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Epistemological Equivalence and Transcendental Complementarity

Two Fundamental Principles in the Constitution of Scientific Experience

Abstract

This article, which is based on a three-volume study by the author, develops two principles that shape our entire cognitive process: *the epistemological principle of equivalence* and the *transcendental principle of complementarity*. The former states that all human knowledge reduces the unknown to the known through action-oriented analogies. The latter shows that the experience of the spatio-temporal *forms* of our world and its *contents*, consisting of force and matter, is based on experience-constitutive complementary relationships between object perception and self-perception. They link the perception of our environment with the perception of our own body, thereby significantly increasing the efficiency of our actions.

Based on a transcendental-pragmatist framework, the article argues that even the causal and dynamic structures of our scientific models do not reflect a reality independent of the subject. Rather, they are *projections of action-guiding schemata* that enable us to practise the interaction strategies we have learned in social relationships in a modified form when in contact with our objects.

Using a simple thought experiment and historical reflections on scientific theory formation, the article shows that the *anthropomorphic* structures of scientific world models are *not a deficiency* but a *transcendental necessity*.

The conclusion calls for a change in epistemology and the philosophy of science: from the search for ontological correspondences between knowledge and the world, to a clarification of the pragmatistical, bodily and socially conditions under which knowledge arises and functions.

1. Introduction: Topic and objective of the article

This article is based on a three-volume study in German by the author (Czasny, K. 2010 a, b, c). Here, one of the most important results of this publication will now be presented to an English-speaking specialist audience for the first time.

The result in question is the discovery that two principles of *physical* cognition postulated by modern physics, the equivalence principle and the complementarity principle, refer to *deeper, more general* principles of cognition that underlie our *entire* experience and cognition. The following presentation of this result will show that it contradicts the metaphysical assumption that science can reflect structures independent of the mind. Instead, the aforementioned discovery locates scientific cognition within a *transcendental-pragmatistic* framework. In this context, cognition is examined as a function of practical orientation, grounded in the embodied and social conditions of human life. The first step of the subsequent argument will explain this approach to the process of cognition in more detail.

2. The Perspective of Transcendental Pragmatism

The key to uncovering the most general principles of cognition lies in the insight that the subject never experiences its sought-after unity with the object within the act of cognition itself, but always only in the successful realization of actions based on that cognition. The site of mediation between subject and object is thus not a purely cognitive process detached from praxis, but rather cognition embedded in a pre-structured and overarching field of *practice*.

From this follows that the *meaning* and *truth* of any statement can only be understood against the background of its functional role within the practical context of the speaker and his interaction partners. Since this role lies in enabling orientation and success of actions directed toward specific objects, the *meaning* of a scientific proposition consists in the action possibilities it implies in relation to those objects, while its *truth* is to be measured by the likelihood of success for actions guided by it. Only those propositions are true that prove themselves in the corresponding praxis; judgments that lead to failure must be regarded as refuted.

This radical orientation of knowledge toward the field of practice grants the present approach access to deeper layers of meaning that are typically overlooked in both everyday and scientific beliefs. At the same time, it sets this approach apart from all ontological and empiricist positions. While the former attribute to cognition the capacity to mirror an object existing independently of human activity, the latter attempt to reduce cognition to a substrate of isolated individual sensory impressions, artificially abstracted from its socio-practical grounding.

Furthermore, all constructivist positions must be rejected as well, since they regard the appearing object as a result of arbitrary constructions—likewise abstracted from the requirements of praxis.

The only genuinely fruitful orientation is offered by the long tradition of *transcendental* thought, whose roots reach back to Descartes. The most important point of reference here is the philosophy of Kant. From Kant, the present approach adopts both the leading question—What is the contribution of the subject to the constitution of the world as it appears to it?—and the conviction that the object too has a share in this constitution, since the subject always experiences its perceptions as arising in contact with something external that appears in a specific manner and resists certain interpretative missteps.

Three main directions of development are required to advance Kant's position. First, we must account for a fact largely overlooked by the founder of modern transcendental thought: that the subject's constitutive accomplishments are not limited to theoretical acts but are rooted above all in its *practical* activity. Second, Kant paid too little attention to the crucial role of *symbolic* mediation—especially language—in the constitution of both self and object experience within the horizon of praxis. Third, contrary to Kant's tendency toward individualism, we must recognize that all experience-constituting activity unfolds within a *social* dimension and must therefore be understood as *social practice.*

All three of these points have already been taken up and developed by various thinkers working in the spirit of Kant or in opposition to him. The task of the study presented here was thus not to invent them anew, but to critically appropriate and further develop these strands, and to integrate them in such a way that they become productive for analyzing the constitution of physical, mathematical, and logical knowledge. The resulting approach is referred to by the author as *transcendental pragmatism.* The name signals a thematic proximity to the approaches of *transcendental pragmatics* (Karl-Otto Apel) and *universal pragmatics* (Jürgen Habermas), while the terminological preference for "pragmatism" over "pragmatics" reflects differences regarding the relation between theory and praxis, and between speaking and acting.

