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DISCONTINUOUS CHANGE

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ABSTRACT: The concept of discontinuous change is discussed and compared to concepts of continuity and gradual change. Alternative views of causality are compared, and some social implications of the concept of discontinuous change are discussed. While interest in discontinuous change is already widespread in the physical and biological sciences, the social and behavioral sciences have lagged in questioning their theoretical frame of reference. Some psychological applications of discontinuous change are alluded to, particularly in the area of brief therapy.

Discontinuous change is an idea whose time has come. A new way of looking at complexity, at continuity and change, has already established itself in the physical and biological sciences. Unfortunately, an understanding of this view of causality has not yet achieved prominence in the social and behavioral sciences, though a variety of new theoretical perspectives and practical applications has begun to emerge. Since an understanding of discontinuous change has implications for the way we view the world and ourselves, as well as for our values, this article is an attempt to bring the issue to public consideration.

Let us begin by exploring the concepts of continuity and change. In psychology, for example, the best predictor of future behavior is past behavior. Jennifer, a 24 year old college graduate, who today feels trapped in a six year relationship with an unstable man (James), unhappy in her work, and intimidated by her father, will very likely feel trapped in the same relationship, unhappy in her work, and intimidated by her father tomorrow. In two days, or a month, or a year, it is also likely that her behavior (e. g., her relationships with and feelings about men, co-workers, and family members) will be similar. But the further into the future we go, the lower the probability that her behavior will remain unchanged.

The way psychologists have interpreted this consistency (and there are parallels in other fields) is to view change as gradual. That is, over some initial period, there is no change at all; then little bits of change accumulate, like grains of sand, forming at first an ant hill and eventually--if one waits long enough--a mountain. While the mountain of change looks qualitatively different from the first few grains, the *process* of change has been gradual and quantitative throughout. Thus, qualitative differences are merely the result of allowing a gradual quantitative process to proceed for a sufficiently long time.

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This implicit view of change as gradual informs the way people think of the world and influences the kinds of questions it is possible for them to ask. There are many different terms for describing such implicit views, each with a somewhat different definition and implications, and with varying usefulness in understanding differing circumstances or conditions. Some of these are *belief system*, *frame of reference*, *assumptive world*, *paradigm*, *epistemology*, *ideology*, *Zeitgeist*, and *Weltanschauung*. While a discussion of these viewpoints is not necessary to the focus of this paper, those who are interested might consult Kuhn's *The Structure of Scientific Revolutions* (1970) regarding paradigms and Pepper's *World Hypotheses* (1942) regarding contextualism and mechanism. Hayes (1988) and Hayes, Hayes, and Reese (1988) discuss behavioral implications of Pepper's work.

The view of change as gradual can be seen in the theory of evolution, in which natural selection operates on genetic variability over extended periods of time, eventually accumulating enough quantitative difference to be called qualitative (a new species). The history of science itself can be viewed as a process of gradual change: each experiment contributes to knowledge, until there is enough new knowledge to challenge old theories and suggest new ones. Gradual change is a pervasive way of organizing and understanding the world.

Before speaking further about change, it is worth pausing to consider what it means to stay the same. Whether or not some characteristic is viewed as staying the same depends in part on the size of the units in which it is measured, as well as on the length of time between measurements. Jennifer might be consistent in her attitude toward James from one day to the next on a two point scale (like/dislike), or a three point scale (like/uncertain/dislike), but not on a scale of seven or 100 points. Similarly, her attitude might be consistent if measured on ten successive days, but not on ten successive months. Another way of putting this is to say that -- at every level from the subatomic to the cosmic -- everything is constantly changing, so that to assert that something is the same means that its changes fluctuate within a certain range.

