Thomas Kuhn: The Structure of Scientific Revolutions and the Change of Paradigms

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Abstract

In this concluding article of the series, I turn to the concept that explains how paradigm shifts occur - and, consequently, how a way out of the deadlock described in the previous articles is possible. Thomas Kuhn showed that science develops not through the linear accumulation of facts but through revolutions - shifts of paradigms in which the old picture of the world is replaced by a new one, incompatible with it. I show that Kuhn's concept is the methodological completion of the entire series: if virtue epistemology described the agent capable of cognition, the theory of dispositions described the qualities of this agent, and the concept of the cognitive niche described the environment in which these qualities are formed, then Kuhn's concept describes the process through which an agent possessing qualities, in an environment that supports thinking, accomplishes a change of that very environment. I show that a paradigm shift is not merely a new idea but a change of cognitive niche, and that the pedagogy forming the CCFP is a strategy for preparing the subject of a paradigm shift. In the conclusion, I return to the question with which the entire series began - "What is the brain?" - and show that the answer to it requires not only new data but a new subject of cognition.

Keywords: Thomas Kuhn, normal science, paradigm, scientific revolution, anomaly, crisis, incommensurability, paradigm shift, cognitive niche, communicative-cognitive framework of personality, subject of a paradigm shift.

The Puzzle Assembled from the Wrong Picture

In the previous articles of this series, I have traveled a long path. I began with David Chalmers's "hard problem" and showed that it is a problem of an exhausted conceptual framework, not a problem of missing data. I examined Colin McGinn's answer and showed that his pessimism is based on a false premise about the fixedness of cognitive limits. I passed through the awareness of complexity, through new approaches to the study of consciousness, through the path of the development of the subject, and through the philosophical foundations of the CCFP model [4; 5; 6]. But all these great minds left one methodological question open: how exactly does the transition from an old, exhausted picture of the world to a new one occur? How does science break its own dogmas when too many insoluble puzzles accumulate? How does a subject possessing qualities formed in a niche accomplish a change of the niche itself?

The answer to this question was given by the American philosopher and historian of science Thomas Kuhn (1922–1996). His book *The Structure of Scientific Revolutions* (1962) became perhaps the most influential work on the philosophy of science in the twentieth century [1]. Kuhn showed that science develops not through smooth, linear accumulation of facts but through sharp, painful, and fundamental shifts that he called paradigm shifts. It is precisely Kuhn's concept that allows me to fully justify the central hypothesis of the entire series: the model of the communicative-cognitive framework of personality is not merely another pedagogical methodology. It is a bid for a new scientific paradigm in which pedagogy ceases to be a service discipline and becomes a strategy for the evolution of the cognitive potential of the species *Homo sapiens* [2].

Normal Science, or the Art of Assembling a Puzzle

To understand a revolution, one must understand what it rebels against. Kuhn introduced the concept of normal science. Normal science is the period when the scientific community unanimously accepts a certain paradigm. A

paradigm is not merely a theory. It is a set of fundamental beliefs, values, methods, and examples of problem-solving that the scientific community shares. It is the glasses through which scientists look at the world [1].

During the period of normal science, scientists do not try to refute the paradigm or discover new fundamental laws. They engage in what Kuhn called puzzle-solving. Imagine that you are assembling a jigsaw puzzle and you have a picture on the box. You know what the final picture should look like. Your task is not to redraw the picture but to find the right place for each individual piece. A scientist in the period of normal science does exactly the same: they refine constants, expand the domain of the theory, and solve particular problems within the accepted rules.

Contemporary cognitive neuroscience, in my deep conviction, is precisely in the phase of late normal science. The paradigm states: consciousness is the product of neural computations; to understand it, one must build more powerful scanners, collect more data, and find more precise neural correlates. Scientists brilliantly solve puzzles within this paradigm. But they do not ask the question: is this the right picture on the box? [2]

Normal science is productive: it accumulates knowledge, refines theories, and expands the domain of application. The problem is not that it is bad. The problem is that it cannot go beyond its paradigm. When the paradigm is exhausted, normal science continues to work, but its work becomes increasingly fragmented and less conceptually meaningful. This is precisely what is happening in contemporary neuroscience. Scientists assemble the pieces of the puzzle with enviable persistence, but the picture on the box has long ceased to correspond to what is taking shape on the table.

