Hegel’s Semantics of Singular Cognitive Reference, Newton’s Methodological Rule 4 and Scientific Realism Today*

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Frederick I. Dretske *in memoriam*:
keen wit, gentle soul, teacher *par excellence*.

Abstract: Empirical investigations use empirical methods, data, and evidence. This banal observation appears to favour empiricism, especially in philosophy of science, though no rationalist ever denied their importance. Natural sciences often provide what appear to be, and are taken by scientists as, realist, causal explanations of natural phenomena, often in terms of forces or entities we do not perceive with our normal, unaided human senses. Empiricism has never been congenial to realism about such scientific posits. Bas van Fraassen’s “Constructive Empiricism” purports that realist interpretations of any “unobservables” mentioned by a scientific theory in principle always transcend whatever can be justified by that theory’s empirical adequacy, and that “explanations” are merely pragmatic, insofar as they are context-specific to the presuppositions of whomever poses the question an explanation is to answer. Here I argue that “Constructive Empiricism” rests upon a series of flawed presumptions about natural science and about epistemology. I draw upon two main resources. One resource is the constraints upon specifically *cognitive* reference to particulars, first identified by Kant (and later by Evans). The second is William Harper’s (2011) brilliant re-analysis and defense of Newton’s *Principia*, which shows that, and how, Newton justified his realism about gravitational force. One surprise is that Kant’s semantics of singular cognitive reference (examined in §3) directly and strongly supports Newton’s Rule 4 of scientific method (§4), which strongly supports his realism about gravitational force (summarized in §2). A further surprise is that Hegel first recognized that this semantics of singular cognitive reference directly and strongly supports Newton’s methodological Rule 4 of experimental philosophy in ways which support Newton’s realism about gravitational force, and about distance forces generally. The textual and exegetical issues these attributions require I examine elsewhere. Here I make these important findings available to philosophers and historians of science.

1. *Introduction*

Empirical investigations use empirical methods, data, and evidence. This banal observation appears to favour empiricism, especially in philosophy of science, though no rationalist ever denied their importance. The natural sciences often provide what appear to be, and are taken by many scientists as,

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realist, causal explanations of natural phenomena, often in terms of forces or entities we do not perceive with our normal, unaided human senses. Empiricism has never been congenial to realism about such scientific posits. Bas van Fraassen's "Constructive Empiricism" purports that realist interpretations of any such scientific posit in principle always transcend whatever can be justified by that theory's empirical adequacy, and that "explanations" are merely pragmatic, insofar as they are context-specific to the presuppositions of whomever poses the question an explanation is to answer. Here I argue that "Constructive Empiricism" rests upon a series of flawed basic presumptions about natural science and about epistemology. My analysis draws upon two main resources. Both are historical; their enduring philosophical importance underscores what systematic philosophers can learn from historical philosophy and from history of science. One resource is the constraints upon singular, specifically *cognitive* reference to particulars, first identified by Kant (and later by Evans). The second is William Harper's (2011) brilliant re-analysis and defense of Newton's *Principia*, which shows that, and how, Newton justified his realism about gravitational force. One surprise is that Kant's semantics of singular cognitive reference (examined in §3) directly and strongly supports Newton's Rule 4 of scientific method (§4), which strongly supports his realism about gravitational force (summarized in §2). A further surprise is that Hegel first recognized that this semantics of singular cognitive reference directly and strongly supports Newton's methodological Rule 4 of experimental philosophy in ways which support Newton's realism about gravitational force, and about distance forces generally. The textual and exegetical issues these attributions require are provided elsewhere; here I make these findings available to philosophers and historians of science.