Finally, in order to say that something is unchanged, one must observe it at least twice. Since observing a phenomenon affects it (to differing degrees and in differing ways, depending on who is doing the observing and how it is being done), the possibility cannot be ruled out that it is the process of observation which makes it appear the same or changed. If someone asked Jennifer whether she were still going out with James, her response would depend in part on who that person was, on the relationship between them -- male or female, close friend, acquaintance, or potential new manfriend -- as well as on a variety of factors other than the requested information. In short, stability -- or the belief that one can know that something is unchanged, without all kinds of qualifiers attached to that knowledge -- is an illusion.

Now let's consider continuity. There is an abstract mathematical concept of continuity (e. g., between any two points on a line, no matter how close together,

there are lots of other points), but this idea is too exacting for our purposes. Discrete physical objects like grains of sand are not continuous in the mathematical sense. While much change may be gradual -- each grain of sand is a very small part of the mountain -- gradual change is not mathematically continuous, since it is possible to put two grains of sand so close together that no others can fit in between.

Instead of making this abstract distinction, I will be using the terms gradual change and continuous change synonymously, to refer to the imperfect way in which physical reality resembles the mathematical ideal. If the phenomenon we are observing doesn't appear to change suddenly, we can regard its occurrence as continuous. We can observe in passing that, since gradual change takes place in small -- but not infinitesimal -- units, all change is discontinuous in the mathematical sense. This is merely a side issue, and not relevant to the main topic of discontinuous or sudden change as different from gradual change.

Considered in this non-mathematical sense, the concept of continuity has two main forms -- apparent stability (e. g., homeostasis) and gradual change (e. g., Darwinian evolution). As we have seen, a phenomenon that appears stable actually varies over time, but within definable limits. Our body temperature appears to remain stable at 98.6° F. (In fact, it varies by a degree or two over a 24 hour period. Studies of circadian rhythms have shown that not only body temperature but other physiological processes vary slightly, in predictable ways, over definable periods of time [Winfree, 1987]. Once again, it is the range of variation that is "stable.") But thermal consistency is not a passive state -- various active processes are at work to maintain it. The evaporation of our perspiration cools us, and we generate heat by shivering. We wear clothes. We heat our homes in winter, air condition them in summer, and have invented thermostats to control indoor temperature in a manner analogous to our bodies' own "homeostats." Even understood in this way, apparent stability is time bound. If we wait long enough, our body temperature will change significantly from 98.6° F, either temporarily, as when we get sick, or indefinitely, when we die.

The second type of continuity is gradual change. The idea of change as taking place little by little is one that applies not only to how things got to be the way they are (explanation), and where they are headed (prediction), but also to how to make something happen (control). A common view is that, since the world is complex and there are so many variables to take into account, change must be difficult to engineer.

For example, psychoanalysis has a view of causality, known as psychic determinism, which has its origin in nineteenth century physics. Psychoanalysts believe that, just as a perfectly spherical billiard ball knocking into another stationary one on a frictionless plane completely determines the latter's motion, so all mental events are completely determined by events which preceded them. Thus,

psychoanalytic therapy is slow because the problems that bring people to treatment emerge at the end of a whole lot of causes that must be addressed.

In contrast, behavior therapy, which developed much more recently, has a more contemporary and probabilistic view of causation. People at streetcorners cross more frequently when the light is green than when it is red, though the green light doesn't cause them to walk in the way that one billiard ball causes another to move. Rather, it increases the probability of walking, even though people sometimes stand when the light is green and walk when it is red. Behavior therapy's probabilistic view of causality could easily comport with the concept of discontinuous change described below. Nevertheless, while treatment is of much shorter duration than that of psychoanalytic therapies, behavior therapy as it is usually practiced relies on gradual processes of learning that require repeated trials.

In general, gradualists would say that the way to make change happen is to define where you are headed, set out for your goal one step at a time, and overcome the obstacles you encounter until you get there.

In addition to gradual change, some discontinuous change is predictable -- for example, developmental stages. Since qualitative behavioral changes, such as the appearance of speech, or physical changes like puberty, occur regularly, they are easily assimilated to a gradualist world view, and are not the subject of this article.

