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Scientific Realism vs. Evolutionary Epistemology: A Critical Rationalist Approach

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Abstract

The compatibility of scientific realism and evolutionary epistemology is a controversial issue in contemporary philosophy of science. Scientific realism is the view that scientific theories aim to describe the true nature of reality, while evolutionary epistemology is the view that scientific knowledge is the product of natural selection and adaptation. Some philosophers argue that evolutionary epistemology undermines the epistemic status of scientific theories and thus poses a serious challenge to scientific realism. This paper examines this problem and explores whether scientific realism can be reconciled with evolutionary epistemology. The paper argues that critical rationalism (CR), a philosophical approach that rejects *justificationism* and emphasizes the role of *criticism*, *rationality*, and *objectivity* in science, can provide a viable framework for integrating scientific realism and evolutionary epistemology. The paper shows that by adopting a non-justificationist fallibilist stance toward scientific theories, CR can reconcile the realist and the evolutionary views on scientific knowledge.

Keywords Evolutionary epistemology · Scientific realism · Critical rationalism · Truth · Rationality · Objectivity

1 Introduction

Evolutionary epistemology is a naturalistic approach that applies the principles and methods of evolutionary biology or psychology to the study of cognition and knowledge. It assumes that human cognitive abilities and organs, as well as the knowledge they produce, are the outcomes of evolutionary processes. This approach uses biological-evolutionary models and metaphors to explain and understand how cognitive mechanisms and theories evolve through trial and error and how they are selected

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and adapted to the environment of humans or other organisms (Bradie, 1986; Bradie and Harms, 2012; Campbell, 1974; Popper, 1972; Toulmin, 1972). The origin of this approach can be traced back to the nineteenth century, when Darwin's theory of evolution opened a new avenue for epistemology, which was first explored by Dewey and other pragmatists (Dewey, 1910; Pearce, 2020). Unlike other naturalistic approaches, such as sociological, historical, and anthropological approaches, evolutionary epistemology focuses on the biological aspects of cognition and knowledge.

This paper addresses the problem that Campbell (1974) noted in the final section of his seminal paper on evolutionary epistemology: whether evolutionary epistemology is compatible with the search for "objective truth"—the aim that scientific realists claim for science. It seems that epistemology based on natural selection is more consistent with a kind of instrumentalism or pragmatism, that is, the view that scientific theories are nothing but tools for predictions or practical applications, and we should not fall into this self-deception that they can provide us with an explanation of what is happening in the world.[1] Many contemporary philosophers believe that evolutionary epistemology is incompatible with scientific realism and does not support the idea that cognitive faculties are reliable in discovering truth (Putnam, 1983, 230–231; Bradie, 1989; van Fraassen, 1985, 260–261). There is a broadly neo-Kuhnian strand of evolutionary epistemology that has a more anti-realist flavor (Kuukkanen, 2021; Wray, 2011). Thomson (1995) argues that evolutionary epistemology presents a dilemma for scientific realism: either we reject the truth of science or we accept that our cognitive apparatus is unreliable in discovering truth (p.26). Several authors have advanced arguments of a similar kind.[2] These arguments vary in their specifics, but they share a common core: standard evolutionary theory entails that the evolutionary process would have needed an epistemically problematic "lucky accident" to produce a cognitive apparatus with the ability to attain a scientific comprehension of the world, which undermines scientific realism (Clark, 1984; de Ray, 2022; Koperski, 2017; Ruse, 1995, 1998; Talbott, 2016).

This paper defends the compatibility of scientific realism and evolutionary epistemology within the *critical rationalist* framework. It argues that by rejecting justificationism and embracing fallibilism, CR can accommodate the evolutionary perspective on cognition and knowledge. Moreover, evolutionary theory can enrich the explanatory power of CR by providing new insights and resources for understanding the development and dynamics of scientific theories.

The paper is structured as follows: Sect. 2 looks at scientific development in an evolutionary approach. In Sect. 3, to clarify the problem situation, we examine the tension between realism and evolutionary epistemology from different perspectives. Section 4 explains how CR reconciles evolutionary epistemology and scientific realism. Section 5 provides the conclusion.

[1] Wuketits (2001, 179) contrasts Campbell's position, which embraces evolutionary skepticism, with the classical realist versions of evolutionary epistemology, which assume that perception reveals some aspects of reality.

