An Indeterminate and Expansive World

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Abstract

The real world is a behavioral world, a totality in which forms of behavior are taken as ultimate, in contrast to worlds in which physical objects, numbers, etc. are taken as ultimate. It is an indeterminate totality, in that we can create new behaviors that change the structure and complexity of everything. The boundary condition for the real world is reality, and the basic form of scientific empiricism is reality-based rather than real-world-based. From a reality-based perspective, acting on phenomena like imaginary numbers and imaginary companions makes sense, and so does acting on scientific theories that later turn out to be imaginary.

In *Six Books on the Revolutions of the Celestial Spheres*, Nicolaus Copernicus (1543/1947) declared his innovative understanding of the real world with these words: “Lastly, the sun will be regarded as occupying the midpoint of the world. The reason for the order in which all these things succeed one another and the harmony of the whole world teaches us their truth, if only—as they say—we would look at the thing with both eyes” (p. 63).

But astronomers of the 16th century who read his work were not especially interested in his sun-centered cosmology. As revealed by a scholarly study of annotations and marginalia in the 601 surviving copies of the first and second editions of *De Revolutionibus* (Gingerich, 2002), they were interested in his methodology for predicting the positions of the planets. Was it mathematically sound? Was it simpler than Ptolemy's method? Was it more accurate? In short, was it an effective and useful way to go about their business as astronomers? For the most part, astronomers of Copernicus' century focused on the technical details without engaging with his revolutionary, and heretical, view of the world (Gingerich, 2004).

In *"What Actually Happens"*, Peter G. Ossorio (1978) expressed his world-changing understanding of the real world with these words: "The only "world" which does not represent an arbitrary, a priori limitation on possible states of affairs and which, therefore, includes all the other "worlds" and qualifies as simply "the real world" is the one which would be most naturally called "the behavioral world," or "the human world," and that is the one that is codified in the Human Model, or Person Concept" (p. 33).

For the most part, members of the Descriptive Psychology community have not been interested in his behavior-centered cosmology. In fact there is general agreement in the Descriptive community that most of us were drawn to the system because it offered powerful and effective ways to go about our business as psychologists, mathematicians, engineers, theologians, and so forth. Like the astronomers of the 16th century, we focused on what was immediately usable in our worlds. We mastered detachable parts of the system (e.g., Judgment Space, Basic Process Unit, Paradigm Case Formulation, Status Dynamics), and utilized them to make significant contributions in our communities.

But if we look with both eyes, we will see that the system as a whole entails a fundamentally different concept of the real world. I hope to give readers an intuitive sense of that concept, as well as an appreciation of the difference that it makes to our behavior potential.

Totalities

The concept of a world is the concept of a totality. Paradigmatically, everything fits together in a totality, and everything is systematically related to everything else. Copernicus' formulation of the celestial world is an example. In a simple, geometrical diagram in Book One of *De Revolutionibus*, he shows the sun at the center of the totality, and the earth and the planets revolving in circular orbits around the sun. The moon moves in an orbital circle around the earth, and the totality is circumscribed by the orb of the fixed stars. The sun is immobile, and epicycles (circles within circles, not shown in the diagram) help to account for known deviations in the circular orbits.

Descartes' creation of a new totality is a second example. Algebra and geometry were treated as separate domains prior to Descartes, but in *La Géometrié*, he demonstrated their systematic interconnectedness. He showed how integers, rational numbers, and real numbers could be represented geometrically, and how the same equations could be solved both algebraically and geometrically. He thereby created the new field of analytic geometry "and made modern geometry possible" (Grayling, 2005, p. 206).

The world of the heavenly spheres and the world of analytic geometry are totalities formulated by exceptional scientists, men who had the vision and will to put things together in innovative ways. The formulation of totalities is not only accomplished by scientists, however. The same kind of achievement is reflected in persons' understanding of the real world. Persons naturally formulate everything that is the case (what there is, what goes on, what occurs, and how things are) as part of a single, conceptual totality.

This totality is structured in terms of behavioral patterns. It is a single domain in which every behavior, social practice, institution, and way of life has a relationship to every other behavior, social practice, institution, and way of life. Within that domain, individual behaviors, social practices, institutions, etc., have sub-domains, such that everything that is needed for the successful enactment of a behavioral pattern has a place in the pattern's sub-domain. In this "placeholder" scheme, the top-level places (statuses) are for behaviors, and behaviors in turn have places (statuses) for everything that is involved in their enactment. Everything—including the 'natural' world and every item in the natural world—has a status in the real world by virtue of the place that it has in the behavior of persons.