Kant's *Critique of Pure Reason* contains an original and powerful semantics of singular cognitive reference,[1] though Kant did not fully realize its implications. In the *Phenomenology of Spirit* (1807) Hegel adopted and justified Kant's semantics of singular cognitive reference, without appeal to Transcendental Idealism (nor to any similar view; Westphal 2009a), and showed how it suffices to refute pre-Critical metaphysics, empiricism, rationalism, and scepticism, whether Pyrrhonian, Cartesian, or empiricist (Westphal 2011b). Hegel further recognized that this semantics of singular cognitive reference directly and strongly supports Newton's methodological Rule 4 of experimental philosophy in ways which support Newton's realism about

[1] Hanna (2001), Westphal (2004), Bird (2006). These studies omit the implications of Kant's cognitive semantics for philosophy of science, which Hegel developed. Kant's awareness of key problems with causal and with descriptions theories of reference was established by Melnick (1989).

gravitational force.[2] Following Harper (2011), I begin with Newton's Rule 4 of experimental philosophy and its role in Newton's justification of realism about gravitational force (§2). Then I summarize Hegel's semantics of singular cognitive reference (§3), and show that it is embedded in and strongly supports Newton's Rule 4, and that it rules out not only Cartesian physics (*per* Harper) but also Cartesian, infallibilist presumptions about empirical justification generally (§4). This result exposes a key fallacy, neglected for thiry three years, in Bas van Fraassen's central argument for his Constructive Empiricism, and in many common objections to realism (§§5, 6). These problems reveal yet a further important regard in which Constructive Empiricism is *in*adequate to its intended domain, not even to Classical Newtonian Mechanics (§7). This highlights a chronic empiricist misunderstanding of Newton's mechanics (§8). Hegel's semantics of singular cognitive reference improves upon the semantic interpretation of scientific theories, and rectifies the presumption that the laws of physics literally "lie" (§9). Finally, van Fraassen's stress upon the "pragmatics" of explanation exhibits a chronic misuse of philosophy of language within epistemology and philosophy of science (§10). Accordingly, Hegel and Newton have invaluable lessons for contemporary philosophy and history of science (§11).

2. *Newton's Rule 4 and his Causal Realism*

2.1. Newton's Rule 4 of experimental philosophy states:

> In experimental philosophy, propositions gathered from phenomena by induction should be considered either exactly or very nearly true notwithstanding any contrary hypotheses, until yet other phenomena make such propositions either more exact or liable to exceptions. (Newton 1999: 796; 1871: 389)

Newton directly adds, "This rule should be followed so that arguments based on induction may not be nullified by hypotheses" (*ibid*.). Newton's Rule 4 requires any competing scientific hypothesis to have, not merely empirical evidence in its favour, but sufficient and sufficiently precise evidence either to make an accepted scientific hypothesis "more exact" or to restrict it by demonstrating actual "exceptions" to it. Rule 4 is central to Newton's methodology, in ways I now sketch.[3]

[2] The textual and exegetical issues involved in these attributions to Hegel are summarised in Westphal (2009b); the details are examined in Westphal (1989, 1998a, 2000, 2002-03, 2011b, forthcoming-a).

[3] Here I follow Harper (2011), who kindly allowed me to study his book prior to publication.

Recent scholarship, especially Harper (2011), shows that Newton was significantly more sophisticated about scientific method than contemporary philosophers of science, that his ideal of explanatory adequacy – and its satisfaction by his mechanics – justified his realism about gravitational force, and also that – when provided the relevant data and analysis – his explanatory ideal justifies the shift from Newtonian mechanics to General Relativity. For present purposes it suffices to focus on one key issue and one central instance of it. This will enable us to grasp a key epistemological insight of Newton's Rule 4, and how it supports his causal realism about gravitational force.

2.2. When rejecting mere hypotheses, Newton famously states that

> [...] whatever is not deduced from the phenomena must be called a hypothesis; and hypotheses, whether metaphysical or physical, or based on occult qualities, or mechanical, have no place in experimental philosophy. In this experimental philosophy, propositions are deduced from the phenomena and are made general by induction. The impenetrability, mobility, and impetus of bodies, and the laws of motion and of the law of gravity have been found by this method. And it is enough that gravity really exists and acts according to the laws that we have set forth and is sufficient to explain all the motions of the heavenly bodies and of our sea. (Newton 1999: 943, 1871: 530; *cf. Opticks*: 401-402).