Although many changes do occur gradually, or at least predictably, we are becoming aware that sudden, unpredictable, discontinuous change is surprisingly widespread. While a natural first reaction would be to ignore such phenomena, and attempt to explain, predict, and control that which occurs regularly, it turns out that the opposite strategy is an extremely fruitful one. As a result, the common view of the world as manifesting gradual change is being challenged by a new view associated with the concept of discontinuous change. What is this view?

If continuous change is gradual, quantitative, and predictable, then discontinuous change is typically sudden, qualitative, and unpredictable. Looking through a kaleidoscope, one sees a complex pattern of reflected bits of colored glass. A slight turn of the cylinder leaves the pattern unaffected, as does a further slight rotation. Eventually, a threshold is reached, so that any additional rotation leads to a rearrangement of the shards and a new and unpredictable visual pattern.

While this pattern change is surely sudden and qualitative, purists might want to argue that it is, in principle, predictable. That is, if we had all sorts of information, such as the exact size and shape of all the fragments of colored glass, their exact positions relative to one another, and the exact speed and amount of rotation of the cylinder, we would be able to predict the new pattern.

Perhaps. However, there is an important limitation to predictability, known as sensitivity to initial conditions (Gleick, 1987), which reminds us that a very slight initial difference in the size, shape, or position of even one of the shards (or in some other variable) could lead to entirely different subsequent patterns. Sensitivity to

initial conditions is sometimes referred to as the "butterfly effect." This metaphor points out that the additional turbulence from a butterfly's wings in one part of the world can be magnified by the swirling forces of nature to produce a hurricane -- that otherwise would not have occurred -- in another part of the world.

More to the point, the focus on predictability -- while of possible usefulness in many instances -- seems to be inconsistent with what the kaleidoscope is all about. One might call it an example of gradualist thinking. In situations where there are many determining elements that interact in complex ways, an observer can't measure everything. Rather than trying to make sense of what happens to every element, a reasonable strategy with complex systems is to accept unpredictability and see where we can go from there. (This is why, for the present discussion, it is unimportant whether we are talking about unpredictability and randomness in principle or merely for practical purposes.) We can count on the kaleidoscope producing one suddenly new and qualitatively different pattern after another; no pattern will gradually fade into its successor. The innovation is to spend some time studying the patterns.

To understand discontinuous change, we have to view phenomena as parts of ongoing, interactive, complex systems. The science of ecology, for example, looks at the world in this way. It has grown dramatically in recent years, and has studied discontinuous changes such as the sudden extinction of species when their environments change. Of special relevance to the present discussion, ecologists' influence has spread beyond their science to everyday life and has already had an impact on people's values. Technology, previously viewed as producing solutions to problems, is now seen by many as itself part of a large, ongoing complex system. The view that technological solutions can produce unexpected consequences -- which may be worse than the problems they were developed to solve -- is an example of the way thinking about discontinuous change is beginning to affect our outlook and lead us to rethink values such as progress.

Since discontinuous change usually refers to a change in pattern, and patterns are by definition relational, such change is not always self evident. As opposed to continuous change, which is by definition only a bit different from what preceded it, a pattern change is something else. It may be obvious, as in the kaleidoscope example, but it may be subtle. The sequence 1, 4, 7625597484987, ..., does not initially seem to manifest a pattern. The pattern, however, is there for the finding, and becomes evident once recognized ($1, 2^2, 3^{3^3}, ...,$).

One can infer from this that those looking for continuous change would value precise measurement, while those looking for discontinuous change would value pattern recognition. While these are not necessarily incompatible abilities, they are different, and they hint at ways in which the social valuation of abilities may be modified if the idea of discontinuous change becomes more widespread.

Another distinctive feature of discontinuous change is its emphasis on the key role played by random elements. Randomness is a problem for those with a

gradualist world view, something to be overcome in explaining causality or in moving one step at a time toward a designated goal. They recognize that the stranger one sits next to on an airplane may become one's spouse or employer, thus completely altering one's life -- but ideally, they would like to be able to predict the encounter and say that its apparent unpredictability was an illusion based on inadequate information.