A totality of this sort is of far greater complexity than the worlds depicted by Copernicus or Descartes. When we say that every behavioral pattern has a place in relation to every other behavioral pattern, we are not speaking of a location in three-dimensional or four-dimensional space. As Ossorio (1998) cautions, "Keep in mind that the real world has many more dimensions than the spatiotemporal ones. Personal, interpersonal, and social phenomena require many additional conceptual dimensions in order to delineate the various phenomena adequately. We live in the real world, not an abstract world of time and space." (p. 31)

The formulation of a multidimensional, behavioral totality may seem like a remarkable achievement, but it comes naturally to persons. Very young children are limited to behaving within the scene/situation of the moment, and are dependent on their parents and other persons to provide the holistic structure of a world for them. But they quickly learn enough of the interconnections in the real world so that parents observe, "She has her own world." By the time that normal children are 3-5 years old, they have achieved an understanding of how things fit together in the real world.

What is the primary point of having this kind of conceptual totality? It is *not* to have a catalog or taxonomy of everything that is "out there". The primary point of having the framework is that it codifies possibilities and non-possibilities for behavior. We can treat a formulation of the real world as a bookkeeping system for codifying what we can and cannot do. The bookkeeping reflects the patterns, regularities, limits, necessities, etc. of the real world, and enables us to make our way in the world easily and naturally, "just like an experienced bookkeeper looks down your balance sheet and he goes this way and this way, and he has the picture" (Ossorio, 1990, p. 23).

Ultimates

The concept of a world also involves the concept of an "ultimate". The ultimates in a world are whatever is accepted as fundamental. In the celestial world, there are ultimate objects—the sun, the moon, the earth, and the planets. In the world of analytic geometry, there are numbers—integers, rational numbers, and real numbers. In atomistic approaches to the real world, there are indivisible objects—corpuscles or atoms or subatomic particles. Wittgenstein (1954) prescribed taking the behavior of persons as ultimate: "What has to be accepted, the given, is—so one could say—*forms of life*" (p. 226e).

The choice of ultimates sets limits to what sorts of facts and what sorts of relationships are possible in a totality, and hence to the kind of world that it is. For example, there is no place for indeterminacy in the world of the heavenly spheres. "The movement of the celestial bodies is regular, circular, and everlasting—or else compounded of circular movements" (Copernicus, 1543/1947, p. 49). It is a clockwork world, in which all of the interrelationships in the system are determined.

In contrast, a totality in which forms of behavior are accepted as ultimate is an indeterminate world. People can create new forms of behavior, such as new games, scientific procedures, religious practices, art forms, etc. While some of these inventions fit neatly in the existing structure of the real world, others "call for far-reaching restructuring of our formulations of the world or parts or aspects of it" (Ossorio, 1982/1998, p. 72). They may change the interrelationships among behaviors within the structure, or add new dimensions that increase the complexity of everything.

This concept of the real world is fundamentally different from the kind of real world that we learned to take as given in school. We were taught, along with our lessons in chemistry, physics, and biology, that we do not have anything to do with the real world being what it is. The real world is simply, transcendentally, "out there", and in no way depends on us. But if the behavior of persons is accepted as ultimate, "there is no real world that in a logical sense is truly external to human lives" (Ossorio, 2006, p. 304).

As noted earlier, everything that is needed for the successful enactment of a behavior pattern has a place in the world built into the pattern. If the behavior pattern is chess, there is a place for a pawn, and the particular place that a pawn has in the game of chess is what makes a pawn a pawn. (It is not as though first there were pawns, rooks, etc., and then we discovered what they could be used for.) Without the game of chess, nothing could possibly be a pawn.

If the behavioral pattern is atom-splitting, there is a place for a neutron bullet. The particular place that a neutron bullet has in the process of atomic fission is what makes a neutron bullet a neutron bullet. (It is not as though first there were neutron bullets, atomic bombs, etc., and then we discovered what they could be used for.) Without the behavior of splitting atoms, nothing could possibly be a neutron bullet.

Thinking seriously about everything in the real world in this way may give readers a touch of intellectual vertigo. We are accustomed to think of the real world primarily in terms of the historical particulars that we see when we look around us. But in a world in which forms of behavior are taken as fundamental, the structure of behavioral patterns and statuses is primary. Only *secondarily* does the real world consist of the historical particulars that we assign to these statuses (cf. Ossorio, 1982/1998, p. 123).

Boundary Conditions

Some totalities can be easily and neatly bounded. Even if a game "is not everywhere circumscribed by rules", we can say what counts as a legitimate move in a game (Wittgenstein, 1934, p. 33e). In contrast, we encounter difficulties when we try to say what the boundaries are for domains like the universe or the behavioral world. For totalities like these, a boundary condition is used rather than a boundary. "What's characteristic of a boundary condition is that it is not located anywhere in the space. It's not about some part of it. It's not about some place in it. It's a statement about the whole thing that makes a difference in what happens within that space." (Ossorio, 1996) Examples of how cosmologists have handled the question, "What are the limits of the universe?", help to illustrate the difference between a boundary and a boundary condition.

