RRREaT-PT

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Theorizing about Situations across Time: The Dynamics of the Actual World

This article presents a discussion regarding the ways in which scientific research is dealing with the uncertainties that are being encountered when studying the actual world. The actual world is a complex and dynamical system. This article is a theoretical article to think through the kind of data that can be collected when studying the actual world. Specifically, the research repository RRREaT-PT will present studies that include complex concepts, such as situations, experiences, and time, which are complex in terms of the variation and the dynamical patterns that can arise in the data. Interpreting such data is closely related to how the actual world has been observed during data collection. In this article, I will discuss the present major scientific theories regarding complex and dynamical systems by including human perceptual observation and scientific concepts, such as randomness, chaos, nonlinearity, irreversible processes, and noise in an attempt to obtain a better understanding of the limitations regarding the detecting of patterns in the actual world. The aim of this article is to reconsider what the actual world consists of in order to find useful views on dealing with the varied and dynamical patterns in scientific data.

A Pattern of Molehills in a Grazing Land: Does it Show Order, Chaos, or Something Else, and What About Its Predictability?

In the area where I live, the green grazing lands of the farmers are alternated with small stripes of woodland and traversed by small roads with large oak trees on both sides and ditches that, in the summer, are overgrown with wild plants and flowers. It is a sparsely populated region with a few cottages and very few livestock farms (i.e., mainly harboring cows). The land itself is rather flat, which enables someone to overlook the scenery for a few miles. During a drive through the area, I noticed a grazing land that was filled with an abundance of molehills, in what seemed to me as a random pattern (i.e., lacking a specific rule, plan, or purpose). Generally, there are not many molehills in this region because the farmers know that the soil of the molehills can contaminate silage with harmful bacteria, the small stones in the soil can damage agricultural machinery, and the soil can produce a weed invasion of the grazing lands. In this region, the grazing lands resemble green carpets, and the approximately seventy-five or more molehills that I witnessed in just about an acre of grassland seemed out of place. I, however, was not so much struck by seeing such a large number of molehills as I was about the random pattern of the black dots in the green grass (see Figure 1). But was it a random pattern that I was seeing?

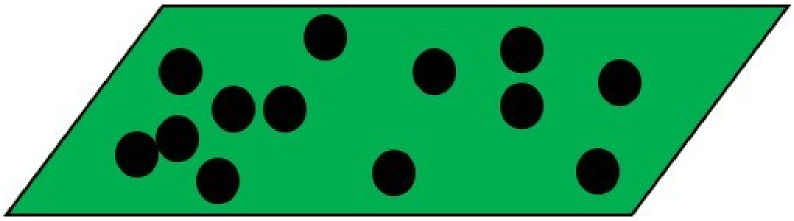

Figure 1. A schematic representation of the random pattern of molehills in the green grassland.

Human interpretation of visual patterns is based on visual-sensory input that someone has become aware of and this process is guided by the brain, knowledge, and perspective taking (Lund, 2001; Radvansky & Zacks, 2011; Revelle et al., 2011). The brain can attach meaning to visual-sensory input, in that it can group visual shapes (e.g., dots, lines, and angles) based on someone's visual experiences (Wagemans et al., 2012). The word of attach seems appropriate in this context because the brain can also come up with "meaningful" interpretations where none exist, such as seeing the shape of animals in certain clouds in the sky. Knowledge can also provide for meaning regarding aware visual-sensory input in terms of, for example, constructing words from letters and meaningful sentences from words. Other examples are, predicting the next-hour weather conditions based on looking out of the window and, regarding our molehills, understanding that these are produced by moles that dig underground tunnels to get from one place to the next. Consequently, if the molehills appear to be connected in term of showing a pattern, then this can reflect the route that the mole(s) have taken underground. However, because our knowledge can have flaws (i.e., things none of us know and things we have not learned yet) and include misconceptions (i.e., incorrect knowledge), untrue meanings may arise. For instance, not the molehills, but a visual check of the underground tunnels made by the moles, for instance by using a ground-penetrating radar, can show with more certainty the pattern underlying the molehills. Finally, perspective taking also can influence the meaning that someone attaches to aware visual-sensory input. Take for example the ancient Greek philosopher Heraclites. According to Heraclites, someone can and at the same time cannot step into the same river twice depending on the perspective that the person takes (Russell, 2006). That is, on the one hand, someone can step into the same river, such as stepping twice into the Nile, the Mississippi, and the Rhine. On the other hand, the second time that someone steps into a river, the water are replenished by fresh water that creates a different river. Overall, the brain, knowledge, and perspective taking enable the interpretation of patterns, though it might include untrue meanings.