[2] For a similar argument against *normative realism* and its criticism, see Street (2006) and Deem (2016).

2 Scientific Development: An Evolutionary Approach

Evolutionary epistemology comprises two distinct but related programs: the Evolutionary Epistemology of Mechanisms (EEM) and the Evolutionary Epistemology of Theories (EET). The former investigates the evolution of the cognitive mechanisms of living organisms. It can be regarded as an extension of evolutionary biology to the cognitive features or organs, such as the brain, neural receptors, and sensory systems of animals. The latter employs the models and metaphors of evolutionary biology to analyze the development of scientific ideas, theories, culture, and cognitive norms (Bradie, 1986). This paper examines the second program, which originated from the works of Popper (1972), Toulmin (1972), Hull (1988), and their followers.

Popper (1972) argues that the minimal difference between a living and a non-living being is the existence of an "expectation" in living organisms from the environment. When the environment fails to meet this *expectation*, the organism is challenged to adapt to the environment, which can be considered a "struggle for survival." According to evolutionary theory, the evolution of a living organism and its survival effort are shaped by trial and error; in this process, only those characteristics that are not eliminated by the environment persist. This explanation can be applied, with some modifications, both at the genetic level and behavioral level.

At the genetic level, evolution involves random and blind mutations. The production of different gene variants increases the probability of environmental adaptation. In the long run, the environment eliminates maladaptive features. This process is called "natural selection." The evolution of this process is slow and gradual. In other words, the genetic structure preserved at the genetic level is relatively rigid. At the behavioral level, where the evolution of behavioral traits occurs through social tradition and imitation, the imprinting of behavioral traits follows the same process but with more flexibility than at the genetic level (Popper, 1994).

Evolutionary epistemology extends this explanation from the genetic and behavioral levels to the cognitive and scientific knowledge level and treats it as a biological phenomenon. This extension is based on *homology* between the organs and behaviors of humans and other animals at the biological and behavioral levels. For example, based on homology, there is a similarity between our ears and those of cats. Although homology does not have a specific criterion and is not self-evident, it is proposed as a hypothesis (Mindell and Meyer, 2001). The evolutionary epistemologist also applies this hypothesis to the level of human knowledge. With this application, the attempt of a living organism to overcome the challenge posed by the environment is interpreted as an attempt to solve a problem. Therefore, from this perspective, the adaptation of a living organism to its environment can be considered a form of knowledge, which constitutes a fundamental similarity between human knowledge and animal knowledge (Popper, 1999). Taking such a generalization seriously results in evolution at the scientific level, where there are theories and other cognitive products. We use linguistic tools to formulate theories; however, we should not reduce them to language and overlook their biological-evolutionary aspects.

Organisms experience evolution at the genetic level through the process of replication. Similarly, at the level of action and behavior, evolution occurs via social tradition and imitation, with selection by the environment. In the realm of science, evolution takes place through learning and selection. Changes at the scientific level parallel those at the genetic and behavioral levels, occurring abruptly as mutations or incrementally over time. This dynamic encompasses both revolutionary and conservative transformations, as delineated by Popper (1994).

Analogous to the genetic level, where organisms evolve through replication, or the behavioral level, where they evolve through social tradition and imitation and are selected by the environment, scientific evolution also occurs through learning and selection. At the genetic and behavioral levels, changes occur sometimes by mutations and sometimes very gradually. Similarly, at the scientific level, there are both revolutionary and creative tendencies, as well as conservative tendencies (Popper, 1994). A clear and fascinating example of this pattern can be seen in Maxwell's analogies in the nineteenth century—that is, the idea that the laws governing mechanics can be applied with changes and modifications in other fields, such as electricity, magnetism, heat, and light. With these analogies, Maxwell could connect problems of mechanics on the one hand and problems of heat, light, electricity, and magnetism on the other—fields that had previously seemed separate (Achinstein, 1991; Einstein and Infeld, 1967). These analogies show that at the scientific level, we have both revolutionary and innovative tendencies and conservative tendencies. An analogy is *innovative* because it is *not* the same as the tradition and is only similar to it; it is *conservative* because it is *similar* to the tradition and is not entirely separate from it.