In *De Revolutionibus*, Copernicus (1543/1946) addressed the question of limits as follows. (The accepted belief in the 16th century was that the universe was finite.)

> "They say that beyond the heavens there cannot be any physical body or place or void or anything at all, and accordingly it is not possible for the heavens to move outward: in that case it is rather surprising that something can be held together by nothing. But if the heavens were infinite and finite only with respect to a hollow space inside, then it will be said with more truth that there is nothing outside the heavens, since anything that occupied any space would be in them." (p. 59)

Following this reasoning, he used the inner concavity of the sphere traditionally associated with the fixed stars as a boundary for the finite space containing the sun, moon, earth, and planets (cf. McColley, 1942, p. 136). The fixed stars were on the other side of this boundary, and hence not in his domain of interest.

This was sufficient for Copernicus' purposes, and he did not need to take a (heretical) position on the limits of the universe. He also did not need to introduce a boundary condition. He concluded that "we do not and cannot know the limits of the world", and decided "to leave to the philosophers of nature the dispute as to whether the world is finite or infinite" (Copernicus, 1543/1946, p. 59).

When Copernicus considered the question, he was visualizing the universe in three-dimensional space, but today the geometry of the universe is formulated in four-dimensional space-time (which is hard to visualize). The universe does not have boundaries in four-dimensional space-time, but it does have curvature. One of the ways that cosmologists use the concept of space-time curvature is to talk about the constraints on the universe. "If it has negative curvature, it will expand forever." "If it has no curvature, the rate of expansion will slow down." "If it has positive curvature, the universe will eventually stop expanding and begin contracting." In these examples, the concept of space-time curvature is a boundary condition.

The real world is also "expanding", i.e., increasing in possibilities and complexity. People create new forms of behavior (e.g., nuclear fission), which in turn reveal new possibilities (e.g., nuclear reactors), which in turn lead to new inventions (e.g., nuclear marine propulsion), and so on. "What are the limits on what we can do?" To handle that question, we need to introduce a boundary condition.

"Reality" is the technical term for "the boundary condition on possible behaviors" (Ossorio, 2006, p. 118). "Reality" is sometimes used interchangeably with "the real world" in the vernacular, but they are *not* interchangeable in the Person Concept. "Reality is more fundamental than a real world, since [a world of behavior patterns] encodes some of our behavioral possibilities and limitations but not all, and that encoding itself may result in unnecessary constraints." (Ossorio, 2006, p. 120)

Consider a historical example. In 1667 Johann Becher proposed that all flammable substances contained phlogiston, which was released when a substance was burnt. His theory was widely accepted, and for more than 100 years, chemists made observations and designed experiments to detect the phlogiston that was freed by burning different materials. In 1772 Daniel Rutherford liberated a gas that others treated as "phlogistated air", and in 1774 Joseph Priestley released "dephlogistated air". Then, between 1775 and 1789, Antoine Lavoisier proved that air is a mixture of two gases, nitrogen (formerly treated as phlogistated air) and oxygen (formerly treated as dephlogistated air), and he explained how combustion works *without* using the concept of phlogiston. Phlogiston lost its status as a real substance in the real world.

The real world of chemistry in the 1600's did not encode all of our behavioral possibilities in that domain, nor could it have. Before Lavoisier invented the conceptual system that involved distinguishing oxygen, nitrogen, hydrogen, etc. from other elements and treating them accordingly, there couldn't have been any behaviors that involved these distinctions. (Cf. Before the game of chess was invented, there couldn't be a behavior of moving "Pawn to Queen 4". There also couldn't be a limitation that "The King can only move one square at a time.") The 17th century bookkeeping was an incomplete and inexact codification of our behavior potential, because more things were possible for us.

The 17th century encoding also resulted in an unnecessary restriction on the behavior potential of chemists. Once Phlogiston was created and accepted by chemists as a game to play, it made sense for them to try to release phlogiston. (Cf. Once Chess was created and accepted as a game to play, it made sense to try to checkmate the other player's King.) For more than a century, chemists devoted their time and energy to the game, as opposed to other avenues that they might have explored. But it was a losing game. There was no way to win at Phlogiston, because there was no element in the natural world that could fill the essential status. (Historical particulars may be secondary, but they are necessary for the successful enactment of behavioral patterns.)

Notice the difference in how the concepts of the real world and reality are used in the Person Concept. Both are content-free, placeholder concepts, but we fill in *substantive* content for the real world. Doing so is fundamental to being a person. In contrast, we *cannot* give definitive content for the concept of reality. Providing that content is not one of our behavioral possibilities. Rather than being a substantive concept, reality is a *methodological* concept. Questions like, "What can we get away with by way of behavior?" or "Can we treat something as being so and carry it off?" are reality-based questions.

