

A Critique of Localized Realism

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In an attempt to avert Laudan's pessimistic induction, Kitcher, Worrall and Psillos introduce a narrower version of scientific realism. According to this version, which can be referred to as "localized realism," realists need not accept every component in a successful theory. They are supposed only to accept those components that led to the theory's empirical success. Consequently, realists can avoid believing in dubious entities like the caloric and ether. This paper examines and critiques localized realism. It also scrutinizes Psillos's historical study of the caloric theory of heat, which is intended to support localized realism.

1. Introduction. Kitcher (1993, 142–149), in an attempt to avert the pessimistic induction, argues that theories contain presuppositional posits and working posits. The former are entities that may help explain some aspects of the working posits but do not contribute to the success of the theories that postulate them. They are suspect and eliminable. In contrast, working posits are the entities that contribute to the success of their theories and are usually retained by successive theories. The preservation of working posits shows that science is cumulative and that success and approximate truth are linked because these entities were responsible for the success of theories.

Worrall (1994), also motivated by the need to deflect the pessimistic induction, introduces a less comprehensive version of scientific realism. He concedes that the empirical contents of older theories are discarded. However, he argues that the continuity and cumulativeness between successive theories are not lost in the process because the mathematical structure of an old theory, which reflects the interactions between real entities, is preserved and retained by its successor. He proposes that realism entails no obligation to accept every constituent of a successful theory or every successful entire theory and that realists are entitled to selective acceptance. This is the core assumption of what can be called 'localized realism'. Psillos's version of localized realism is stronger because it contends that

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some empirical assumptions are also retained in the process of theory replacement (1996). Localized realism is a novel attempt to defend scientific realism against one of the most powerful antirealist attacks. Yet this position has some problematic consequences. This paper examines this position and addresses its consequences and their implications for realism.

2. The Basic Assumptions of Localized Realism. Worrall (1994, 336) contends that realists should adopt a realist attitude towards selected theoretical claims within successful theories. According to his view, even the most successful scientific theory would contain some idle assumptions that the realist is not required to accept. Thus Worrall proposes shifting the locus of belief from whole theories to single constituents of theories.

Psillos (1996; 1999, 108–114) elaborates on this position and calls this restricted version of realism the “divide et impera strategy.” According to Psillos, not all constituents of a theory contribute to its success. Some constituents, he maintains, are idle and others are not empirically supported. The realist has no obligation to endorse such constituents, despite the success of the theories that contain them. For example, the entities of caloric and luminiferous ether cannot be regarded real in spite of the empirical success of the theories that posited them. Yet the caloric theory of heat and the optical ether theory contained some approximately true constituents that facilitated their success. Such a selective attitude to components of theories is supposed to help the realist avoid believing in false assumptions or discarded entities that were postulated by an old theory without denying the approximate truth of such a theory. According to localized realism, a theory that postulates entities or mechanisms that turn out to be false can remain approximately true so long as its success did not depend on such false components.

When it comes to determining the correctness or incorrectness of a theory, localized realism downplays the significance of a theory’s depiction of reality and stresses the existence of valid assumptions within this theory that led to successful predictions. Consequently, one may accept some assumptions from a theory that provides a false account of some phenomena. What matters for localized realism is the soundness of the constituent assumptions of the theory, not the theory as a whole.

Localized realism aims to deflect the impact of the pessimistic induction, which has recently been advocated by Laudan (1981). This inductive argument concludes that empirical success does not necessarily signify approximate truth. It also entails that if currently accepted theories are approximately true, older theories cannot be approximately true because newer theories negate the reality of the entities and mechanisms advanced by their predecessors.

To respond to this argument, Psillos argues that the success of past theories was not based on the false assumptions that these theories included. Rather, empirically supported and approximately true constituents within these theories led to their success while the false elements remained idle. Consequently, the antirealist cannot argue that the link between success and truth has been severed. Moreover, the approximately true constituents of old theories tend to be retained in newer theories, and this reaffirms their validity. Worrall, on the other hand, argues that the retention of the mathematical structure of older theories within their successors implies that an element that reflects the real structure of the world has been passed from older to newer theories. By “the structure of the world,” Worrall means the relationships between various entities in nature.