Then, there are also circumstances in which the brain, knowledge, and perspective taking appear unable to attach a meaning to what is being seen, in that the observed patterns become non-interpretable. For example, I could not detect in the grassland with molehills a clear route that could reflect the underground tunnel of a mole or several moles by looking at the molehills. But, if I had known the route of the underground tunnel better by using a ground-penetrating device, could this then still mean that the tunnel made by the mole(s) was random in the sense of the way a mole choses to go and dig its underground route? Is the tunnel made by the moles random from the point of view of the moles? Likely, moles dig underground tunnels in search of food (i.e., earthworms), but they might have other reasons as well. Therefore, from my point of view the molehills pattern appeared to be random, from the view obtained via a ground-penetrating device the molehills pattern might appear to be partly random, but is it random from the moles' point of view? When we cannot know precisely the point of view of the mole in terms of us recreating a molehills pattern, is it then random or is it merely non-interpretable to us? When patterns appear non-interpretable, they often are chaotic or in a state of utter confusion or lack of order.

Chaos, Complexity, and Dynamics: The Continuing Actual World

Chaos theory originally comes forth from physicists and mathematicians who raised questions about scientific causality and predictability, and once chaos theory was established, it found its way into other scientific disciplines (i.e., the social and natural sciences, and humanities), but it is still unclear how it should be defined appropriately due to questions regarding its existence in the actual world (Bishop 2017; Oestreicher, 2007; Rickles et al., 2007; Robertson & Comb, 2014; Strauss, 2015; Strogatz, 2018; Zuchowski, 2017). As aforementioned, the meaning of chaos according to the Webster dictionary is a state of utter confusion, but physicist and mathematicians describe chaos in terms of involving complexity and dynamics to enhance the study of chaos. Overall, chaos can be considered from three perspectives. First, there might be the experience of a state of chaos in terms of human ignorance or the failing to see patterns. In this case, the human brain appears to be insufficient, even with the help of devices such as computers, to understand the complexity and dynamics of the actual world. Complexity refers to having very many parts, functions, and relationships, and dynamics refer to evolving over time; together, they define chaos theory as the study of nonlinear dynamics. Most actual-world behavior, events, and trajectories appear to occur chaotic, in that the underlying products and processes cannot be acknowledged, recognized, overseen, and understood due to their complexity and dynamics. A contributing factor can be that it can take some time before humans recognize that certain behavior, events, and trajectories are taking place, by which time a clear starting point often has become obscured, which can further disguise the (scientific) observation of patterns and underlying reasons. Therefore, humans can experience chaos, though there actually may or may not be a structuring or organizing that explains the functioning at work.

Second, there might be the experience of a state of chaos as a result of applying mathematics to actual-world behavior, events, and trajectories. Chaos theory as a mathematical theory started off with Lorenz (1963), a geophysicist studying weather conditions, who intended to understand better why idealizations (i.e., the solutions of his equations) of convection roles in the atmosphere did not repeat their past history exactly, but approximately (i.e., closely following the previous line). Later, it was found that actual-world behavior commonly reveals non-linear behavior, and that it is also very difficult to mathematically calculate and understand this non-linear behavior. This can raise the question of whether the difficulty of understanding the results of complex and dynamic actual-world behavior, events, and trajectories are a consequence of the mathematics applied, the actual-world model states, the constant changing of the actual world, or the observations usually being incomplete and inaccurate. For example, if the same mathematics is applied to perform certain (i.e., often differential) calculations and equations, is it then surprising that we find the same patterns over and over, in that it can be a consequence of doing the same kind of calculations again and again. Accordingly, we can question how numbers can be used to reflect (a part of) the actual-world nature and how mathematical calculations and equations can be used to reflect its workings. Therefore, science has shown that mathematics can be useful for gaining information about non-dynamic behavior, such as velocity, amounts, and proportions, but discordance can also be found especially regarding dynamical and complex behavior, which may or may not be the result of the mathematical system being in development (Penrose, 2004).