Recall the Red Queen's (methodological) approach to any and all difficulties: "Off with their heads." She encounters a (substantive) problem when only the head of the Cheshire-Cat appears before her. Can her executioner behead the cat if the cat only has a head? Frustrated, she declares, "Off with everybody's head." Can her executioner carry out that command? The concept of reality provides the necessary anchor for a behavioral world. Even in Wonderland, we cannot "construct just any old world and get away with it" (Ossorio, 1982/1998, p. 73).

Reality-based Empiricism

In the world of 17th century science, there was no need for the concept of a "boundary condition on possible behaviors". In light of the publication of Copernicus's heliocentric model of the universe, the behavior potential that mattered to scientists was detecting causal patterns in the natural world and representing those patterns geometrically and mathematically. Persons were limited to being merely spectators of the natural world.

Feynman (1966) summarizes the traditional scientific world view as follows: "We can imagine that this complicated array of moving things which constitutes 'the world' is something like a great chess game being played by the gods, and we are observers of the game. We do not know what the rules of the game are; all we are allowed to do is to *watch* the playing. Of course, if we watch long enough, we may eventually catch on to a few of the rules…" (p. 24).

Ossorio (1978) characterizes the basic form of scientific empiricism in this world as "pictorial" or "real-world-based". For example, a 17th century scientist might have asked, "Does the picture of combustion offered by phlogiston theory apply to what we actually observe in the real world?" In the idiom of Feynman's chess game model, another question might have been, "Are the circular orbits described by Copernicus a true picture of how the gods move the (planetary) pieces?" Because the goal of science was to achieve a complete understanding of the "rules of the game" of the natural world, the natural world itself functioned as a limit on what scientists could say.

The behavioral world is fundamentally different. *Pace* Feynman, "we can imagine that the multidimensional space of behavioral patterns which constitutes 'the world' is a great bookkeeping system which codifies our behavior potential. We formulate the system, and we reformulate it whenever we discover that our encoding is incomplete or incorrect."

What form of scientific empiricism makes sense in this kind of world? Think about what the bookkeeping system of a business is like. The account sheets in a general business ledger have columns headed "date", "item", "posting reference", "debit", "credit", and "balance". Each of these headings holds a place for facts about business transactions. Taken together, the headings organize the facts into a form useful to a businessman. The system is open-ended in so far as additional columns can be added if placeholders are needed for different kinds of facts. But before adding a new column, an accountant generally asks, "What's the point?" If the new column does not make a difference in some business-related behavior, it will probably not be added.

Ossorio (1971/1975/1978/2005) characterizes this kind of approach as "methodological" or "reality-based", and it is the form of empiricism that makes sense in a behavioral world. With respect to accepting new scientific formulations, he offers the following formula as a guideline: "Has it been demonstrated that *as a matter of fact there is a point in talking that way?*" (p. 36). The expectation is that the answer to the question will be "Yes", and a scientist will move on to elaborate: "*When* is there a point in talking that way, and *what* is the point then?" (p. 98). A scientist may claim that there is a point in talking a certain way and acting accordingly, usually in a given context or for a given purpose, without any associated claim to truth or universality (Ossorio, 1985, p. 36).

This is not to say that the traditional scientific values of accuracy, range of applicability, consistency, etc., do not matter in what we accept. But the primary value of scientific formulations in a behavioral world is that "they can be used effectively *in* some form of human behavior" (Ossorio, 1968/1981, p. 52). There is a point in talking a certain way, even if it is not literally true or universally applicable, if there are forms of behavior that involve talking that way.

The Actor-Observer-Critic Loop, a conceptual resource in the Person Concept, is helpful in seeing the new formula in action. Briefly, Actor, Observer, and Critic are the designations for three jobs that persons master and that are fundamental to their behavior. The job of Actor is to "do one's thing", to create one's behavior out of nothing. The job of Observer is to note how things are going, what is the case, what is happening, etc. The job of Critic is to evaluate if things are going okay, diagnose the problem if they are not going okay, and prescribe what to do differently as needed. The three jobs form a feedback system. As Actor, I initiate a behavior. As Observer, I monitor its course. As Critic, I evaluate and feed the evaluation back to the Actor. My participation in any behavior pattern is a matter of doing all three jobs simultaneously.

When scientists are "doing their thing" as scientists, the reality-based Critic evaluates, "Is there a point in talking that way?" As long as there *is* a point the Critic prescribes, "Keep going." If there is *not* a point, the Critic may recommend that the Actor do something else.