Worrall and Psillos differ mainly on what is retained from past theories. While Worrall contends that the mathematical structure of older theories is what is retained Psillos asserts that the empirically supported theoretical structures and assumptions within an older theory are retained. Psillos’s view is more ambitious and radical, since it implies that more substantial components of old theories are retained by their successors. Yet Worrall’s view is not profoundly different from Psillos’s. For Worrall, mathematical structure reflects how real entities in nature relate to each other, and this implies that a limited aspect of the empirical content of the old theory has been retained and expressed in mathematical terms.

Psillos’s strategy can be summarized as follows. First, the success of an old theory is due to the presence of approximately true components within that theory. The existence in a theory of invalid or idle components does not necessarily impede its success and, consequently, does not preclude its approximate truth. Second, it is possible to identify the approximately true elements in a theory that led to its empirical success. Furthermore, these elements are usually retained by newer theories, and this increases our confidence in their approximate truth. Although individual constituents of theories are seldom empirically tested, and although the evidence for the approximate truth of the entire theory does not extend to all its components, the approximate truth of some constituents can still be determined. To determine which components of a theory are approximately true one can trace the attitudes of the scientists that proposed this theory towards its various components. Those components that the scientists expressed strong confidence in their contribution to the success of their theories are the approximately true components (1999, 112). Other components, which are idle or invalid, can also be spotted because scientists would express doubts or reservations about their roles in the success of theories.

Does such reliance on the attitudes of scientists suggest that there are no other, more objective ways to identify the approximately true com-

ponents of a theory? This is highly probable because, as Psillos rightly points out, the predictions of theories are generally derived from a set of components, not from a single component, together with auxiliary assumptions. Confirming a prediction, for this reason, is generally construed as a validation of all the constituents and assumptions that contributed to its derivation. That is, when the conjunction of several basic assumptions and laws leads to a successful prediction such success cannot be attributed to just one of these assumptions and laws.

It is curious that Psillos does not explain why the scientists who constructed theories are in a unique position to discern the parts that are responsible for the success of their theories. Clearly, he wants, for good reasons, to avoid leaving such judgment to historians of science who come some time later to decide with hindsight which assumptions led to success. This, for sure, would lead to biased judgments because by that time the fate of the theory in question and the status of its components are likely to have been already decided. But Psillos does not explain why could not other scientists than the authors of the theory in question, well-informed science critics, or diligent localized realists identify the success-producing assumptions during the lifetime of the theory.

3. Laplace's Prediction Draws on the Caloric Model. Psillos (1999, 119–121) appeals to Laplace's novel and confirmed prediction of the speed of sound in air to support localized realism. He denies that this prediction depended on the hypothesis that heat consists of material substance. Although Psillos acknowledges that Laplace utilized the notions of latent heat and specific heat, which are among the basic assumptions of the caloric theory, he is careful to stress that Laplace's reasoning did not rely on the notion that heat consists of material particles. Consequently, Psillos concludes, the success of this prediction was not fueled by the false assumption that heat consists of material particles. This, however, is not an accurate representation of Laplace's view, which affirms the existence of repulsive forces between gas molecules. Such repulsion, according to Laplace, is caused by the mutual repulsion of caloric molecules that are attached to gas molecules.

According to the caloric theory of heat, caloric particles repel each other but tend to associate with material molecules. As it was firmly believed at that time, gas molecules themselves, like any spherical bodies, attract each other by gravitation but their mutual attraction is weak. Once gas molecules combine with particles of caloric or become surrounded by them the repulsive force between caloric particles overcomes the molecular attraction and the gas volume expands (Truesdell 1980, 31–36). So Laplace's prediction presupposes that gas molecules retain their caloric by attractive force and that the mutual repulsion of caloric particles causes

volume expansion. As we know from the history of science, it was firmly believed in Laplace's era that attractive and repulsive forces act on material bodies, not on immaterial entities. This clearly shows that Laplace's position adopts and utilizes the notion of material particles of heat and endorses their physical properties that the caloricists have already proposed.

Laplace also explained the observed constancy of temperature in his experiments on gases in terms of a dynamic equilibrium resulting from radiating and absorbing caloric particles (or caloric rays) at equal rates (Fox 1971, 167). Like Lavoisier, Laplace proposed that latent caloric causes volume expansion of gases while sensible caloric causes heating of gases (Fox 1971, 159). Moreover, Laplace utilized the principle of heat conservation, which is based on the assumption that heat, for being material, is neither created nor destroyed (Truesdell 1980, 32). It was believed in Laplace's time that matter is conserved but conservation of energy was not yet established. Consequently, heat conservation implied the material nature of heat. Laplace was already familiar with the writings of earlier caloricists that linked heat conservation to the assumption that heat consists of indestructible material particles. So Psillos's claim that the material entity of caloric played no role in the formulation of Laplace's prediction is unsubstantiated.