When the Pieces Do Not Fit

Kuhn showed that normal science has a limit. Sooner or later, anomalies begin to accumulate - facts or phenomena that stubbornly refuse to fit into the existing paradigm, no matter how scientists try to adjust them. At first anomalies are ignored or declared experimental errors. But when there are too many of them, the phase of crisis sets in. Scientists begin to doubt basic axioms. Competing theories appear. The scientific community splits. And only then does a scientific revolution - a paradigm shift - become possible [1].

Let us return to the puzzle analogy. An anomaly is a piece that categorically does not fit anywhere, no matter how much you turn it. At first you think it is a defect. Then you find ten more such defective pieces. At some point you understand: you are assembling the wrong puzzle. The picture on the box is wrong. You need to throw it away and start assembling a completely different picture.

What are the anomalies of contemporary neuroscience that we have spoken of in this series? Chalmers’s hard problem: correlations do not explain qualia. Varela’s explanatory gap: third-person methods are fundamentally blind to first-person experience. The failure of reductionism: the sum of the parts does not explain the emergent properties of consciousness. The paradox of recursion: a system cannot fully describe itself without increasing its complexity. The hypothesis of cognitive closure: the biological brain may be evolutionarily unsuited to self-knowledge. These anomalies do not disappear despite trillion-dollar investments in neurotechnologies. We are in a state of deep methodological crisis. And according to Kuhn, a way out of the crisis is possible only through a paradigm shift [1].

It is important to emphasize that anomalies do not refute the paradigm in the logical sense. They create pressure that makes a paradigm shift possible. Kuhn says that a paradigm is not falsified but exhausted. Scientists do not abandon a paradigm because it has been refuted; they abandon it because it ceases to be productive. This distinction explains why a paradigm shift is not a logical inference but a historical event that requires certain social and cognitive conditions.

The Tower of Babel of Paradigms

One of Kuhn’s most important and provocative theses is the principle of the incommensurability of paradigms. Kuhn argued that the old and new paradigms speak different languages. They use the same words but invest them with different meanings. Therefore, supporters of the old paradigm often literally cannot understand the new one, considering it nonsense or heresy [1].

Imagine the supporters of Ptolemy’s geocentric system and Copernicus’s heliocentric system. When Copernicus spoke of the motion of the Earth, the Ptolemaists heard this with their own ears, but their brain, trained in the paradigm of the immobile Earth, interpreted it as absurd. They could not accept the new theory because to do so they would

have had to abandon their entire picture of the world, including the physics, theology, and common sense of that time. It is as if you came to a person who has spent their whole life assembling a puzzle with a ship and said: in fact, it is not a ship but a dragon. They will look at you with bewilderment, because all the pieces they have already assembled form a ship. And only if they agree to turn the picture over and start again will they see the dragon.

Today we observe the same incompatibility. When I, or Varela, or Tononi say that understanding the brain requires developing the researcher's mental mechanisms, the traditional neurobiologist hears: this person proposes replacing fMRI with meditation and philosophy. But this is a distortion. The new paradigm does not abolish fMRI. It asserts that fMRI without a modernized cognitive apparatus of the observer produces only beautiful but meaningless pictures [2]. A paradigm shift is not adding a new room to an old house. It is demolishing the old house and building a new one on a new foundation.

Incommensurability is not merely different points of view. It is a difference in the conceptual scheme that determines what counts as a fact, as evidence, as an explanation. Supporters of different paradigms cannot simply discuss their disagreements, because they do not even agree on what counts as a disagreement. How can one convince a supporter of the old paradigm if they do not understand the language of the new one? Kuhn answers: through conversion, not through proof. A paradigm shift is not a logical inference but a gestalt shift that occurs under the influence of many factors, including social, psychological, and historical ones.

The Paradigm as a Habitat

Here I want to take a step that Kuhn did not take but that, in my view, is a logical consequence of his concept. If we combine Kuhn's concept with the concept of the cognitive niche, then a paradigm shift appears as a change of cognitive niche [6].

What does this mean? A paradigm is not only ideas in the heads of scientists. It is a set of practices, instruments, institutions, norms, and values that shape how scientists think. A paradigm is the cognitive niche of the scientific community. When a paradigm changes, not only the theory changes but the entire niche: the instruments that are used, the questions that are asked, the standards by which results are evaluated, the institutions that support research.