In contrast, those who think in terms of discontinuous change view randomness as a fact of life, something to be taken advantage of rather than overcome in promoting change. As an alternative to setting a goal and gradually working toward it, their strategy would be to expose people to new information, situations, and relationships, and see what happens. (A more limited goal would be to attempt to describe the conditions under which a chance encounter is more or less likely to lead to a new life path [Bandura, 1982].)

In provoking -- rather than planning -- change, one begins by going beyond the phenomenon itself to see where it fits into a larger complex system. Since homeostatic or other continuity-maintaining processes are at work in the system, strategies for change involve provoking pattern disruption, such as by introducing new unexpected elements or interfering with event sequences. As the system reorganizes into a new pattern, it is understood that the nature of the new outcome is unpredictable. This is the case not only because of the presence of new elements, but more importantly because the complex interaction of multiple forces, each of which is to some degree unpredictable, makes the ultimate pattern that will emerge unforeseeable.

Because discontinuous change is rapid, it is of great interest to therapists. A few clinically relevant examples may be useful in illustrating what it looks like.

Watzlawick, Weakland, and Fisch (1974), in developing their approach to brief therapy, sought out examples of spontaneous change which occurred without the intentional intervention of therapists or anyone else. Here is one of their examples:

> On her first day of kindergarten, a four-year-old girl became so upset as her mother prepared to leave that the mother was forced to stay with her until the end of the school day. The same thing happened every day thereafter. The situation soon grew into a considerable stress for all concerned, but all attempts at solving the problem failed. One morning the mother was unable to drive the child to school, and the father dropped her off on his way to work. The child cried a little, but soon calmed down. When the mother again took her to school on the following morning, there was no relapse; the child remained calm and the problem never recurred. (p. 79)

From the authors' perspective -- and that of discontinuous change -- the father's taking the daughter to school interrupted the interactional pattern that had developed among the mother, daughter, and those at school, allowing a new problem-free pattern to emerge.

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Two condensed case studies can illustrate what discontinuous change looks like in brief therapy. The first is of my treatment of the woman mentioned at the outset of this article.

> When Jennifer, a couple of months after breaking up once again with her unstable manfriend James, began receiving 2:30 a.m. phone calls from him asking if he should commit himself to a mental hospital, she became desperate. She renewed contact with him and treated him compassionately, as she always had done; but she began to feel hopeless about ever escaping from him, her unsatisfying job, or her domineering father. She sought my assistance; and, following detailed questioning about her current situation and events leading up to it, I sent her home with a simple assignment: ask James to help her become more independent from her father.
>
> The next session, Jennifer reported that James had reacted angrily to her request; and she was upset that, after all she had done for him, he wouldn't help her with a problem of her own. I suggested she call James at 2:30 a.m., so he would understand how important the request was to her.
>
> Therapy lasted five sessions. During that period of time and in the months following termination, many changes took place. Jennifer broke up with James for good, applied to graduate school in a field different from her work (something her father had opposed), and was accepted by and entered a graduate program in a distant city (her father had opposed her moving away and she had felt too timid to do so). Prior to leaving, she invited her parents for dinner at her apartment -- something she had never done -- in a step toward a more egalitarian relationship among them.

From my point of view, Jennifer's asking James to help her interfered with the ongoing pattern of her taking care of him; and as that relationship reorganized it had ramifications in ever larger parts of her social field (and, presumably, of his).

The other case example is of the initial phase of my treatment of a family consisting of a father, a mother, and their ten-and-a-half-year-old daughter Mary. They sought out family treatment because, according to the parents, they all had problems: Mary was picked on by her classmates (though she was doing well in school), had no friends, and was disobedient at home; the mother was depressed; all three had low self-esteem and were easily hurt; and the parents indicated that they had marital problems related to their daughter. They also indicated that Mary's behavior was the most important problem, and was the primary reason they

were seeking therapy, though I couldn't get a clear sense of why it was so important.