In sum the author's transcendental pragmatism argues that all knowledge claims derive their epistemic function from their role in the coordination of practical action. Cognition is not an autonomous mirror of the world, but a tool embedded in socially mediated praxis. This shifts the focus of epistemology from abstract representation to orientation of action.

3. The Epistemological Equivalence Principle

3.1 Reduction of the Unknown to the Known

The search for the *first* and *highest* principle of all cognition is guided by the question of how cognition contributes to the orientation of action. It leads to the conclusion

- that cognition has never been, is not, and never will be anything other than the *reduction of the unknown to the known*,
- and that such reduction always takes the form of recognizing an unfamiliar phenomenon as *equivalent* to something already familiar—on the grounds that it *behaves* like the known, and *can therefore presumably be dealt* with in the same way.

All scientific models fulfill this function of enabling orientation through reduction. Every model claims that some unfamiliar state of affairs can be understood on the basis of a familiar pattern, and it thereby implicitly promises that we may interact with this unfamiliar phenomenon as we would with its well-known counterpart. We then act accordingly—and as long as our action is successful, we regard the model as valid. Only when we fail to achieve our aims using that analogy are we compelled to search for a better-functioning model, which in turn must prove itself in practice.

A glance at the history of physics—from prehistoric worldviews to modern theories—confirms the *universal validity of this principle*. It is not an invention of modern science, but already operative in the animistic nature beliefs of early humans. A closer analysis of Einstein's *equivalence principle* reveals that it is nothing more than a translation of this always-valid principle of cognition into the language of twentieth-century physics.

A detailed analysis of this principle—referred to here as the *epistemological equivalence principle*— can shed new light on both the *dynamics* of cognition and the *formal shape* of our conception of nature. For this principle is not an optional heuristic, but a fundamental condition of cognition. All knowledge treats the unknown as if it were already part of the known, which enables the subject to act meaningfully towards it. This method underlies both our scientific modeling and our everyday understanding of the world.

3.2 The Schema of Communication

Because the most elementary layers of what we consider "familiar" contain praxis-proven certainties from interpersonal contexts, we tend to ascribe to the structures of the objective world a form that *resembles social relations*. However, this attribution is not some-

thing we practice at the level of the reified surface of our everyday consciousness, but occurs on a deep level of meaning that is accessible only through critical reflection.

Once reflection reaches this depth, it becomes clear that in actual practice—despite all contrary beliefs—we always ...

- treat every object *as if it were a subject* and an interaction partner,
- interpret every causal relationship as a form of *social interaction* and
- model *natural laws* by analogy to the normative force of *human action rules*.

A possible objection arises: Don't we conversely often interpret ourselves *by analogy with the object world*—for example, through machine models of the body, the mind, or social systems? Yes—But these attempts at self-understanding are merely the inverse application of the equivalence principle, whose regulatory force extends so far that even all self-related cognition is subordinated to it. Whenever an empirical object structure is recognized as "known," it is readily used as a model for the reduction of some phenomenon in the subject domain.

The result of this radical application of the equivalence principle is a *complex mesh of mutual mediation* between subject and object. Although it can never be fully reconstructed in detail, we may assume that *at the base* of every such structure lies the reduction of an objective fact to a familiar *social phenomenon*. For the underlying motivation of such reductions is always the same: the subject's desire to render the unknown *actionable*. Cognition aims not at adjusting the subject to objective reality, but at *preserving the subject's autonomy in action*. Therefore, the object must ultimately be treated as a *"virtual subject"*[1], whereas the opposite view—that the subject is merely a "virtual object"—must always remain a provisional hypothesis to be overcome by deeper understanding.

It is important to note that equivalence is never full identity, but always *"sameness under specific practical points of view."* They are defined by the demands of the actions that should be guided by the relevant knowledge. Just as mass and energy are not identical but equivalent under the perspective of dynamic transformation, so too the analogies between our social practices and the object-relations we project onto nature must be recognized as *limited*. The author's study therefore attempts to define these boundaries as precisely as possible wherever it detects such hidden analogies.