There is an interesting parallel in physics to the distinction between real-world-based and reality-based empiricism. Some physicists in effect take a reality-based approach to quantum mechanics: "Is there a point in talking about photons, hadrons, quarks, etc.?" The range of new behaviors (e.g. the use of lasers) that involve these concepts demonstrates that there is a point in talking that way. Other physicists recognize the behavioral value of the concepts, but nonetheless adhere to a traditional, real-world-based approach to empiricism. Einstein, for example, treated quantum mechanics as logically consistent and useful, but believed that it was "not yet complete" because it "seems not to present us with any fully *objective* picture of physical reality" (Pais, 2005, p. *x*).

The Real World + x

What happens when there are things that we can do in reality, but those things do not fit in the real world?

In the 16th century, mathematicians were faced with the problem of solving quadratic equations such as $x^2 + 1 = 0$. The problem wasn't solvable if mathematicians restricted themselves to real numbers, because the squares of both positive and negative real numbers are positive. An Italian mathematician, Rafael Bombelli, offered a solution by proposing that mathematicians proceed *as if* there were a number whose square is -1, and he showed how to do addition, subtraction, multiplication, and division with such numbers. Mathematicians found his solution useful and began to work with the new numbers.

In the 17th century, Descartes formulated his system in which integers, rational numbers, and real numbers could be represented geometrically. Unfortunately, he did not see a way to represent Bombelli's numbers geometrically. Because there was no place for them in his geometry, he degraded them as "imaginary" and recommended against their use.

There was a net gain in behavior potential for mathematicians from Descartes' masterful creation of analytic geometry. Nonetheless, mathematicians of the day were not willing to suffer the loss of the behavior potential that went with throwing out Bombelli's numbers. Rather than accept an unnecessary restriction, they created a mathematical world + *x*, i.e., an elegant geometrical scheme of things plus the non-fitting reality of imaginary numbers. They acted on the idea that there is a point in having imaginary numbers, even though they're not "real numbers", if there are equations that they could solve using the numbers.

Bombelli's numbers had the status of "imaginary" until the end of the 18th century when Caspar Wessel, a Norwegian mathematician and surveyor, demonstrated their geometrical significance. Today they are granted full status as part of the system of complex numbers and are considered "absolutely fundamental to the structure of quantum mechanics" (Penrose, 1989, p. 236).

There is an interesting parallel to imaginary numbers in the development of children. A young child initially has a diversified reality rather than a single, coherent real world. In other words, a child has lots of scene/situations that are real to him or her, i.e., lots of things that he or she is prepared to act on. Part of the job of parents is to put pressure on the child's reality constructions to conform to the requirements for a single, public real world.

The child's reality may be more extensive or diverse than can fit into a single totality, however. Children acquire the ingredients for a real world in a piecemeal way, and sometimes when they go to put these ingredients together into the structure of a real world, there are pieces left over. When parents begin to impose the logical restrictions called for by the real world, children may simply throw out the non-fitting parts so that the reality constructions that are left hang together with the kind of consistency that the real world (and the parents) require.

Under some conditions, parents are not completely successful at holding children to real world requirements for coherence and logical consistency. Children, instead of throwing out those ingredients that are real for them but do not fit in the parental world, recreate some of the non-fitting parts in the form of imaginary companions. In other words, young children create a real world $+ x$, where x is their imaginary companion. For a child there is a point in having an imaginary companion, even though it's not literally real, if there are meaningful things the child can do that involve the companion (cf. Roberts (1988, 1991, 2006)).

Imaginary numbers and imaginary companions are analogous to reality-based empiricism. Notice:

- There is a point in having imaginary numbers, even though they're not "real numbers", if there are equations that mathematicians can solve using the numbers.
- There is a point in having an imaginary companion, even though it's not literally real, if there are meaningful things the child can do that involve the companion.
- There is a point in talking a certain way, even if it is not literally true or universally applicable, if there are forms of behavior that involve talking that way.

The *x* for mathematicians in the 17th century was the non-fitting reality of imaginary numbers. The *x* for young children is the non-fitting reality of an imaginary companion. The *x* for scientists is the new way of talking that does not yet fit in the existing structure of the real world.

A real world + *x* is a fundamentally different bookkeeping system from the one that the majority of us use in our behavior. Paradigmatically, everything fits together and everything is connected to everything else in our codifications of the real world. But in a real world + *x*, there is an irregularity, an inconsistency in the bookkeeping. That would be an anathema to most traditional scientists.

For example, Kepler observed a discrepancy of eight minutes of arc between the predicted and the observed position of Mars in its orbit. (One minute of arc is equal to one sixtieth of one degree.) He considered 2′ an acceptable observational error, so he could not dismiss the larger error, even though it seems negligible. A deeply spiritual scientist, he knew that God's totality did not have irregularities, and the discrepancy helped him to see that planetary orbits are elliptical, not circular. He later wrote, "Because these 8′ could not be ignored, they alone have led to a total reformation of astronomy."