Psillos could argue that the equations and calculations that Laplace used to coin his prediction included no values or variables that can be directly ascribed to the existence of material particles of heat. In fact, he explicitly asserts that the hypothesis that heat consists of material substance was not "essentially and ineliminably" involved in the derivation and explanation of the laws of calorimetry (Psillos 1999, 119). It is true that no quantitative elements in Laplace's formula are directly derived from the supposition that heat consists of material particles. Yet Laplace's formula includes values for specific heat under constant volume and pressure. It is important to recognize that the concept of specific heat, which was introduced by Black around 1760, is founded on the material model of heat. Thus the caloric model (or entity) indirectly but crucially influenced Laplace's formula.

Suppose that the caloric was depicted as an immaterial strain in space or an ether-like medium. In that case, the law of conservation of matter would not apply to the interactions and reactions of the caloric. Consequently, Laplace would not be justified in utilizing the notion of heat conservation and would not be able to formulate his equation in its known form. Similarly, caloric as a strain in the medium or as an immaterial wave would not bind to the material molecules of gas, and, as a result, Laplace would not be able to explain volume expansion of gases by heat and his famous equation would not be possible to construct. This shows

that the entity of caloric material particles exerted a significant influence on Laplace's calculations and equation.

It is obvious at this point, after realizing that Laplace viewed the caloric as a material entity, that the assumption that heat consists of material particles was not idle in Laplace's theory because it helped producing a confirmed prediction. This realization poses an extremely serious problem for localized realism, which affirms that non-idle assumptions that produced successful predictions are approximately true. In fact, Laplace's non-idle assumption about the materiality of heat particles turned out later to be false. This assumption, which contributed to the success of Laplace's theory, was subsequently rejected by thermodynamics and all subsequent physical theories, which deny the material nature of heat. Consequently, the basic claim of localized realism that non-idle (i.e., successfully predictive) assumptions should be considered approximately true is untenable. Chang (2003) explains further how the success of the material theory of heat depended on the belief in the material nature of caloric particles.

There are many other examples in the history of science for assumptions that led to the predictive success of their theories but were subsequently considered false. Let us review an example from biological science. Slater's theory of oxidative phosphorylation, which was proposed and accepted in the 1950s, postulated that a high-energy intermediate compound transfers energy from the oxidation of fuel substances (e.g., sugars and fatty acids) to the reaction that leads to forming ATP molecules in mitochondria. The latter molecules become the direct source of energy for cellular reactions. This assumption of an intermediate high-energy molecule was responsible for successful predictions in the areas of muscle fiber contraction and pumping sodium and potassium across cell membranes. Yet this assumption was declared false around twenty years later because credible experimental data showed that no such intermediate molecule exists (Ling 1984, 507–509).

4. Localized Realism Adopts Empiricist Methodology. The fact that the postulated physical properties of caloric particles were not explicitly utilized in generating a successful prediction is not unique to the caloric theory. Contemporary theories that postulate subatomic particles contain laws and equations that do not directly refer to such particles or do not include variables that derive directly from their physical properties. Most of these theories infer from empirical data and theoretical laws the existence of particles as the best explanations of data. The success of these theories frequently depends on confirming some of their consequences before the posited particles are empirically detected.

Consider the case of Fermi's theory of beta decay. This theory proposes

that beta decay is a process that involves the decay of the neutron into an electron, a proton, and a neutrino. The neutrino was not known to exist at that time and remained a theoretical entity that is not yet empirically detected for around two decades (Allen 1958, 24). But postulating its existence supports the law of energy conservation that was challenged by the phenomenon of beta decay. Fermi's theory was supported, before neutrinos were empirically detected, by existing empirical data and by its ability to predict the positron spectra of cobalt, sodium, and phosphorus (Franklin 2000, 77). The neutrino played no central role in the success of these predictions.