1 The term 'virtual' refers to the 'as if' attitude of the perceiving subject that underlies all modelling. It behaves towards its object *as if* it were another subject and thus an interaction partner. In other words: If I treat an object as a "virtual subject", I treat it as a system that appears to respond, resist, or follow rules in analogy to an intentional agent.

The crucial question is always: *What are the practical goals from whose perspective these equivalences appear?* To understand the significance of this question, let us take a closer look at the example of the equivalence of mass and energy. This makes sense in light of the goal of *changing the state of motion* of an object. From the perspective of an actor who seeks to accelerate an object, energy and mass function analogously: both resist acceleration. For example, more force is required to accelerate a red-hot piece of iron than a cold one. This additional resistance appears as *mass*, even though it is due to the object's *energy content.* Hence, from the standpoint of the actor, energy becomes functionally equivalent to mass.

The *general equivalence between social and object-oriented structures* is different. It does not arise from a *specific* goal like motion change, but from a *general intention* that precedes all specific aims: namely, the impulse to apply the structure of *communicative action* even to interactions with inanimate objects. Communicative action, as we learn it socially, is always rule-based and presupposes partners who themselves act according to rules. If I wish to apply this behavioral logic to my dealings with objects, I must assume—at least provisionally—that objects behave in a *rule-governed* way, analogous to persons.

Throughout human history, different views have prevailed concerning *how* objects follow their rules. Each view corresponds to a different mode of communicative engagement:

- In *pre-scientific epochs*, objects were seen as partly free in their rule-following. This gave rise to *dialogical strategies*: one might plead, flatter, or curse objects to influence them (e.g. to make it rain, or not rain).
- In *classical physics*, objects are presumed to follow their rules *mechanically and necessarily*. The communicative strategy becomes *strategic* rather than dialogical: one manipulates initial and boundary conditions so that deterministic rules lead to desired effects.
- The shift from classical to *quantum theory* reflects a further transformation in how we assume objects follow their rules—a topic explored in detail in chapters 5 and 6 of the third volume of the author's study (Czasny, K., 2010 c, 120-182).

Taken together, the equivalence relations between the structure of our social practices and the ordering patterns we project onto nature form a *coherent schema of communication*, which underlies all object cognition. Historical analyses in volume I of the author's study demonstrate that the specific form of this schema changes over time with the evolution of social relations—but its *basic structure* remains stable. This confirms that the analogy be-

tween social and natural order functions as a *transcendental a priori* of scientific world-construal.

This apriority marks an important distinction between the fundamental equivalence principle discussed here and the more familiar equivalence claims within particular scientific models. The latter do not structure all experience, but are always grounded in *empirical generalization*: they follow from observations that two different phenomena react identically to certain actions. The former, by contrast, is a *pre-empirical* general hypothesis.

Finally, a word on the *anthropomorphism* of physical models, which is so striking that it has been frequently noted. What has been lacking is a systematic epistemological analysis of this fact. The true reason why the communicative schema plays such a central role in cognition becomes clear only when we adopt a thoroughly *pragmatist* view:

- Cognition's primary function is not passive representation, but *enabling action*.
- Specifically, it serves to make possible a communicative mode of action even in dealings with nonhuman entities.
- All models projected onto objects must therefore allow the actor to *enter into interaction*, and this is why they must portray the world in terms of *communication processes.*

4. The Transcendental Complementarity Principle

4.1 From Kant to the Question of Two Ordering Systems

Kant famously argued that the subject contributes to experience by providing its formal conditions—specifically, spatial and temporal structures. However, he did not ask *why* we must structure experience in this way. This omission is due to his strict separation between theoretical and practical reason. As a result, he did not consider the possibility that our structuring of experience through spatial—temporal relations might stem from *practical requirements*.

The author's approach addresses precisely this question, but pushes it even further. He doesn't merely ask why we apply spatial—temporal orderings to sensory stimuli. He asks why do we apply *two different* kinds of ordering—one spatial, one temporal?

This leads to a preliminary question, which has so far been largely overlooked by cognitive science:

Under what conditions do we say that two different sensory impressions refer to two events that occurred *next to each other*, and under what conditions do we say that they refer to

two events that occurred *one after the other*— that we are therefore dealing with a *change*? In other words: *How do we distinguish spatial from temporal relations?*

4.2 A Thought Experiment: Red and Green in the Dark

To answer this, the author proposes a simple thought experiment, easily replicable by any reader. Imagine entering a completely dark room, where the only visible object is a small red light. You close your eyes, and when you reopen them, you now see a green light. Nothing else is visible.