Third, there might be the experience of a state of chaos in terms of the necessity of having both order and chaos in the actual world to develop a more appropriate organization or synthesis (Polkinghorne, 1989; Prigogine, 1984). Specifically, Polkinghorne assumes that order and disorder can both emerge in the actual world as the interplay between regularity and chance, respectively, and Prigogine assumes that the actual world consists of open systems and sub-systems that are continually fluctuating by organizing and de-organizing itself simultaneously. Both, Polkinghorne and Prigogine, are influenced by Darwin’s evolution theory, in that they view chaos as an opportunity (i.e., the emerging of new possibilities) rather than a disaster (i.e., the destroying of something essential). They are also both in agreement about humans having limited knowledge of the actual world, but they disagree about how to remedy this lack of knowledge. Polkinghorne (1996) argues that because scientific experiments study only parts of the actual world, in that physical causation cannot adequately describe and explain the manifold of what is happening in the actual world, it should be replenished with philosophical analyses in terms of using two contrasting kinds of intellectual discovery. Prigogine and the Brussels-Austin Group’s scientific contribution (Kondepudi et al., 2017) consists of (a) reformulating thermodynamics from a theory of states into a theory of processes (i.e., relating the change of energy and entropy to irreversible processes), which led to (b) the realization that irreversible processes or chaos can produce self-organization or dissipative structures (i.e., the complex structures created by irreversible processes), which accordingly led to (c) the formulation of a theory of non-unitary transformations (i.e., irreversibility is a fundamental part of physics), in that the physical formulation of mechanics is limited because it lacks an extension that makes probability and irreversibility a fundamental outcome of mechanics. Therefore, in this third theory, order and near-chaos interact to create the only appropriate way to obtain a functional actual world, with the consequence that this actual world cannot be completely predictable.

This short summary of the three overall perspectives on chaos suggest that humans might experience a state of chaos in terms of their focusing on target systems and details rather than the actual-world nature. Scientists are trying to understand the actual world by observing objects (i.e., existing things, such as persons, trees, and tables), phenomena (i.e., observable facts, such as gravity, a disease, and learning), and processes (i.e., a series of actions leading to a result) to establish rules and causal explanations. Then again, for both humans and scientists, gaining information about the actual world can be difficult because there can be so many indistinguishable sub-states (i.e., objects, phenomena, and processes) in an actual-world state (i.e., a specific observation or data-collection moment), and the sub-states can change in non-linear fashions when the continuous nature of time (i.e., its progression rather than the intensity of experiences or window frames) is taken into account. This can raise the question of how to distinguish the many (sub-) states of the actual world, assuming that the observed (sub-) states exist and are in agreement with the actual world, and being able to do so independently of the limitations that can arise from using “human-thinking systems” (i.e., the brain’s basic numerical, verbal, and logical faculties, and the scientific devices, such as mathematics, observation apparatuses, and computers). Therefore, if we could forget, for argument’s sake, about the in principle arbitrary (i.e., because we cannot prove it) doctrines regarding the actual-world existence that range from determinism, via different kinds of realism, to subjectivism, and forget about having to solve the actual-world status via mathematics, to focus instead on what is actually going on in the actual world while acknowledging the limitations of human observation and interpretation, then this might help to discover other avenues to observe the actual world.

As aforementioned, the starting point in chaos theory is that there is an actual-world state with a certain position and duration in the, so to speak, continuing actual world as it takes place in time. The actual-world state can be imagined as including sub-states (i.e., objects, phenomena, and processes), each of which can have a certain motion (i.e., a change of place) and format (i.e., a change in appearance). In this view, an actual-world state agrees with a specific situation within the continuing actual world. A first realization here is that it is impossible to include all of the continuing actual world in human observations, in that it will always be *an* actual-world state or a specific situation because the human brain needs to process the perceptual input regarding the perceiving of the world, and scientific observations uses (mechanical) devices to capture the world: hence, observations always contain a part of what is actually going on while place and time continue. This means that an observation can be visualized as a cube resting at some point in the continuing actual world. A cube, because this agrees with the three-dimensional form in which we humans picture or experience actual-world objects, and these objects can be related to certain phenomena and processes. For example, we perceive a student as a three-dimensional object that can exhibit metacognitive knowledge, which is a phenomenon that requires reflective activity, which is a process in which experiences are analyzed and critically evaluated. If we picture a specific actual-world state as a cube, then this cube must be permeable because the continuing actual world surrounding the cube, although not included in what is being observed, might be already in the process of influencing the objects, phenomena, and processes in the cube. This issue is related to the so-called window frame of observations (Buehner, 2005), in terms of there being present already certain influences that are not observed yet (i.e., both in the cube and coming from the surrounding of the cube), but that can become observable in the near future although we have missed to observe the starting point of these influences.