The analogies of Maxwell and other nineteenth-century physicists illustrate how the innovative and progressive aspects of science coexist with the conservative and traditional tendencies of the past, leading to new explanations and, of course, new problems. Some of these problems include determining the speed of molecules and how they are distributed and the philosophical question of whether molecules are real. Although these problems are important, the more fundamental problem is why we should adopt a realist interpretation of theories and consider their basic hypothetical entities to be real.

3 Realism and Evolutionary Epistemology: Problems and Challenges

Although realists have offered arguments, such as *inference to the best explanation* or *no-miracle argument*, to defend their positions (Leplin, 1985), they seem to face difficulties with the components of realism if they accept evolutionary epistemology. In the following, we outline the most important of these problems (Mansouri, 2015; Thomson, 1995).

3.1 The Problem of Convergence to Truth

Evolutionary epistemology seems to pose a problem for realists, who view truth as the aim of science, as evolution is a non-teleological theory (Thomson, 1995). Evolution does not have an aim or direction, and one cannot even use the concept of long-term improvement of a species. The first problem is that there is no equilibrium state of adaptation in the evolutionary process because there are no perfect optimal solutions for complete adaptation. Moreover, the emergence of a new structure or doctrine is associated with a change in environmental conditions, which may make some new elements more effective in the environment and change it, creating new pressures and challenges. This change, in turn, affects the organism. Therefore, it should be noted that evolution does not need a specific direction—that is, biological characteristics are not necessary for achieving an aim—even if the entire process of evolution is not toward adaptation. A feature may have multiple effects. In brief, evolutionary theory is not teleological, and it cannot be said that the evolutionary process converges to a certain equilibrium state (Thomson, 1995).

If we generalize this view to the scientific level, the result is that the evolution of theories does not necessarily converge to *truth*. The natural selection approach eliminates some theories, but some remain. However, the remaining theory is not necessarily true, and there is no guarantee of moving toward true theories because fitness or successful prediction is not equivalent to being true. Additionally, every new revolutionary theory acts like a new and powerful sense organ, creating new problems. In addition, changes in organisms may cause environmental changes, affecting living organisms. Both the world and our theories are always evolving. This implies that truth is not a static thing that falls into the net of our theories, and we discover it. Therefore, it seems evolutionary epistemology creates a problem for realists who view truth as the aim of science.

3.2 The Problem of Progress

A consequence of non-convergence in evolutionary development is that the notion of progress becomes meaningless. Survival of the species does not imply the existence of any progress or improvement in the evolutionary process. In biological evolution, the survival of one mutation does not justify further mutations. Mutations persist just because the environment has not eliminated them, not because they have any intrinsic value for life and survival (Thomson, 1995).

At the behavioral level, although the behaviors are not blind, in the sense that the organism learns something—for example, it avoids repeating the behavior that causes failure—there is still a degree of blindness in the trials, and a behavioral pattern does not guarantee success. Moreover, the gradual and lengthy process of evolution is sufficient only to ensure survival. It is not necessarily a corrective process.

At the cognitive level, one might argue that long survival time is evidence of the truth-conduciveness of an organism's cognitive system (O'Hear, 1984, 212; Musgrave, 1993, 284; Nozick, 1993, 123; Quine, 1969, 126). However, this approach is not compelling (Bradie, 1989, 407–408). Dinosaurs had a more complex cognitive system than bacteria did, but bacteria survived, and dinosaurs became extinct. Moreover, our survival time compared to dinosaurs is not long enough to confidently claim that our survival is due to our adaptable cognitive system. Dinosaurs outlived us. The cockroach is an older species than us, but it does not seem that it has a better intellectual position than us (Putnam, 1983, 232).[3]

Similarly, no matter how long our theories have lasted, we do not know if they will be valid. Therefore, at the epistemological level, from the perspective of evolutionary epistemology, we should not expect a process of selection to guide the evolution of theories toward truth. In other words, our metaphysical theories or intuitions are tentative conjectures. Their survival in dealing with the environment and the fact that they have not yet been eliminated does not provide any justification for their validity and truth (de Ray, 2022; Thomson, 1995).