Luminiferous Ether

What is real is what it makes sense to act on, and it contrasts with what is "imaginary", "illusory", "hallucinatory", etc., i.e., what it does *not* make sense to act on. Persons operating in a real world + *x* recognize *ex ante facto* that they are acting on objects that are not real in the ordinary way. They therefore only behave in ways that are appropriate for objects in a special status, i.e., "real but not like other real objects" (e.g., real but not like other 'real numbers'). In contrast, theories that have a respectable, accepted place in the scientific world sometimes turn out to be about "imaginary" objects and processes. *Ex post facto*, scientists discover that they have been treating something imaginary *as if* it were real, as illustrated in the following brief historical account of the theory of special relativity.

In the late 19th century it was a given that light waves required a medium in which to travel. This medium was known as luminiferous ether, and scientists believed that it was the absolute frame of reference for motion, i.e., the one frame of reference that was truly at rest and hence could be used to find the real velocity of the earth. In 1887 Michelson and Morley designed their ingenious experiment to measure the velocity of the earth relative to the immobile ether once and for all. The velocity that they measured was essentially zero.

Scientists were dumbfounded by this outcome, and a number of physicists began work on explaining what had gone wrong. They of course knew Galileo's principle of relativity: There is no local way to distinguish uniform motion from rest. It explains why we do not detect the motion of the earth around the sun. The Galilean transformation was also a given: A simple equation ($x' = x - vt$) can be used to convert between the viewpoint of an observer at rest and the viewpoint of an observer in motion. But that transformation can only be used for velocities much less than the speed of light, so it was not applicable in the context of the Michelson and Morley experiment.

In 1892/1895 Hendrik Lorentz, a Dutch mathematician and physicist, created a new theorem to explain the relationship between the viewpoint of an observer at rest *in the ether* and the viewpoint of an observer in motion *relative to the ether* at a velocity close to the speed of light. An important part of his theorem was the equation for "local time" ($t' = t - xv/c^2$). Using this time transformation he was able to invent a set of equations analogous to the Galilean equation that could convert between observers' frameworks when one observer is moving close to the speed of light.

In 1905 Henri Poincaré, a French mathematician and physicist, modified and finalized the equations of Lorentz, named them the "Lorentz transformation", and recognized the significance of what Lorentz had accomplished. Lorentz had successfully explained the "failure" of the Michelson and Morley experiment by demonstrating the "principle of relative motion", i.e., that it is impossible to detect uniform motion relative to the immobile ether.

Later in that same year, Einstein published his theory of special relativity. In contrast to Lorentz and Poincaré, Einstein threw out the concepts of ether and an absolute frame of reference, and showed that all inertial frames of reference are equivalent for measuring motion, space, and time. His formulation was elegant and was quickly accepted.

From the behavioral perspective, the explanations where ether could be used are what gave it a place in the real world for almost 100 years. The Michelson and Morley experiment sounded the knell for luminiferous ether because it demonstrated that there was a point in *not* talking that way. The final degradation of ether came in 1905 when Einstein offered a viable alternative. Once luminiferous ether was no longer needed for explaining phenomena, it was degraded as useless. As with any degradation ceremony, the significance of the ceremony is that "What ether is now is what, 'after all', it was all along." It was an imaginary substance, a phantasm.

What was the point?

When scientific theories turn out to be about imaginary processes and objects, it puts traditional scientists in an awkward, if not impossible, position. From an *ex post facto* perspective, the value of the work to which they have devoted their lives is called into question. In the face of this kind of threatened degradation, theorists may affirm the legitimacy of their theories. Joseph Priestley maintained until he died that he had released dephlogistated air, and Hendrik Lorentz never fully accepted the degradation of ether.

Did it not make sense for scientists to act on these concepts? The question will serve as a vehicle to deepen our understanding of the indeterminate behavioral world. First, consider the question from the traditional pictorial perspective. In that world, scientists are merely spectators, trying to figure out "the rules of the game being played by the gods". Language from this perspective is primarily a set of labels that we put on logically pre-existing objects, objects that exist in the world independently of words and to which words refer. Thus, “luminiferous ether” refers to a logically pre-existing ‘referent’ labeled “luminiferous ether”, and scientists studying it try to understand what part it plays in the natural world.