Now ask yourself: Under what conditions would I say that the green light appeared *next to* the red one, and under what conditions would I say that it appeared *after* the red one—that the red light *became* green?

The answer will probably be:

I perceive a "next to" relation only if I register that *I moved* between the two perceptions—i.e., I shifted my position or my viewing angle.
If, by contrast, I register that I remained still, I perceive a "one after the other" relation—a *transformation* of the red light into green.

Thus, the experienced *mode of relation* between two sensory impressions—whether "beside" or "after"—depends on whether I experience myself as *moving* or *at rest* between the two perceptions.

4.3 A Transcendental Analogy to Quantum Complementarity

This logic is structurally analogous to *Bohr's principle of quantum complementarity*. In quantum physics, whether light appears as a particle or a wave depends on the observer's experimental arrangement—that is, on the actions they take. Likewise, in the present thought experiment, whether two impressions are related spatially or temporally depends on the perceiver's actions—specifically, on their own *movement* or resting.

In both cases, we are dealing with a form of *perceptual alternative* that is *complementary* to the subject's actions. In quantum physics *the experience of light as a wave or particle depends on the observer's interventions.* The author's claim is that *the experience of space and time is similarly shaped by the movement behaviour of the perceiving subject*.

We may therefore speak of a *transcendental complementarity principle*, governing the deep structure of sensory experience:

- If we perceive sensory impressions against the background *of self-movement*, we link them by the relation "*next to*."
- If we perceive them against the background of *self-rest*, we link them by the relation *"after"*.

But why do we need to distinguish between 'next to' and 'after'? The answer lies in the *need to link the perception of the environment with the self-perception* of our own motion state. This integration enables *faster and more efficient responses* to environmental events. It links what happens *in the world* with what happens *in the body* of the acting subject.

The advantage of this linkage is practical: The distinction between spatial and temporal relations allows us to embed sensory changes within *action-relevant frameworks*—to interpret them differently depending on our own bodily state, and thus to plan our responses accordingly.

4.4 Two Possible Objections

A possible objection arises: Don't we perceive spatial and temporal relations independently of our own motion? Doesn't the objective world present us spatial distances and temporal changes that are not contingent on how we move?

Yes—and this objection is valid. Our ordinary experience of spatial and temporal relations is *objectivized*, and largely *independent* of our immediate bodily state. But the author's claim does not concern these higher layers of experience. It concerns a *deeper layer*, prior to objectification, which is typically overlaid by later developments in perception and cognition.

The above thought experiment aims to reconstruct a situation in which the habitual spatial-temporal reference frame is disabled—so that this deeper pre-objective layer becomes visible again. It shows that the *origin* of our distinction between spatial and temporal relations lies in the self-perception of motion and rest—even if later developmental and cultural processes lead us to treat spatial and temporal relations as objective features of the world.

A second objection might be: Isn't the perception of one's own movement already dependent on spatial and temporal concepts? Doesn't it presuppose the very distinction that needs to be explained?

The answer: No—not in the sense intended here. The relevant perception of movement in this context is not *physical motion* (as tracked by spatial coordinates and timepoints), but rather a *pre-physical bodily experience* of moving or remaining still. We are not talking about

registering that "my body was at point A at time t_1 and at point B at t_2," but rather about *feeling oneself to be moving or at rest*—something even a child or an animal can experience without having any abstract space–time framework.

In early phases of human development, and presumably in early phases of human history, this distinction between "beside" and "after" does not yet exist. But infants (and presumably early humans) already have *body-related self-experiences*—including the experience of movement and rest. At some point, these experiences related to one's own body are linked to sensory impressions (e.g. visual or auditory changes) that relate to the environment. And—this is the key thesis—it is only *through this link* that the subject begins to distinguish "next to" from "after," and thereby constructs his space–time framework.

The distinction between "next to" and "after" thus results from a functional requirement. It creates a *clear structuring of the action field* allowing the subject to plan alternative courses of action based on whether it perceives two events as *coexisting* or as sequential.

The above thought experiment *recreates*—under simplified conditions—that primordial state in which the spatial-temporal reference frame was absent, in order to recover the *deepest layer of sense* that underlies our experience of space and time.

This experiment thus shows that our distinction between spatial and temporal relations arises not from objective features of the world, but from the subject's bodily experience of motion and rest. This reveals the deep action-dependence of the most basic categories of world-constitution.