3.3 The Problem of Rationality

Evolutionary epistemology inherently leans toward a descriptive stance to maintain consistency with evolutionary theory. It observes and explains the naturalistic processes through which theories mutate, compete, and survive or perish. This perspective aligns with the biological understanding of mutations—spontaneous, rare, and undirected changes at the genetic level that contribute to the diversity and adaptability of life forms.

However, this descriptive focus presents a challenge for realists seeking prescriptive insights akin to those found in traditional epistemology. *Rationality* in science is inherently *prescriptive* because it involves a commitment to a *methodology*. One may be disappointed if they expect evolutionary epistemology to offer justifications for rationality or normative prescriptions for scientific inquiry. Even at the biological level, mutations that occur at the genetic level are rare, so realists cannot derive prescriptions based on evolutionary patterns. The descriptive nature of evolutionary epistemology does not readily translate into the prescriptive frameworks that guide rational attitude. It does not dictate how scientists should think or which theories they should pursue; rather, it explains how scientific thought has evolved and continues to do so.

3.4 The Problem of Objectivity

Yet another problem is the conflict between evolutionary epistemology and a certain conception of *objectivity*. In the evolutionary approach, a living organism has an "expectation" from its environment, which, if not met, leads to an environmental

[3] While evolutionary pressures may prioritize survival over truth-conduciveness, as Boulter (2004) argues, this does not refute metaphysical realism as a precondition of visual perception. The independent existence of a prepackaged world remains essential for visual perception, and the complexities of evolutionary processes do not diminish the significance of this metaphysical foundation for understanding perception.

challenge or a *problem*. This *expectation* and adaptation to the environment can be regarded as a kind of a priori *knowledge*. Even the belief in the stability of environmental conditions is an unjustified hypothesis. If the environment is unstable, there are no adaptation conditions over time, and the organism will face difficulties.

Therefore, in this approach, science does not start with observation but rather with a problem. Even ordinary observation depends on a choice: what to observe? This requires selection and prioritization based on the initial expectations. To express this in Popperian terms, most of our knowledge is *genetically* a priori. Kant rightly showed that a posteriori knowledge is impossible without a priori knowledge: something must be considered experience or experiential. Popper adopts Kant's idea with some changes and argues that we have long-term knowledge related to our sensory organs, which can be interpreted as a kind of a priori knowledge, and this a priori knowledge is a necessary condition for a posteriori knowledge. Long-term knowledge precedes short-term a posteriori knowledge (Popper, 1999, 45–6, 63, 69–73).[4] This a priori knowledge includes not only the perceptions related to our sense organs but also all of our previous knowledge, expectations, and value judgments, and we choose and interpret our observations and experiences with all of these. Due to the existence of our epistemological and value expectations and prejudices, theories are evolutionarily contaminated with values and preferences.

Thus, in short, this inherent structure and these expectations impose a kind of a priori knowledge and value judgment on theories from our perspective. This conflicts with the conception of objectivity that objective science should be free of value judgments from theorists and that the objectivity of science results from reducing the role of prejudices and values and dedicating ourselves to reality.

4 Critical Rationalism and Evolutionary Epistemology

Accordingly, evolutionary epistemology does not seem to guarantee that scientific theories are true, rational, and objective. It is unclear whether evolutionary epistemology can be compatible with realism, or at least coexist without conflict, given its inability to guarantee the truth, rationality, and objectivity of scientific theories. For the peaceful coexistence of realism and evolutionary epistemology, mainstream scientific realism must be able to modify its doctrine regarding the role of *truth* and the *aim* of science, as well as its approach to *rationality* and *objectivity*, without compromising realism. It should also explain what it means to talk about *progress* in a realist context where convergence to truth is not demonstrable. In the following, we argue that CR has made valuable suggestions in this regard, which, unfortunately, have been overlooked in mainstream scientific realism.

[4] Popper uses the term "genetically a priori" to indicate knowledge that exists before any perception, aligning with his view that all knowledge is hypothetical and conjectural, and that our sensory experiences are interpreted through this pre-existing framework. This differs from Kant's concept of a priori, which refers to pure forms of experience and judgment necessary for any possible experience and cognition (ibid.).

Popper himself is one of the leading philosophers of evolutionary epistemology, and the numerous and long references to Popper in Campbell's, 1974 article show his sympathy with Popper's views (Popper, 1994, 1999). Popper also always considered himself a realist. In what follows, we explain how CR, despite the arguments presented, can reconcile realism and evolutionary epistemology.