What is the significance when scientists find out that there is *no such entity*? For example, what if I spend my life researching quonks in chess, and then I find out that “quonks” doesn’t refer to anything in the game? There is not now, and never has been, anything labeled “quonk” in a game of chess. My life work amounts to a substantive zero. Friends might try to comfort me by reminding me that, “That’s just how science works. One hundred years of phlogiston prepared the way for Lavoisier’s new paradigm; 100 years of luminiferous ether prepared the way for Einstein’s breakthrough; and almost 2000 years of circular orbits prepared the way for Kepler’s ellipse.” Being reminded of that larger context offers little comfort if *my* work on “quonks” did not really make sense.

How does it look from a reality-based perspective? In the world of methodological empiricism, scientists are primarily Actors, “doing their thing”, reformulating parts or aspects of the world in ways that reveal new behavior potential. They use the question, “Is there a point in talking that way?” as a guideline in evaluating their work.

The approach to language in this world is non-referential. Language is a set of social practices in which people make certain distinctions because they have forms of behavior that call for those distinctions. For example, “pawn” is not primarily a label for an object out there. Instead, “pawn” is a distinction that is made by chess players because it is called for in the game of chess. “Luminiferous ether” is a distinction invented by scientists because it was called for in their behavior. (“Space-time curvature”, “oxygen”, and “neutron” are also distinctions invented by scientists.)

What is the significance when scientists find out that they cannot bring off certain behaviors that involve the invented concept? They have demonstrated that there is a point in *not* talking that way in that context, under those conditions, for that purpose, etc. (There is no claim to universality with reality-based empiricism.) It does not invalidate all of the other ways of using the concept that have been demonstrated to be effective. Thus, the degradation of luminiferous ether did not invalidate the Lorentz transformation or the Lorentz equation for time, mathematical formulas that are still in use today. Because there was a point in talking about luminiferous ether in those contexts, Lorentz' work using the concept did not amount to a *methodological* zero.

After Einstein published his theory of special relativity, Lorentz spoke about ether in this way: "According to Einstein, it has no meaning to speak of motion relative to the ether… As far as this lecturer is concerned, he finds a certain satisfaction in the older interpretations, according to which the ether possesses at least some substantiality…" (Pais, 2005, p. 166). Lorentz affirmed that interpreting things using the concept gave him satisfaction, i.e., the *behaviors* continued to have value for him.

But isn't Luminiferous Ether a losing game just like Phlogiston? (There obviously is *no* element in the physical world that can fill the essential status.) Didn't it create an unnecessary restriction on the behavior potential of scientists? (Some historians believe that if only Lorentz and Poincaré could have let go of luminiferous ether, they would have created the theory of special relativity first.) Isn't it obvious that if Luminiferous Ether had not been invented, it need never have existed?

Those things are obvious now, *after* the Michelson and Morley experiment and *after* Einstein's invention of the theory of special relativity. But that does *not* mean that the behaviors that scientists engaged in for 100 years did not make sense. Instead, those facts illustrate the way in which the real world is an *ex post facto* world.

Ex post facto laws are laws that apply retroactively, i.e., they extend back in time to a date prior to their enactment. For example, if City Hall passes a law that makes it illegal to drive over 55 miles per hour and sets the effective date to be 10 years earlier than the date of the passage of the law, then anyone who has driven over 55 mph in the past 10 years is now a criminal, even though at the actual time of the deed, the person did not commit a crime.

Einstein's degradation of luminiferous ether is like the passage of an *ex post facto* law. Before the publication of his special relativity theory, scientists who used the concept of luminiferous ether were at a minimum participating in the accepted social practices of the scientific community, and their behavior made sense. After he demonstrated that the concept was unnecessary, it became the case retroactively that scientists had been playing a losing game all along, and that they had been operating with an unnecessary restriction on behavior potential.

That kind of phenomenon is commonplace in a behavioral world, in which we create new forms of behavior. Because the behavioral world is a totality, when we accept a new form of behavior that changes the interconnections among other behaviors, that also changes *what* things are in the real world. What a particular behavior is (its place, its significance) depends on the whole of which it is a part. The new forms of behavior that are accepted into the totality may generate a net increase in behavior potential for the community, but sometimes at the cost of a loss of significance and status for older forms of behavior. (This is a well-known phenomenon in times of rapid social change. Social innovation calls into question the legitimacy of the lives of elderly persons who have followed the old ways.)

Even if we grant that it is unfair to judge the behavior of scientists by *ex post facto* laws, there is still something disquieting about the fact that scientists acted on imaginary concepts for such long periods of time. Why did it take 100 years to recognize that there is nothing in the natural world that can be cast for phlogiston? Why did it take roughly 2000 years for us to realize that planetary orbits are not circular?

In a behavioral world, everything that is needed for the successful enactment of a behavior pattern has a status in the world built into the pattern, and each status carries with it standards by which an individual embodying the status is properly to be judged.