This explains why a paradigm shift is so difficult. It requires not merely the acceptance of a new theory but the restructuring of the entire niche, and this requires time, resources, and, most importantly, new people who have grown up in the new niche and are not burdened by the habits of the old one. Here pedagogy enters the game. If a paradigm shift is a change of niche, then preparing the subject for a paradigm shift is preparing them for life in a new niche. And this means that a school must be not a place for the transmission of knowledge about the old paradigm but a place for the formation of dispositions that will allow the student to create a new niche.

The CCFP as the Core of a New Paradigm

How, then, does Kuhn's concept confirm my hypothesis? First of all, it teaches one to recognize a crisis not as a failure but as a harbinger of a breakthrough. My hypothesis directly points to the fact that contemporary neuroscience has exhausted the potential of the brain-as-computer paradigm. The accumulation of correlates has reached a dead end [2]. Furthermore, my CCFP model proposes a new foundation. In the old paradigm, the object of study was only the brain, and the instrument was considered to be the neutral, unchanging mind of the scientist. In the new paradigm, the object of study becomes the system of the brain plus the cognitive apparatus of the researcher. We acknowledge that the instrument must be modernized in order to study the object [3].

According to Kuhn, scientific revolutions are accomplished not by aging dogmatists but by a new generation of scientists unburdened by old dogmas. My hypothesis draws a radical conclusion: if we need a new paradigm in neuroscience, we must raise a new generation of researchers. And this can be done only through the purposeful development of the eleven mental mechanisms within the CCFP. Pedagogy becomes the forge of cadres for a scientific revolution [2]. And finally, if a paradigm shift is a change of cognitive niche, then the goal of pedagogy is not to transmit knowledge about the old niche but to form the capacity to create a new niche. This means: to develop dispositions that allow the student not merely to adapt to the existing environment but also to restructure it.

The connection between the CCFP and Kuhn's concept can be formulated as follows. Kuhn describes the structure of scientific revolutions: normal science, anomalies, crisis, revolution, new normal science. The CCFP describes the

subject of these revolutions: a person possessing dispositions for a paradigm shift. Pedagogy describes the process of forming this subject. Three levels - structural, subjective, and procedural - form a complete picture: how paradigm shifts occur, who accomplishes them, and how to prepare this subject.

Instruments of Revolution

How exactly do the mental mechanisms of the CCFP prepare a scientist for life in a new paradigm and for accomplishing revolutions? Critical thinking, MM-6, is the main instrument for deconstructing the old paradigm. A student who possesses this mechanism does not accept axioms on faith. They are able to ask the question: what if the assumption that the brain processes information like a computer is fundamentally mistaken? Without this mechanism, science is doomed to eternal normality [2].

Socratic dialogue, MM-5, is an instrument for overcoming the incommensurability of paradigms. When scientists speak different languages, only a deep, structured dialogue that uncovers the hidden foundations of each position can create a bridge for understanding. Socratic dialogue teaches one not to win an argument but to seek truth together beyond current dogmas [2].

Forecasting and strategic thinking, MM-11, is the capacity to see an emerging new paradigm before it becomes mainstream. A scientist with a developed MM-11 can hold in mind multiple scenarios of the development of science, assess which of the current anomalies will become the key to a future breakthrough, and build a long-term research strategy rather than chase momentary publications [2].

Building deep causal relations, MM-1, is an instrument for the transition from describing correlations to understanding mechanisms. The new paradigm requires not the statement of the fact “area A lights up” but an understanding of the multilevel causal chain that generates meaning [2]. Information search and analysis, MM-9, in the era of paradigm crises allows a researcher to synthesize data from neurophenomenology, cybernetics, philosophy, and biology, creating that very transdisciplinary picture that is necessary for the new paradigm [2].

The list of mechanisms relevant to a paradigm shift is not limited to those enumerated. Any of the six mechanisms of the core can be an instrument of a paradigm shift, because all of them constitute the act of re-conceptualization. I single out precisely these five because they are most directly connected with Kuhn’s task: the deconstruction of axioms, dialogue between paradigms, foresight of a new paradigm, transition from correlations to mechanisms, and synthesis of transdisciplinary data.