4.1 Critical Rationalism as a Non-justificationist Approach

Although evolutionary epistemology does not guarantee the truth of scientific theories, CR and evolutionary epistemology are compatible in this respect because non-justificationism is a prominent feature of both approaches. CR posits that all knowledge—including problems, theories, and metaphysical postulations—are provisional conjectures, accepted without justification and held as true only until evidence and reasons to the contrary emerge (Bartley, 1964; Miller, 1994, 2006; Popper, 1963). This approach stands in contrast to other realist proposals, such as Massimi's (2022) Perspectival Realism, which risks diminishing the critical stance by anchoring the *justification* of knowledge within specific historical and cultural contexts, or Chang's (2022) Pragmatist Realism, which CR advocates might perceive as an attempt to *justify* theories based on their practical utility—a notion CR finds problematic.

4.2 Truth as a Regulative Idea

CR adopts truth as a *regulative idea* to avoid the abyss of relativism, conventionalism, and instrumentalism.[5] Moreover, drawing on Tarski's theory of truth, it also reconciles evolutionary epistemology with the absolute and objective concept of truth, without requiring a *universal criterion for truth*. Popper argues that such a criterion is neither necessary nor possible. Even logically, regardless of the traditional arguments of skeptics, it can be shown that it is not always possible to prove or justify the truth of all propositions (Popper, 1963, 225; 1972, 46, 317, 321; Miller, 2006, 169–180). However, the absence of a universal criterion for truth does not imply the non-existence of truth.[6]

[5] The incorporation of "decision" and "agreement" elements within some of Popper's works has raised concerns about a whiff of irrationalism or conventionalism within Popper's philosophy (Miller 1994, 29–30). For instance, in his discussion of "the problem of the empirical basis," he suggests that basic statements are ultimately the result of a decision, agreement, and convention (Popper 1934/2002, ch. 28–30). Nonetheless, it is untenable to ascribe to Popper a variant of conventionalism that stands in opposition to his realist stance. As Miller points out, firstly, the decision to accept basic statements is based on experience, not as a replacement for it. Secondly, basic statements are *objectively true*, not just consistent with other statements or conventionally true. However, they are fallible and are provisionally agreed upon only because continuous criticism is not practically possible in scientific activity (Miller 1994, 29–30).

[6] Kuhn argues that accepting Darwinian evolution entails abandoning the concept of truth, because Darwinian evolution lacks a specific direction (Kuhn 1990, 95–96; 1962/2012). However, this argument is based on a misunderstanding: The absence of a criterion to justify truth does not imply that truth cannot be an aim. This argument overlooks the possibility of a regulative role for truth, and despite the emphasis of critical rationalism, it remains attached to "justification." Kuhn (1990, 96) assumes that the problem of

4.3 Progress

CR, as a non-justificationist proposal, repudiates all forms of *justificationism*. As a result, the suggestion of scientific progress is not contingent upon *justification*; rather, it should be viewed as a conjecture that remains tenable until a rationale for its rejection emerges (Miller, 1994, 45–6). This perspective aligns with Popper's metaphor of "groping in a dark room," which underscores the provisional and unjustified nature of scientific knowledge. However, how can one talk about progress if the evolutionary approach is not teleological?

One perspective posits that an evolutionary analogy serves to reasonably establish the primary aim of science as identifying empirically inadequate theories (Rowbottom, 2011, 138). However, critical rationalism, as elucidated by Miller (1994, 48; 2006, 57–58, 80), extends beyond mere *refutations* and negative approaches toward theories. It also encompasses a positive aspect: the formulation of *conjectures* about the world. While there exists no universal criterion for distinguishing truth, conjectures that withstand criticisms can be deemed as conjecturally true. Critical rationalism harmonizes skepticism with common-sense realism. It does not forsake truth as the aim of science; rather, it challenges the pretensions of justified truth.

Popper, who was interested in some "improvements"[7] in Neo-Darwinism, proposed distinguishing between *external and internal selection pressures* and suggested that organisms are *active* agents and have inborn mechanisms that create and reorganize their environments rather than passive recipients of environmental influences (Popper, 1974, 138; 1984a, viii, 13; Wuketits, 1986, 194–5). External selection pressures are the environmental challenges that necessitate adaptation, while internal selection pressures are the active problem-solving mechanisms inherent within organisms. This distinction is crucial as it underscores the agency of organisms in shaping their environment, a concept that extends to scientists who are not mere passive recipients of empirical data but active agents in creating and reorganizing their theories and hypotheses.