Given the parents' priorities, I spent much of the second session trying to get them to agree on something they wanted their daughter to do differently. With considerable difficulty I got them to agree a) that she should make her bed every day before noon, b) on a detailed definition of what constituted a made bed, and c) on the consequences for making and for not making her bed.

In the third session, it turned out that the effects of the intervention had been mixed (e. g., some slovenly bed making), and that the parents disagreed over whether change was taking place. Had the result been more positive, I might have continued in the same vein. However, given the parental discord evident in the first two sessions, I switched to a paradoxical task (Selvini Palazzoli, Boscolo, Cecchin, & Prata, 1978; Papp, 1983) which I had prepared as a backup. I read the following explanation aloud, and led them through a rehearsal of the ritual described below, which I asked them to do as indicated:

> Mary has low self-esteem and disobeys so that you (mom and dad -- especially mom) can worry about her. By having low self-esteem, she shows that she is like her mom, and by disobeying she distracts her mom from worrying about herself -- since she can worry about Mary instead. In addition, Mary gives her dad a chance to support her mom by getting him to yell at Mary when she acts up.
>
> For this reason, it might not be a good idea for Mary to change. Instead, the family can celebrate her helpfulness by performing the following ritual at least once a day -- and extra times when she is particularly unhappy or disobedient:
>
> Mom lies down.
>
> Mary stands at her side, holds her hand and says "It's all right mom. You don't have to worry. I'm unhappier than you."
>
> Father pats Mary on the head, smiles at her, and says "That's my girl!"

When the family came for the next session, it turned out that dramatic changes had taken place. Though they had only performed the ritual a few times, Mary's disobedience and low self-esteem had ceased to be problems. She had made her bed every day, and had even cleaned up her room without being asked. She had also slept over one night at the house of one of her friends -- though the sudden appearance of those friends was unexplained. I dismissed Mary from therapy with the comment that her parents seemed not to need her help anymore. While she was in the waiting room, her parents revealed that they had had a big blowup about their sexual relationship during the same week; and the focus of

therapy shifted to the marital relationship. In addition, the father, an ex-Marine, revealed the reason that he had considered Mary's problems to be so important. Her disobedience and talking back to him had made him so furious that he was afraid he might lose control and harm her.

From my point of view, the ritual interfered with the pattern of Mary's problem behavior deflecting the hostile interaction between her parents. Once her unhappiness and disobedience were redefined as helpful, they ceased to be useful in provoking parental concern and anger. Her withdrawal from the marital conflict led in turn to its escalation and the concomitant revelation of previously secret information. In addition, this example illustrates the difference between gradual change with the first intervention, and discontinuous change with the second one.

In all three examples, it is the sudden and qualitative shift -- resulting from a change in the interactional pattern of which the problem behavior is a part -- that makes it reasonable to regard the change as discontinuous.

While the idea of discontinuous change may itself appear discontinuous, there are intellectual antecedents that may be pointed to as setting the stage for or provoking it. Probably the most important of these is a shift from viewing the universe as an harmonious and comprehensible Newtonian clockwork to recognizing it as operating probabilistically (quantum mechanics) and as being, in principle, partially unknowable (Wolf, 1989). In physics, the Heisenberg uncertainty principle set limits to what is knowable by pointing out the way in which making observations alters that which is being observed (Wolf, 1989). Even more fundamentally, Gödel's proof demonstrated that mathematics, the logical language in which science expresses itself, is incomplete (Hofstadter, 1980). That is, mathematical statements exist whose truth or falsity cannot be determined. Furthermore, given any unknown mathematical proposition, it is impossible to determine whether it is one of those undecidables.

