantly across the distance between one mass and another (Nicolson, 1980, p. 165). As Bunge (1959) notes, the notion of instantaneous physical actions was actually quite prevalent during this period of history (p. 64).

[8]How well machines actually embody these characteristics is, of course, open to debate. The order that machines represent does not have to be considered linear in nature. That is, the directionality implicit in mechanisms does not have to be framed in absolute and linear terms. Historically, however, machines and linear time have tended to be highly associated.

[9]Morris (1984) presents a similar challenge: "Nor can any meanings be attached to the statement that time 'flows equably.' If the flow of time is not uniform, how can one measure its irregularities?" (p. 210).

[10]Einstein did not believe, however, that causal relations were relative to each observer's inertial frame of reference. He considered the order of cause and effect to be invariant and absolute (Ballif & Dibble, 1969, p. 412).

[11]Bohm cites other examples of instantaneous change, including empirical experiments (pp. 71-72). Essentially, a molecule of two atoms is disintegrated, resulting in the two atoms flying apart. While the atoms are in flight (and potentially separated by great distances), any attempt to

measure the spin of one atom is instantaneously registered in its "brother" atom. No time has occurred in which to allow any "transmission" from one atom to the other, yet the two are somehow instantaneously related.

[12]Rychlak (1988) is a notable exception, because he has accused psychological experimenters of an "S-R Bind." That is, an S-R type of linear framework is imposed on a nonlinear style of theorizing in order to make the latter more "scientific" (in the linear sense). This is perhaps most readily seen in the confounding of the S-R theory with the IV-DV of method (Rychlak, 1988, 172-174).