Popper's distinction between external and internal selection pressures is echoed in the contemporary discourse on evolutionary theory, particularly through the lens of Niche Construction Theory and the Extended Evolutionary Synthesis (EES). Niche Construction Theory, as articulated by Odling-Smee, Laland, and Feldman (2003), posits that organisms are not merely passive entities molded by environmental forces but are active agents that modify their environments, thereby influencing their own evolutionary pathways. This theory parallels Popper's view of scientists as active problem-solvers rather than passive observers. Similarly, the EES framework,

Footnote 6 (continued)
"justification" is that it is oriented toward an external aim out of paradigm, whereas he claims that justification should be inside the paradigm or framework. However, he fails to recognize that the problem of justification is not inside or outside, but its impossibility and redundancy in science.

[7] As Hull (1999) says, Popper's point about the active role of organisms in evolution is not new or controversial among Darwinians, but "Popper is right that organisms as active agents tend to get lost in much of the literature in population genetics with its heavy emphasis on genes and characters.".

expanded upon by Laland et al. (2015), underscores the organism's active participation in evolution by incorporating concepts such as developmental plasticity and epigenetic inheritance, which resonate with Popper's emphasis on the purposeful nature of scientific progress. The EES's alignment with the Evolutionary Epistemology of Theories (EET) program, as discussed by Sarto-Jackson (2021), further reinforces the dynamic interplay between an organism's cognitive development and its evolutionary context. Additionally, De Benedetto and Luchetti's (2023) work on theory choice as a form of niche construction offers a novel perspective on the co-evolution of scientific theories and epistemic values, illustrating a feedback loop that mirrors organisms' active role in their evolution. This contemporary understanding of niche construction and the EES provides a robust theoretical backdrop that supports and extends Popper's vision of organisms—and, by extension, scientists—as active participants in the evolutionary process, shaping their trajectories through intentional and problem-oriented actions.

By subjecting their conjectures to criticism and refutation, scientists can *actively improve* their understanding of the world by *eliminating errors*. Scientific innovations, therefore, are not blind but *purposeful attempts* to solve problems by overcoming difficulties in the existing theories. Progress, therefore, involves deliberately replacing erroneous conjectures with new and improved ones. This aligns with an evolutionary epistemology that emphasizes *purposeful adaptation* over blind evolution. Popper acknowledges a disanalogy with biological evolution, recognizing that while biological evolution does not have a purpose, scientific progress is driven by the rational and purposeful improvement of our understanding of the world (Hussey, 1999; Popper, 1975, 1984b).

The role of criticism is paramount in this process. By subjecting their conjectures to rigorous criticism and refutation, scientists actively engage in the elimination of errors. Progress is achieved when *new conjectures* withstand criticisms and address previously unexplored problems, thereby expanding our knowledge frontier. The progress of science transcends the mere identification of novel problems. It can be seen as moving closer to the truth through successive theories that are more truthlike than their predecessors. Progress is defined as the elimination of false conjectures and the proposal of better alternatives (Popper, 1975). This means that even if a theory is not completely true, it can still represent progress if it is a better approximation of the truth than previous theories.

Truthlikeness, or verisimilitude, refers to the idea of how closely a theory approximates the truth. It is a measure of how closely a theory approximates the truth, even if it is not entirely true. However, developing a satisfactory theory of truthlikeness has proven challenging. Popper's initial attempts were criticized for their simplicity and inadequacy (Miller 1974; Tichy 1974). Later theories, while more sophisticated, often suffer from technical complexities and issues like language dependence. These problems make it difficult to objectively measure and compare the truthlikeness of different theories (Niiniluoto, 1987; Oddie & Gustavo, 2022). Despite these challenges, the concept of progress in critical rationalism remains valid. The absence of a perfect theory of truthlikeness does not undermine the idea that science progresses by approximating the truth. Scientific progress encompasses the elucidation of emergent problems and the explanation of the inaccuracies inherent in antecedent theories. These explanations are not underpinned by justification; rather, they are also conjectural in nature, maintained in the absence of compelling reasons for their rejection, albeit with the acknowledgment of their potential fallibility. This process ensures that scientific inquiry continues to move closer to the truth, even if the exact measure of truthlikeness is elusive (Miller, 1994, ch. 10).