Within the physical and biological sciences, discontinuous change has already achieved prominence in diverse areas. It can be found in the evolutionary theory of punctuated equilibrium, in which new species are thought to form rapidly and then remain stable over long periods of time (Eldredge, 1985) -- in contrast to the theory of slower and more long-term gradual evolution. In addition, mass extinctions are thought to play an important role in evolution. For example, a random event -- a comet striking the earth -- may have been responsible for the extinction of the dinosaurs and most contemporaneous species (Eldredge, 1985). Ecologists speak of the unpredictable effects of putting new substances into the biosphere; and global warming and depletion of the ozone layer are considered as (possibly) disastrous examples of unwanted discontinuous change (Schneider, 1989; Fishman & Kalish, 1990). Chaos theory has become prominent in many areas of science, as patterns of discontinuous change are found in the weather, population

dynamics, heart and brain activity, and epidemiology (Gleick, 1987; Pool, 1989a, 1989b, 1989c). In mathematics, the area known as dynamical systems has experienced new excitement as an outgrowth of its applicability to the understanding of chaotic phenomena (Devaney, 1989; Ornstein, 1989; Abraham, Abraham, Shaw, & Garfinkel, 1990). (Since mathematics exists independently of the sciences, the attention to discontinuous change can be seen not as constituting new discoveries about the world, but as reflecting an interest in such issues within mathematicians' social communities.) In fact, the history of science itself has come to be viewed as consisting of alternating periods of normal science and revolutionary paradigm change (Kuhn, 1970) -- an image of scientific evolution similar to the punctuated equilibrium theory of the evolution of life.

Outside of the physical and biological sciences, where discontinuous change has not yet become a prominent way of thinking, there are many signs of its growing importance. Within the arts, which are sometimes thought to be harbingers of new ways of thinking, chance elements have played an important role in recent work (Pool, 1989d). There have been deliberate attempts to introduce randomness into the creation of contemporary music, dance, painting, sculpture, and literature.

Meanwhile, increasingly frequent examples can be found within the social and behavioral sciences of theoretical conceptualizations and practical applications involving discontinuous change. For example, in anthropology, rubbish theory (Thompson, 1979) studies the way artifacts such as cars, houses, or curios gradually lose value over time, then go through a period of worthlessness (rubbish), following which certain ones suddenly enter a phase of high and increasing value as antiques. Applications of chaos theory are being studied in economics -- exploring whether the business cycle or the stock market behave chaotically -- and in political science, applying chaos theory to the arms race (Gleick, 1987; Pool, 1989d). Social scientists are rethinking their views of child rearing practices, as the emphasis shifts from the individual, with his or her own life cycle, to the family system and its organizational life cycle. Particular attention is now being paid to events at transition points in patterns of family interaction (Hoffman, 1981), especially when new members enter or leave the system (e. g., the birth of a child, or an adolescent leaving home). We are now looking at how effectively the family as a whole reorganizes following such transitions, rather than just focusing on the members as individuals (e. g., no longer viewing parents' behavior as merely a collection of specific parenting skills or expressions of their personalities). Systems theory -- with a concept of interference with state-maintaining processes leading to discontinuous change -- is becoming an important force in psychotherapy; and many new brief therapies have been developed (e. g., Haley, 1987; Minuchin, 1974; Papp, 1983; Watzlawick, Weakland, & Fisch, 1974). As was illustrated by the case examples, problems are generally viewed as part of a complex pattern of repetitive interaction among people (rather than as existing within individuals); and therapeutic strategies are aimed at

provoking change to qualitatively different problem-free patterns. Not surprisingly, therapists influenced by systems theory often work with a couple or family, rather than with an individual; and some professionals have begun consulting with businesses and other non-familial organizations to deal with interpersonal problems in those larger interactive contexts (Selvini Palazzoli et al., 1984).

As the concept of discontinuous change becomes more widely known, its usefulness is likely to be explored in increasingly diverse areas. It will be interesting to see what unexpected changes the future brings.

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