A second realization is that each object, phenomenon, and process in a specific actual-world state can make up that world state, in that all the objects, phenomena, and processes that are present in that world state play a role merely due to these objects, phenomena, and processes being present: (a) being there (e.g., other objects, phenomena, and processes can “notice” their presence); (b) being existent in a specific “format” (e.g., some other objects, phenomena, and processes have to reckon with them); (c) being related (e.g., being connected in a specific way to certain other objects, phenomena, and processes); and (d) being reactive (e.g., giving catalytic and postponing reactions to certain other objects, phenomena, and processes). Hence, all the objects, phenomena, and processes in a specific actual-world state, independent of them being observed, are essential because together they make up the behavior, event, and trajectories in this world state. For example, all the present objects, phenomenon, and processes in an actual-world state can be influential by causing an increase versus a decrease of themselves and others, participating in a passive versus an active mode, and eliciting changes versus promoting and hindering adaptation. Therefore, a cube as a representation of a specific observation or actual-world state is filled with observed and unobserved objects, phenomena, and processes, which means that from a scientific point of view, it can contain observed, unobserved, and emerging variables.

A third realization is that you will need more than one observation or actual-world state to account for the continuing actual world because this continuing actual world is taking place in the so-called fourth dimension of time. However, it seems impossible to have observations (i.e., cubes, in the plural) that will completely agree with the elapsing of time in the continuing actual world. First, as aforementioned, observations via the senses and the brain require processing, which means that not everything that has happened enters someone's (sub-) consciousness. Second, observations via devices that can record the fourth dimension (e.g., film, audio tape, and computer) and those that will produce gaps (e.g., photo, microscope, and pen and paper), might still miss certain information due to being a device for specific purposes, and their products require human interpretation. Finally, observations as separate data-collection moments can vary in, for instance, minutes, hours, days, and weeks. Therefore, at a certain moment in time we observe and interpret a specific actual-world state as it is at that moment, and in between the next observation, this actual-world state can have changed because the continuing actual world is changing as a consequence of time. This can raise the question of what exactly has changed (see Figure 2).

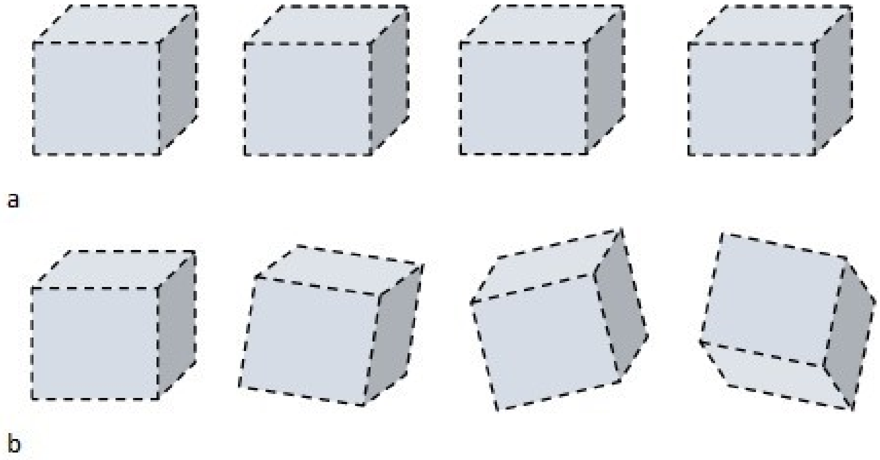

Figure 2. A representation of multiple observations in the continuing actual world as it accounts for time, in that it contains objects, phenomena, and processes as the sub-states in four actual-world states from the perspective of (a) the observer watching from an outside external and (b) the observer watching from an inside internal.

When the continuing actual world that surrounds several observations (i.e., the cubes in Figure 2) changes as a result of the elapsing of time, then this can be expected to change the objects, phenomena, and processes that are present in each observation (Figure 2a), but it can also reflect a change of the static character of the observations, as represented in Figure 2b. That is, every observation is relative because it is taken from the perspective of the observer (Einstein, 1916). For example, where the researcher observes a continuation of certain objects, phenomena, and processes as they appear from the research data from an outside-external perspective, the participant in the data-collection moments may notice changes in the objects, phenomena, and processes that the researcher may not because the participant observes from an inside-internal perspective. Similarly, two persons observing the same situation may nevertheless experience it differently because their observation perspectives differ. For instance, the first person may observe the situation via a film (i.e., data) and thereby is neither present (i.e., outside) nor participating (i.e., external or not relying on direct personal sensory information), whereas the second person is present (i.e., inside) and participating (i.e., internal). Where the researcher might observe approximately similar behavior (i.e., accounting for variance) in a participant, the participant might observe having different emotions, intentions, and consequently behavior due to a change in situational circumstances. Hence, the elapsing of time produces that (a) we cannot observe everything because we observe specific observation moments (i.e., the actual-world states represented as cubes), (b) we observe objects, phenomena, and processes in specific observation moments as they are being influenced by their surrounding environment (i.e., represented as permeable cubes), and (c) due to the relativity of the observer, we may not notice changes in the static character of the observation moments (i.e., represented as rotating cubes).