While Kuhn accepts the evolutionary nature of scientific progress, he justifies the superiority of new theories over old ones using criteria such as prediction, specialization, problem-solving, and accuracy (Kuhn, 1970, 264–265). He concedes that later theories are better by some measure but maintains that "being better" does not equate to providing an almost true description of nature. In contrast, CR regards the truth of propositions or theories as independent of whether or not there is a criterion to determine it. It considers truth as a *regulative idea* that guides our pursuit of knowledge. Progress is defined by conjectures that provide solutions to previous problems and having more explanatory power (Popper, 1972, 16–17).

4.4 Rationality

While evolutionary epistemology provides a *descriptive* account of the development of scientific theories, it is the *prescriptive* dimension of *rationality* that guides the methodological aspect of scientific inquiry. Rationality in science is not merely a passive reflection on how theories evolve; it is an active, prescriptive force that shapes the methodologies scientists employ to test and refine their theories.

As a non-justificationist proposal, CR offers a robust alternative to this descriptive limitation. Popper was reluctant to embrace a naturalistic approach to methodology and opposed deriving the methodology and prescriptive aspects of rationality from historical or evolutionary descriptions. He advocated for Hume's dichotomy of "ought/is," arguing that a naturalistic approach to methodology inevitably leads to *psychologism* (Popper, 1945/2013; 1934/2002, sec. 2, 9–11). In his *The Open Society and Its Enemies*, Popper posited that opting for a rational attitude is not a rational choice per se but a *moral* one, an irrational *faith in reason* (1945/2013, 436–8). He further suggested *methodological rules as conventions*, contingent upon the aims and values we embrace; in his case, the ultimate aim was *truth* (1934/2002, sec. 11, p.15).

However, Bartley highlighted that forsaking rationality in the realm of *decisions* and *standards* originates from a tacit adherence to *justificationism*. Responding to such criticism, Popper revised his stance. In an addendum[8] of *The Open Society*,

[8] He also added this footnote in *LScD*: "I believe that a reasonable discussion is always possible between parties interested in.

truth, and ready to pay attention to each other (Cf. my *Open Society*, chapter 24)" (Popper 1934/2002, 15).

"Facts, Standards, and Truth: A Further Criticism of Relativism (1961)," he elucidated that the rational attitude extends beyond mere decisions, standards, and values and persists further.

Critical rationalists elaborated further on the concept of rationality and its role, emphasizing that rationality is not a property of theories but rather our method and attitude toward them. A rational approach embodies a critical attitude, while irrational approaches—manifested in various forms of relativism, foundationalism, and fideism—result from an unreasonable demand for a task beyond our ability. A rational approach is a critical attitude, and irrational approaches, in various forms of relativism, foundationalism, and fideism, are all the outcome of an unreasonable demand for a task beyond our ability. Indeed, they are predicated on the erroneous belief that knowledge is "justified true belief" and the unattainable demand to justify our beliefs (Popper, 1963, 3–30; 1984b; Bartley, 1964; Miller, 2006, 50).

Just as biological evolution occasionally exhibits resistance to environmental pressures, scientists also do not always welcome criticism and sometimes resist it. This conservatism underscores the significance of tradition and acknowledges that theories are not conceived in isolation. Nonetheless, such resistance should not be seen as undermining the importance of criticizing as the rational attitude. It is not indicative of a dogmatic stance; rather, its intent is to discern between superficial and substantive criticism, thereby maximizing the extraction of a theory's epistemological content.