5. Consequences for the Understanding of Scientific Models

What does all of this imply for our conception of scientific theories and models?

At the core of both principles presented—the epistemological equivalence principle and the transcendental complementarity principle—lies a rejection of the idea that the structures of our experience simply reflect objective, mind-independent features of the world. Instead, these structures emerge from the *conditions under which the subject must perceive and act* in order to remain capable of orienting itself and acting effectively.

From this perspective, scientific models are not mirror-like representations of an external reality. Rather, they are *tools for action,* grounded in deeply embedded *pragmatistic schemata* that have evolved from the subject's need to cope with its environment. Their func-

tion is to enable the subject to interact successfully with what appears, not to describe the "thing-in-itself" behind appearances.

This has far-reaching implications:

- The *space–time framework* of physics is not a passive map of how the world is "in itself." It is a *pragmatistic orientation tool*, that arose from the need to differentiate sensory impressions based on whether they occur in conjunction with bodily movement or rest.
- Likewise, the distinction between *force and matter* is not a reflection of an ontological duality in nature, but the result of linking body-related self-experiences of *acivity* vs. *passivity* to sensory impressions that relate to the environment. A surface pressed by an actively moving hand is perceived as "matter," while a passive hand experiencing pressure without its own activity perceives "force."
- The *causal structures* identified by scientific theories are not discovered in the world "out there," but are patterned after social interaction models, *projected onto the object domain* via the epistemological equivalence principle.

In all these cases, science operates not by "reading off" the structure of the world, but by *mapping onto the world* schemata derived from human action. These schemata—such as communicative rules, norm-following behavior, interactional regularities—are themselves the result of *practical learning and socialization*.

Thus, the *objectivity* of scientific theories does not reside in their *correspondence* with a mind-independent reality, but in their *pragmatistic reliability* across a wide range of situations. As already indicated in the second section, theories should not be measured by metaphysical claims to truth, but rather by their degree of functional adequacy: *they are true to the extent that they enable us to intervene successfully, make predictions and coordinate actions*.

Seen in this light, the *anthropomorphism* of scientific models is not an unfortunate bias to be eliminated. On the contrary, it is a necessary feature of all object cognition. It expresses the *structural isomorphism* between the action-guiding schemata of human practice and the models projected onto nature.

And this projection is not arbitrary. It is governed by strict rules defining the *transcendental conditions of possible experience*. These conditions ensure that what appears to us as "the world" is not a random flux of impressions, but a *coherently organized field of possible action*.

6. Conclusion and Outlook

The two principles developed in the author's study —the epistemological equivalence principle and the transcendental complementarity principle—shed light on the deep structure of human knowledge. They show that the way we experience and conceptualize space, time, matter, force, causality, and objectivity depends largely on the conditions under which we must perceive and orient ourselves in order to act successfully. In order to describe these conditions, we must analyse the *bodily and social structures of our collective practice*. They shape our approach to the world and thus determine how this world appears to us.

By recognizing this, we can overcome the lingering metaphysical assumption that scientific theories aim at a final, ontological description of reality. Instead, we see them as *instrumental constructions*, deeply grounded in action-oriented perception and communication structures. These constructions are neither arbitrary nor subjectivist; rather, they are structured by *transcendental imperatives*—not of thought alone, but of *praxis*.

This opens several avenues for further research:

- Developmental and cognitive psychology and evolutionary research could investigate the *emergence of spatial and temporal distinctions* in relation to self-awareness of bodily movement and stillness.
- Philosophy of science could investigate the extent to which models and theories (including those of the formal basic sciences of logic and mathematics!) are implicitly based on social analogies and how this affects scientific explanations.
- Foundations of quantum theory could be reinterpreted through the lens of *action-dependent appearance*, placing Bohr's complementarity principle within a broader transcendental-pragmatic framework.

Ultimately, the task of epistemology is not to purify knowledge of its anthropomorphic traces, but to make *those traces transparent*, and thereby to understand knowledge as what it always has been: *a guide for practical orientation within a world* whose appearance was constituted by our perception in a way that we can act successfully within it.

References

Czasny, K., 2010a, Erkenntnistheoretische Grundlagen der klassischen Physik, Band I; Grin Verlag, (zweite Auflage: disserta Verlag, 2014

Czasny, K., 2010b, Erkenntnistheoretische Grundlagen der klassischen Physik, Band II; Grin Verlag, (zweite Auflage: disserta Verlag, 2014

Czasny, K., 2010c, Quantenphysik als Herausforderung der Erkenntnistheorie, Verlag Karl Alber