The fact that observations are influenced by the continuing actual world that surrounds them and the relativity of the observer raises the question of how to disentangle this knot of possible influences upon an observation. Where it concerns theories on chaos, multiple observations (i.e., several data-collection moments, motion, and trajectories of objects or the changing of phenomena and processes; measured as behavior, events, and trajectories) can involve linear and nonlinear values, reversible and irreversible processes (Bishop 2017; Oestreicher, 2007; Strogatz, 2018; Zuchowski, 2017), and noise. The fact that science has come up with these dichotomies might already suggest that all exist in the continuing actual world or, at the least, in the world as we can experience it, which justifies a short review. Because the issues of nonlinearity, irreversibility, and influential conditions have been studied preeminently in physics, most of the examples presented in what will follow confine to physics to avoid unnecessarily complex descriptions.

Obtaining linear data from multiple observations means having values that fall in straight and curvilinear lines by having relatively constant slopes, such as exponential growth, decay, equilibrium, circuits, and harmonic oscillators or waves, all of which can be solved mathematically. Obtaining nonlinear data means having values that show complex and unpredictably curved lines, such as irregular circuits and inharmonic oscillators (e.g., turbulence and heart fibrillation). Mathematically, nonlinear data can be solved, if at all, (a) by referring as much as possible to linearity, but this almost always involves a loss of data and (b) via geometry rather than analytically by using phase spaces (Strogatz, 2018). Practically, most actual-world events, trajectories, and behavior are nonlinearly or typically complicated in both space and time. For example, if you place a heavy weight on a wooden beam, so that you know that the beam will buckle, you may not know which way the beam will buckle because this can depend on influential conditions (e.g., the construction of the beam and environment factors, such as the strength of the wind and the decrease of gravity with the increase of height). Nonlinearity often follows linearity and is then called chaos (e.g., turbulence when the flow of water increases, convection of air when certain weather conditions worsen, and light waves turning into laser beams by increasing external energy). As these examples show, nonlinearity is almost always susceptible to changes in influential conditions (e.g., receiving energy). Then again, nonlinearity in the actual world of Earth is possible because we have a constant supply of energy from the sun.

Physical processes are said to be reversible (i.e., restoring the process to approximately the same initial states) and irreversible (i.e., the process cannot be restored to the initial state), where most natural-world processes are irreversible. Reversible physical processes are found primarily in laboratory experiments where the change in energy and entropy (i.e., a measure of chaos) approximates zero (i.e., equilibrium). For example, when a gas expands against the external pressure of a piston, then the expansion can be reversed by reversing the motion of the piston. An example of an irreversible physical process is that when a gas is free to expand in its surroundings (i.e., not in a laboratory setting), then it will permanently change the surroundings, and it can no longer return to its previous state. Although it is important to study the nature of reversible physical processes to understand the thermodynamics of physical processes, the actual world mostly shows irreversible physical processes.

Observations in the actual world can also contain noise. The definition of noise in the research literature ranges from having (a) undesirable variability regarding the same process (Kahneman), (b) a lack of predictability (e.g., using past states and neural networks to examine predictability regarding present states, Elsner & Tsonis, 1992; using the Lyapunov exponent to calculate the average rate at which perturbation effects grow: Ellner & Turchin, 1995), and (c) measurement contamination. However, the observations used to study noise always involve a selection in advance of time scale (i.e., length of observation moments and delay in between the observations) and number of observation points (i.e., expected event, trajectory, and behavior, often perceived as models) rather than using estimates based on the observational information (Cencini et al., 2000; Theiler, 1991). Similarly, noise in human observation also arises as a consequence of the selection of a time scale (i.e., time appears to go slower when the observation is intensive, but mostly humans observe their actual world globally rather than perceiving details: Zadra & Clore, 2011), the number of observation points (i.e., humans tend to observe selectively based on their frame of reference: Bendor, 2001), and measurement contamination (i.e., the human mind requires perceptual processing and it interprets what is being observed via knowledge and perspective taking).