Before more reliable experiments pointed to the existence of neutrinos, most scientists have accepted the reality of these entities based on inference to the best explanation. Traditional scientific realists would have done precisely the same. Fermi's view of the neutrino was the most convincing explanation for most of the basic aspects of beta decay, and this fact enhanced the acceptance of the reality of neutrinos among physicists on theoretical grounds. Had localized realists been active during that era, when credible experiments were still pending, they would have considered the neutrino eliminable and inessential. For sure, Psillos, before the emergence of evidence for neutrinos, would have acknowledged the components of Fermi's theory that were directly used to formulate the predictions of positron spectra but not the neutrino hypothesis. According to localized realism, the neutrino assumption was idle until recent empirical evidence appeared because the physical properties of that entity did not seem to offer input to the formulas or equations that led to the predictions of positron spectra.

If Psillos's criterion for the existence of entities (i.e., playing a central role in issuing a confirmed prediction) is strictly applied, very few unobservable entities would gain wide acceptance before convincing experiments reveal that such entities have observable physical effects. These experiments usually appear at a later time. This situation points to a critical rift between the positions of conventional realism and localized realisms on what qualifies a theoretical entity for being real. Conventional realists, unlike empiricists, are satisfied with inferences from credible theories while empiricists require the experimental confirmation of the existence of a proposed entity as a condition to accept its reality. By demanding that the postulated entity play a direct role in producing confirmed predictions, localized realists implicitly regard inference to the best explanation incapable of determining the reality of entities. In that respect, they deviate from the realist norms. Moreover, if localized realists have doubts about the validity of inference to the best explanation, they should not employ it to conclude that the assumption that leads to a theory's success is approximately true.

It is generally agreed that scientists and realists strongly believe that electrons and photons exist. Yet the history of science shows that neither the electron nor the photon provided the theories that proposed them with confirmed predictions although they later contributed to the empirical success of other, newer theories. There is no reason for treating the caloric particle differently. Psillos could justifiably dismiss the caloric entity only if he shows that the abductive method that was used to infer its existence and materiality was defective. He stops short of doing that.

5. Are Scientific Theories Needed? The primary function of theories is traditionally believed to be providing a relatively broad or comprehensive representation of an aspect of reality. Single beliefs may describe discrete parts of the world but cannot offer extended descriptions. But Localized realists, as already seen, recommend selective acceptance of theoretical constituents rather than whole theories. Their implicit rationale is that a theory can be believable only if all its constituents produce successful predictions. This, however, does not happen in reality because every theory contains components that fail to produce confirmed predictions. They refer to these components as idle. Moreover, some components can be invalid and eliminable. Thus localized realism considers whole theories less credible than some of their components, and this implies that the epistemic status of theories is inferior to that of its selected components.

The question that arises here is whether there is any point in constructing theories. If individual constituents of theories are the units of belief or disbelief and are also the ultimate building blocks of scientific knowledge, why do we need theories at all? Why should not scientists formulate and test single beliefs about the world without assimilating them within integral theories? Scientists can derive single beliefs from experiments and from empirical laws, for example. It is not the case that all scientific knowledge is presented in the form of theories. There are basic assumptions, circumscribed hypotheses, empirical laws, and generalizations from empirical data. It is unclear why localized realists do not oppose constructing theories although they recommend against accepting all their components.

A possible explanation for not opposing the construction of theories is that localized realists assume that the only way of producing valid assumptions is to build a theory then fragment it to derive some approximately true components. If that were their position, theories would be valued only because they provide assumptions for the localized realist to select from. That is, theories have a heuristic rather than informative function. But scientists in reality do not perceive the function of theories this way.

Scientists build theories from simpler, preexisting constituents that are

derived from empirical data and established theories to provide an account or a unified description of an extended segment of the world. Scientists do not construct theories in order to extract from them some correct individual beliefs nor to fragment them into scattered assertions. On the contrary, they use individual beliefs that they consider valid to generate a more holistic view of reality. Within a theory, single beliefs and assumptions are linked together in an inferential network in a way that leads to producing conclusions about the general structure of the world.

Another possible explanation for why localized realists do not object to constructing theories is that they believe that the only way to have confirmed assumptions is to derive them from a theory that has previously been tested and confirmed. But, as we have seen, localized realism asserts that the evidence for a theory does not extend to all its components. It follows that validating single beliefs is not the primary function of theories. So it is evident at this point that localized realism does not address in sufficient detail or clarity the question of the function of theories and fails to explain why integral theories are needed and valued although they are less credible than their individual components.