4.5 Objectivity

Popper agrees with Lorenz that natural selection can shape our a priori categories of thought, but he denies that this implies a direct or necessary connection to the "thing-in-itself" (Mariscal, 2010, 450–451). He argues that "the *tabula rasa* theory is absurd" and that "at every stage of the evolution of life and of the development of an organism, we have to assume the existence of some knowledge in the form of dispositions and expectations" (1972, 71). He maintains that our perception and reasoning are always biased by our prior knowledge, *expectations*, and hypotheses. Living organisms—and *a fortiori* humans—-harbor *expectations* of the environment. This endows the organism with a kind of a priori knowledge and value judgments on theories, which stands in contrast to the concept of "objectivity" as something *impartial*, *value-free*, and *without prejudice and bias*. However, Popper rejects such a conception of objectivity and argues that the traditional positivist view of objectivity, which equates it with empirical verifiability and value-free inquiry, is flawed (Popper, 1945/2013, ch. 23; Paya, 2011). This view aligns with the contemporary arguments presented by Douglas (2009), who contends that non-epistemic values play a legitimate role in scientific inquiry, thus refuting the value-free ideal. Furthermore, Kourany (2010) and Longino (1990) contribute to this reevaluation by highlighting the integral role of social and moral values in scientific practice, thereby challenging the notion of detached objectivity. Steel (2015) also supports this thesis by examining the precautionary principle, which necessitates the inclusion of values in scientific reasoning.

Popper suggests a new conception of objectivity: to be *intersubjectively criticisable* in the scientific community. According to Popper's theory of three worlds, the theoretical products residing in World 3 are all objective in the sense that they are accessible and can be evaluated by the scientific community. Therefore, in CR, objectivity is neither equivalent to truth nor reality, nor does it mean being value-free! Objectivity is the characteristic of our epistemological claims or conjectures in World 3 (Paya, 2011; Popper, 1972). Therefore, a priori knowledge, or bias and prejudice, does not undermine the objectivity of knowledge. Even false theories are objective because they also inhabit Popper's World 3. Just as the abandoned nest of a cuckoo can be occupied by another creature or used for another purpose with changes, false theories are also part of World 3. They can be transformed into other theories with major or minor changes or absorbed into them.

The emphasis on *intersubjectivity* is important since CR does not confine criticisms and objectivity within a framework, perspective, or paradigm. Although CR shares common ground with Perspectival Realism in recognizing that knowledge is shaped by perspectives, it diverges in its refusal to limit objectivity to these perspectives. Instead, it advocates transcending the confines of frameworks and perspectives, as discussed in Popper's (1994) *The Myth of the Framework*. The primary reason that various viewpoints, which concede the impact of values on scientific endeavors, fall prey to the myth of "framework" or "perspective" is their persistent adherence to justificationism—a stance not shared by CR. For proponents of these viewpoints, objectivity emerges from justification and reliability within a given framework, paradigm, or perspective.

Evolutionary epistemology is based on the similarity between humans and other living organisms. Nevertheless, despite the similarities mentioned between humans and other living organisms at the cognitive level, there are also differences: Both amoeba and Einstein know the world around them based on expectations or a priori knowledge, but "objectivity," in the sense explained above, is a feature of human knowledge that has emerged through the evolution of language (Popper, 1972, 1999). The amoeba's knowledge and expectations perish with its death, but Einstein's theoretical products, which are considered the inhabitants of World 3, exist independent of him and even after him. Scientists can criticize or reject his theories or transform them into new theories with innovative changes.

5 Conclusion

This paper has suggested that evolutionary epistemology does not necessarily undermine scientific realism, contrary to some objections. One possible way to reconcile these views is to adopt CR, which rejects justificationism and offers new views on objectivity, rationality, criticism, and truth in science. The paper has also argued that scientific innovations are not blind but *purposeful* attempts to solve problems by overcoming difficulties in the existing theories. According to this view, progress means replacing erroneous conjectures with new and better ones. This view is inspired by the evolutionary epistemology of Popper and Campbell, who suggested that organisms are active agents with inborn mechanisms that create and reorganize their environments rather than passive recipients of environmental influences. Moreover, the paper has demonstrated how CR can account for the similarities and differences between biological and scientific evolutions and explain the role of conservatism and resistance in both processes.

Finally, the paper suggests that the compatibility of evolutionary epistemology and scientific realism is not a matter of choosing between two rigid attitudes. Rather, it has been argued that resolving the inconsistencies between these views requires rethinking the concepts of objectivity, truth, and rationality and adopting more evolutionary interpretations that emphasize the active role of organisms and their internal mechanisms in evolution. This implies that philosophy and biology can interact constructively with each other to advance the understanding of scientific knowledge.

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Declarations

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