This short review of chaos related concepts implies that the relativity of the (scientific) observer especially relates to the time scale applied (i.e., the amount and length of observation points), the kinds of measurements employed (i.e., the devices and the experimental setups), and the nature of the human mind (i.e., the processing and interpreting regarding sensory information). For example, some observed linear actual-world events, trajectories, and behavior (e.g., the growth rate in weight from baby to adult and the cognitive ability of reading) might only appear linear due to the applied time scale, such as using years rather than hours and days. Another example is that some observed reversible actual-world event, trajectory, and behavior might only appear reversible due to the kinds of measurements applied (e.g., the aforementioned isolated system of gas expanding and the piston). However, most difficult is the nature of the human mind that requires the processing of perceptual information and the interpreting of experiences, both of which can increase the kinds of observations experienced from the continuing actual world. Therefore, rather than the decontextualized observations of the present experimental setups employed in science to enable scientists to focus on specific details, we also need to find ways to study the specific details via multiple contextualized observations, because the so far studied specific details are part of the continuing actual world. A full understanding requires a complete picture, and a complete picture needs to be compiled from multiple and contextualized positions. Of course, the main issue then becomes how to do so while still seeing the wood for the trees.

Degrees in Events, Trajectories, and Behavior: The Continually Changing Actual World

The previous sections in this article presented a theoretical discussion of the continuing actual world that rests largely on dichotomies (e.g., linear versus nonlinear phenomena, reversible versus irreversible processes, and deterministic versus stochastic perspectives), in that the continuing actual world presents itself to us via simple to complex objects, phenomena, and processes and static to dynamical events, trajectories, and behavior. For example, Smolensky (1988, p. 22) pointed out that science describes the rich behavior displayed by cognitive systems (e.g., human behavior and language) as follows: "… on the one hand tightly governed by a complex system of hard rules, and on the other to be awash with variance, deviation, exception, and a degree of flexibility …" Several other researchers (e.g., Bishop, 2012, 2017; Strogatz, 2018) have stated similar questions about scientific research regarding the complex actual world: (a) What to do with the conflate between empirical accessible states and behavior versus the actual states and behavior?; and (b) How to deal with the fact that fundamental laws are always acting in concrete contexts?

Specifically, each individual person in the continuing actual world is a uniquely complex organism that can show a variety of dynamic behavior. To describe comprehensively the individual persons in the continuing actual world as a set of givens is a nearly impossible task, although some researchers have given it a try by attempting to list the essential features of human cognitive behavior. For example, the aforementioned Smolensky (1988), in presenting a theoretical connectionist computational model (i.e., artificial intelligence) that is based on cognitive science (i.e., neurobiological and cognitive psychology), describes the individual as a person who possesses a network of (a) personalized knowledge (i.e., culturally formalized and personally experienced knowledge involving learning and application in interaction) that is (b) stored in the brain in line with the brain's continually developing structure (i.e., plasticity) and flowing of neurotransmitters that leads to (c) processing capabilities (i.e., perceiving and interpreting), which in turn have to reckon with, on the one hand, (d) certain strengths, weight (i.e., personal valuableness), and flexibility (i.e., allowing for hypothetical and alternative possibilities) of the network connections and, on the other hand, (e) certain incompleteness, informal-ness (i.e., reformulations), and impreciseness (i.e., idealizations) of the stored information.

The interaction between these five constituents, Smolensky argued (1988, p. 9, remains somewhat of a black box, in terms of giving ". . . reasonable higher-level approximation . . .," rather than rules, that is guided by intentions, expectations, constraints, situations or contexts and inferences, and stability of the network across time. Presently, computational researchers have begun to work out these black-box interactions via computer models that possess deep learning (Alzubaidi et al., 2021;

Janiesch et al., 2021; Sarker, 2021). These computer models are used for classifying (i.e., diagnosing, categorizing, detecting, and identifying). Where machine learning refers to a sequential of processing steps (i.e., pre-processing, feature extraction, wise feature selection, learning) to train the computer in classifying information or data, deep learning adds multiple layers in the computational network model to optimize the training process, often directly from the input, rather than the need for human feature extraction, by using weight sharing features of local connectivity. Hence, for a computer to mimic human cognitive behavior, multiple layers of feature processing (i.e., similar to the visual cortex) are required that involve local connectivity in the computer network. This deep machine learning can resemble, and sometimes outperform, human cognitive behavior of classifying, in that a complex and dynamical system is disentangled by enabling the interaction between the five computational constituents of Smolensky (1988) through multiple layering and local connectivity. In computational research, the multiple layers are functioning by shared weights summation of the local feature connections that, interestingly, produces real numbers and non-linear output, and it is based on some nearby feature connections rather than the whole of connections.