The Resistance of the New

Kuhn was pessimistic in one respect: he believed that the old guard never accepts a new paradigm. As the physicist Max Planck joked: a new scientific truth triumphs not because it convinces its opponents but because its opponents eventually die and a new generation grows up familiar with it [1].

My hypothesis proposes a more optimistic, Vygotskian path [5]. We do not have to wait for a natural change of generations. We can accelerate this process through pedagogy. If we begin to introduce the development of the eleven mechanisms into education already today, we will not merely improve the school. We will purposefully form the cognitive architecture of those very young scientists who in twenty or thirty years will accomplish the necessary scientific revolution in the understanding of consciousness. They will not resist the new paradigm, because they will think in its categories from childhood [2].

This is an optimistic reading of Kuhn, and it is vulnerable to criticism. Kuhn indeed believed that a paradigm shift is a social process that requires a change of generations. My hypothesis proposes a pedagogical acceleration of this process. But one may object: will this not lead to indoctrination, to the formation of a generation that is incapable of seeing alternatives to the new paradigm? The answer: no, if pedagogy forms not content but dispositions. A disposition toward critical thinking does not bind one to a particular paradigm; it makes the student capable of calling any paradigm into question, including the one in which they grew up. It is in this sense that CCFP pedagogy is not indoctrination but the cultivation of freedom.

The World That Changes Together with the Scientist

Here is Thomas Kuhn's quote, which should become an anchor for the reader and the final chord in the justification of my hypothesis: scientific revolutions are not cumulative episodes of development in which the old paradigm is replaced wholly or in part by a new one incompatible with it. They are episodes in which the very world in which the scientist works changes [1].

This phrase reminds us of the scale of the task. We are not merely looking for a better way to scan the brain. We are changing the very world in which the science of the brain works. We are changing the definition of who a scientist is and what cognition is. My hypothesis takes the next step: in order for this new world to arrive, one must purposefully prepare minds for it through CCFP pedagogy [2]. A paradigm shift is not merely a change of theory. It is a change of ontology - of what is considered real, a fact, an object. When a paradigm changes, not only what we think about the world changes but also what we consider the world to be. This is a radical thesis, and it explains why a paradigm shift is so difficult: it requires not merely the acceptance of new information but the restructuring of the very way of being in the world. This is precisely what CCFP pedagogy does: it prepares the subject for life in a new world, not merely for the assimilation of a new theory.

The Completion of the Cycle

This article completes the series of fourteen portraits of thinkers on whose shoulders my hypothesis stands. We have traveled from the formulation of the problem through the awareness of complexity to new methods, through the path of the development of the subject, through the philosophical foundations of the CCFP model, and finally to the understanding of the mechanism of scientific breakthrough. Now the picture has become complete. The hard problem is not a dead end. It is an invitation to epistemological recursion. And the key to this recursion is the purposeful development of mental mechanisms [2; 3].

But I want to end this series and our entire journey with one more thesis that ties everything said together. The path from the hard problem to a new pedagogy is not merely a change of theory. It is a change of cognitive niche. It is a transition from a niche in which thinking is limited by the framework of an exhausted paradigm to a niche in which thinking is capable of creating new paradigms. And this transition begins not in laboratories and not in academic discussions. It begins in school, with concrete teachers and students, in concrete lessons. Every lesson in which a teacher helps a child ask a genuine question is a step toward the new niche. Every studio where a child tries their hand at music or painting is a step toward the new niche. Every workshop where they learn to work with their hands is a step toward the new niche. Every school working according to the CCFP model is an investment in a future in which humanity will finally be able to answer the question that Tatyana Vladimirovna Chernigovskaya honestly called unresolved: what is the brain? And this scientist of the future, the one who will say "I know," will carry within themselves the cognitive architecture laid down by pedagogy, which today seems to many to be merely an appendage to real science. But it is precisely pedagogy, understood as the design of cognitive niches, that is the very real science without which all the others will remain blind [2].

At the beginning of the series, Chernigovskaya's question was a verdict: we do not know what the brain is, and we cannot know. Now it is an invitation: we do not know what the brain is, but we can create the conditions in which the answer will become possible. This is the difference between despair and hope, and it is precisely this that I wanted to convey through the entire series. The puzzle is not assembled. The picture on the box may be wrong. But we have hands, eyes, and persistence. And perhaps that is enough to one day see that what is taking shape is not a ship but a dragon.

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