6. Other Implausible Elements in Localized Realism. As seen above, Psillos recommends relying on scientists' attitudes to their assumptions to identify the ones that led to the success of their theories, i.e., the approximately true assumptions. Yet analyzing the attitudes of scientists is not at all a reliable procedure. In most instances there are no clues to the attitudes of scientists to their assumptions. Scientists seldom leave documented comments on their assumptions although they may comment on their integral theories. Psillos does not tell us how to distinguish success-producing assumptions if scientists remained totally silent on that matter.

But even if we had an access to publicized, authentic expressions of scientists' attitudes towards their assumptions, could we be assured that the reported attitudes correlate accurately with the epistemic status of theoretical assumptions? It does not seem possible to affirm with confidence that the degree of certainty or conviction expressed by a scientist toward one of his or her assumptions reflects the degree of epistemic significance of that assumption. In fact, Psillos provides no argument for such correlation. Chang (2003, 910) maintains that the scientists quoted by Psillos as expressing doubt about the caloric were actually recommending caution towards all available theories of heat. Stanford (2003, 918–920) argues that many scientists strongly defended the reality of entities and mechanisms that turned out later to be false and nonexistent. It is known, for example, that Priestly, who was a great scientist, defended the reality of the phlogiston until his death.

Also, the notion of idle assumptions is problematic. Recall that the

view that not all components of a theory lead to its success is among the basic claims of localized realism. Psillos emphasizes that the success that we should count on is predictive success. He also argues that idle assumptions, to which localized realists attach negative attributes, can be identified because they do not contribute to the predictive success of their theories (Psillos 1999, 112). The question now is whether the epistemic worth of an assumption is solely determined by its ability to contribute to producing a successful prediction. Many assumptions that do not directly issue predictions connect various parts of the theory to ensure the inferential and conceptual unity within that theory. Others clarify the relations between the basic elements of the theory, thus augmenting its internal coherence and empirical effectiveness. Such assumptions provide the ‘metaphysical glue’ that holds the theory together and may offer positive heuristic for further research. Yet localized realists would consider these assumptions idle and eliminable. Their view, obviously, is extreme.

Psillos and Worrall do not clarify whether an idle assumption is supposed to remain permanently idle, and do not address the possibility of a previously idle assumption acquiring subsequent significance. As long as a theory is accepted it is always possible to experimentally confirm some of its aspects that were not initially tested. A theory may be accepted on the basis of a confirmed prediction but later it could furnish another successful prediction. Consequently, some of its components that did not contribute to its earlier success are no longer idle and acquire the status of valid assumptions. As the history of science reveals, many theories produced different impressive predictions over decades after their acceptance. So it would be premature to judge an assumption idle if it contributes nothing to the early successes of a theory.

An example for the temporariness of idle assumptions has been discussed by Psillos. He considers the assumption that heat consists of material fluid idle in the caloric theory of heat. But the same assumption, as argued above, was not idle by Psillos’s standards in Laplace’s theory of gases because it promoted the success of this theory. So localized realism allows an assumption to be eliminable when presented by a theory and approximately true when presented by another. For these considerations, it appears that the notion of “idle assumptions” is redundant and implausible.

7. Conclusion. Kitcher’s, Worrall’s, and Psillos’s attempts to answer the pessimistic induction raise new problems that are difficult to resolve or ignore. Their recommendation to accept only those theoretical components that appear to contribute to the predictive success of a theory undermines the significance of scientific theories as integral structures. Also, the view that theoretical entities that do not contribute to predictive suc-

cess should not be considered real is too restrictive and could lead to eliminating almost all currently accepted unobservable entities. Indeed, this stance represents in an important sense a nonrealist position and undermines the validity of inference to the best explanation, to which localized realism itself appeals to justify its own assumptions.

Psillos's case study of the caloric theory of heat reaches conclusions that are not historically supported. Furthermore, Laplace utilized the assumption of the materiality of heat to formulate a successful prediction. Yet this non-idle assumption was subsequently falsified. This implies that producing a successful prediction, contrary to the view of localized realism, does not necessarily entail the approximate truth of the assumption in question. Localized realists also stop short of clarifying the function and role of integral theories in science. For these reasons, localized realism fails to be a coherent position that overcomes the pessimistic induction.

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