However, when we go beyond classifying, there seems to be an important difference between computationally weighted features and human cognitive behavior, in that human cognitive behavior is not completely passively determined or influenced by the (local) surrounding features. I can clarify this via the following experience. I was thinking about what the continuing actual world might be in reality, when I was driven by car to a Corona vaccine site. As aforementioned, I live in a rural area, and we had to travel to a neighboring small city for a Corona vaccine appointment. This means that we had to take the car and drive through a crisscross of small land roads for an appointment at 9:00 hour. The driver of the car adjusted the car's navigation program and took off, while I rather sub-consciously stared out of the car's window en let my mind wander. The driver said that he remembered having driven to this city once before via the shortest possible route, and he intended to take this short route again. Unfortunately, at some point he must have taken a wrong turn because the car's navigation system arranged a new route with an ending time of 9:06 hour. Not being particularly happy with this new route, he tried to find shortcuts, but this only led to longer new routes. Hence, 9:06 hour became 9:18 hour, and eventually 9:21 hour. Then he came across a sand road through the woods, which wasn't even indicated on the car's navigation map, and we arrived at 9:03 hour at the Corona vaccine site. And then the idea came up that this is exactly where humans and numbers differ. Humans may not always undergo the things as they are (i.e., in this case, arriving at 9:06 hour at the Corona vaccine site) because they can also attempt to redirect situations. We are not completely passive, we are directing.

When we now return to the present discussion of the continuing actual world and its complex and dynamical manner, we have stated that observed behavior, events, and trajectories can be influenced by underlying "reasons" or inescapable givens (e.g., the presence of food that urges the mole to dig in a certain direction), the relative perspective of the observer (e.g., the personal interpretation of the given circumstances based on the current awareness of knowledge, beliefs, and emotions) as well as the directing influence of certain objects, phenomena, and processes in the observation of a present situation. In other words, many different kinds of influences are interacting in an actual-world state and this can have consequences for the next actual-world states. These different kinds of influences can be visualized (see Figure 3) as the presence of objects, phenomena, and processes in a certain actual-world state from a certain person's perspective producing different degrees of certain behavior, events, and trajectories (i.e., in a cube). That is, some behavior, events, and trajectories will always take place in an unvarying manner in an actual-world state because it depends on the mere presence of certain objects, phenomena, and processes (i.e., they are also irrespective of the relativity of the observer), some can vary due to the interacting influences of some objects, phenomena, and processes, and some can arise in terms of being completely new; all depending on the givens (i.e., objects, phenomena, and processes), their interactions, and their directing influence in an actual-world state, while accounting for the nearby surrounding environment, the relativity of the observer, and the passing of time. Below Figure 3, three examples are given.