When we engage in actual behavior, we assign particular, historical individuals to occupy each of the statuses called for by the pattern, and evaluate and treat them accordingly. For example, if we are playing baseball, there are statuses for the bat, the ball, the bases, the pitcher, the catcher, the first baseman, etc., and we cast particular individuals (persons and non-persons) for each of these parts. We judge how well the pitcher plays his or her part in the game by things like number of strikeouts, hits allowed, walks allowed, wild pitches, etc., and vary our strategy as hitters accordingly.

In general, if we cast effectively, i.e., if we assign historical individuals to statuses that are a good fit for them, it will be easy to bring off the behavior pattern successfully. If we cast poorly and assign individuals to parts they cannot play, there may be no point in trying to bring off the behavior. Between these limits, there is an awkward range in which the match between a given individual and a status is not good enough for an enactment of a behavior pattern to be non-problematic, but not bad enough for us to quit trying to enact the pattern. In these situations, we try to compensate for the inadequacies of particular individuals, adjust our standards, make allowances, ignore mistakes, evoke relevant strengths, etc., for the sake of preserving behavior potential. We generally do not ask, "Is there something wrong with the pattern?" After all, the pattern is encoded in our bookkeeping system as a possibility for our behavior, as something that it makes sense for us to do.

In the 2nd century, when Ptolemy created his system for calculating planetary position, he took it as a given that planetary orbits were circular, in accordance with the Aristotelian tradition of the perfection of circular motion. He was aware that *actual* planetary orbits had "eccentricities", i.e., they were not a perfect match for the status of "circular". He therefore introduced epicycles, small loop-back circles, to compensate for the observed irregularities. Over the centuries, astronomers repeatedly detected additional inconsistencies between the orbits they observed and perfect circularity. Whenever they did, they simply updated the system to allow for them, and the system became increasingly ad hoc, jury-rigged, and complex. (A

Castilian king, studying the Ptolemaic system in the 13th century, groused: “If the Lord Almighty had consulted me before embarking upon the Creation, I should have recommended something simpler.”)

When Copernicus formulated his heliocentric picture in the 16th century, he was very familiar with all of the adjustments needed to help eccentric planetary orbits succeed at being circles. Even after his switch to a heliocentric model, there were still orbital irregularities. Nonetheless, he did not question the basic pattern, “predicting the position of a planet in its (circular) orbit”. Instead, he introduced a new computational procedure, possibly borrowed from Muslim astronomers, to help with the calculations. His system was no easier to use than Ptolemy’s, and astronomers stuck with the old but familiar, difficult and complex system.

Inspired by Copernicus’ *De Revolutionibus*, Johannes Kepler finally questioned the pattern, threw out epicycles as absurd, and showed that planetary orbits were elliptical, not circular. He formulated laws for “predicting the position of a planet in its (elliptical) orbit” and published them in *Astronomia Nova* in 1609. The match between the status of “elliptical” and the actual planetary orbits was perfect, and astronomers were free from “the millstones (as it were) of circularity” (Kepler, 1609/2004, p. 27). His work was ignored by his contemporaries Descartes and Galileo, but gained acceptance into the bookkeeping system of the real world after it was accredited by Isaac Newton.

The longevity of imaginary concepts in science reflects the inertia of behavioral patterns in our bookkeeping system. Both are illustrative of the significance of our formulation of the real world for our behavior. As Ossorio (1990) puts it, “It’s not just idle talk or pretty metaphor to say that the world, the real world, is a way of codifying our behavior potential.” (p. 33) We act on that codification and pay a price for its limitations.

Conclusion

Copernicus, Descartes, Kepler, and Newton were revolutionary system builders who changed how we see and treat the world. Their remarkable appreciation of issues of totality and logical structure is reflected in the systems that they created in the 17^{th} century. They set the standard for the elegant formulation of worlds as closed, determinate systems.

Ossorio, also a revolutionary system creator, recognized that the 17^{th} century standard was *not* appropriate for a world that includes persons. Not accepting the unnecessary restriction on behavior potential that it entailed, he formulated the real world as a behavioral world, i.e., as a bookkeeping system for codifying our behavior potential.

Unfortunately, the concept of a behavioral world is sometimes hard to accept, in part because we do not easily let go of 400 years of intellectual and scientific tradition. Einstein encountered the same problem when he was faced with the implications of quantum mechanics. In 1931 he expressed his reluctance in these words: "Newton, forgive me… The concepts which you created are guiding our thinking in physics even today, although we now know that they will have to be replaced by others farther removed from the sphere of immediate experience, if we aim at a profounder understanding of relationships." (quoted in Pais, 2005, pp. 14-15)

If we can let go of the concept of the real world as something "out there", categorically independent of us and our behavior, then Ossorio offers a viable replacement, one that enables us to achieve a profounder understanding of the relationships between persons, behavior potential, and the real world.

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