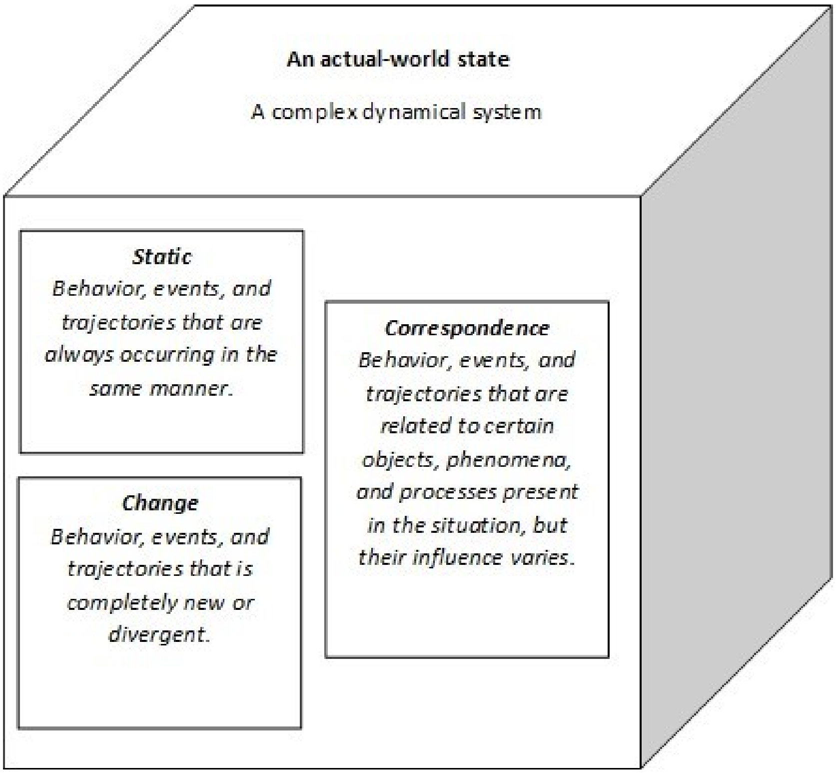

Figure 3. A representation of the observation of an actual-world state that can produce invariable, flexible, and new behavior, events, and trajectories based on the presence, interaction, and directing of the objects, phenomena, and processes.

Example 1: Watering the garden by using the outside water tap under the kitchen window

Static	Turning the handle of the water tap produces a steady stream of water that flows down from the tap based on gravity and the pressure in the water pipe.
Correspondence	Air in the water pipe produces a splattering of water.
Change	The water flow stops altogether (for instance, because the water pipe is broken somewhere behind the wall).

Example 2: The brain processing a cognitive task

Static	The neural highway produces automated formalized knowledge associations.
Correspondence	The presence of certain neurotransmitters produces certain cognitive and emotional interpretations.
Change	Neural plasticity enabled the development of an unrelated skill that now produces a creative interpretation.

Example 3: Dance performance

Static	Some well-rehearsed movements are performed correctly.
Correspondence	Some movements are flawed because they are not well rehearsed. Some movements are flawed because they are difficult to perform.
Change	Some completely new movements are performed.

Figure 3 can bring back the aforementioned question raised by the ancient Greek Heraclitus: Can we or can we not step into the same river twice? To say it differently, can we observe the exact same specific actual-world state and its scientific result more than once or will the continuing of the actual world always lead to changes in observations? The answer to this question has consequences for interpreting the observations of the continuing actual world and, likewise, the obtained scientific data. If, for arguments sake, we will accept that the world is always changing, in that someone cannot step into the same river twice, and we thus select the difficult option of Heraclitus's question, then how can we scientifically observe this continually changing actual world accurately?

When we view the continually changing actual world as consisting of multiple and relative actual-world states (i.e., rotating cubes in space), this can raise two elementary issues: (a) we cannot know what the meaning is of nonlinear behavior, events, and trajectories and how we can solve nonlinear actual-world information, if we cannot include all of the present and influential information as variables and parameters (i.e., What is present in each cube and which influential information is coming in from the surrounding environment) and (b) we cannot understand what the objects, phenomena, and processes will do in the actual-world states, if we do not have a solution for accounting for the nature of the objects, phenomena, and processes that are present in that actual-world state, the relativity of the observer, and the passing of time (i.e., what is interacting in each cube and what is observational error). These two issues refer to the conditionality regarding scientific observations or the necessity of first obtaining an understanding of how certain behavior, events, and trajectories are based on the presence of certain objects, phenomena, and processes in an actual-world state. Therefore, the study of behavior, events, and trajectories based on the presence, interaction, and observation error between objects, phenomena, and processes in actual-world states is essential to obtain a better understanding of the present scientific theories and models of behavior, events, and trajectories as these are decontextualized.

To conclude, an attempt was made in this article to describe the actual world by discussing the relationship between the ways in which it can be observed and scientifically investigated, specifically where it concerns random and chaotic patterns. To this end, scientific perspectives, theories, concepts, and critics were brought together to obtain a possible visualization of the actual world. This resulted in arguing that when scientists could become able to work with clearly defined actual-world states in terms of knowing which objects, phenomena, and processes each state include and how these can influence one another, it might lead to understanding the degrees in which behavior, events, and trajectories can and will take place in the continually changing actual world. Of course, this argument requires the revisiting of the present scientific assumptions regarding the conducting of research. That is, on the one hand, we need to obtain evidence that fully accounts for the context (i.e., the actual-world state itself and the surrounding environment, the relativity of the observer, and the passing of time) and, on the other hand, we need to narrow down some of this context appropriately in order to obtain evidence at all. Importantly, how we will do this will determine what we will find, which means that we must begin by finding ways to do justice to the complexity and dynamics that is our continually changing actual world when we are conducting research.

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