This passage has been persistently misread by generations of philosophers – starting at least with Berkeley and Hume – for two reasons.[4] First, it has been widely assumed that by "deduction" from the phenomena Newton meant logical deduction, though this makes his view hopeless because statements can only be deduced logically from other statements, not from experiences nor from natural phenomena (nor from anything non-propositional). Second, it has been widely assumed that by "induction" Newton meant simple numerical induction. Both assumptions are incorrect.[5]

Newton first states Rule 4 in the third edition of the *Principia*, but it is not new to Newton's mechanics, and can be seen to inform Galileo's determination that the acceleration due to free fall is proportional to time (squared) rather than to distance, and to inform Kepler's painstaking determination of the (very nearly) elliptical curvature of planetary orbits. Bohr's (1949: 229) reply to Einstein's objection to Quantum Mechanics is a very close cousin of Rule 4: "There could be no other way to deem a logically consistent mathematical formalism as inadequate than by demonstrating the departure of its consequences from experience or by proving that its predictions did not exhaust the possibilities of observation, and Einstein's argumentation could be directed to neither of these ends."

[4] Berkeley (*Principles*: §§105-106) and Hume (first *Enquiry* 7.1.25n; 1975: 72 note) espouse strictly instrumentalist views of Newtonian gravitation.

[5] Both mistaken assumptions result from the deductivist view of scientific explanation, which is presupposed by both Hume's Problem and by Goodman's Riddle of Induction, and was central to Logical Positivism and Logical Empiricism up to *circa* 1980; see Suppe (1977), Grünbaum and Salmon

Newton uses the term "deduction" in a broader sense tantamount to "justify" by evaluating empirical evidence; recall the forensic use of the term 'deduction' from evidence. The question then is, what sort of "justification" Newton proposes to derive from natural phenomena. An especially important example of Newton's "deduction from the phenomena" is provided by Harper's reply to the concern that Newton appears to assume as an hypothesis, rather than to prove on the basis of phenomena, that the inverse-square law of mutual gravitational attraction holds generally, not merely for those few spaces in the cosmos occupied by bodies observed in our solar system (Harper 2011: 28-31, 137-142).

Three aspects of Harper's response to this concern suffice for present purposes:

1) Newton's method seeks converging measurements by various independent means of causal parameters, where:
    - *i*) Systematic dependencies identified by a theory make the phenomenon to be explained measure the value of the theoretical parameter which explains it.
    - *ii*) Alternatives to the phenomenon would carry information about alternative values of the parameter which explains it.
2) This feature of Newton's method highlights the importance of the evidentiary links between Newton's three independent ways of measuring centripetal force and acceleration fields.
3) Newton's Rules of Philosophizing – and centrally Rule 4 – support generalizing the causal parameters thus measured. (Harper 2011: 257-264, 361-364)

Newton's analyses and proofs are, as Harper shows, very rich, subtle, and thorough; here only some of their rudiments may be illustrated briefly. One illustration of the kind of "systematic dependencies" mentioned in (1) is Newton's

(1988), Kyburg (1988), Salmon (1989). That observation statements do not follow logically from observations (experiences) was stressed by Hempel (1935) and Schlick (1935); it recurs in Davidson's (1983/2001) view that only a belief can justify another belief: "The relation between a sensation and a belief cannot be logical, since sensations are not beliefs or other propositional attitudes. What then is the relation? The answer is, I think, obvious: the relation is causal. Sensations cause some beliefs and in *this* sense are the basis or ground of those beliefs. But a causal explanation of a belief does not show how or why the belief is justified" (Davidson, 2001: 143); "... nothing can count as a reason for holding a belief except another belief" (Davidson 2001: 141; *cf.* 153, 155). A further misconception underlying the complaint that observations do not entail statements or propositions is neglecting the distinction between appearances, observations, or data and the regular natural phenomena established, investigated, and often explained in the sciences; see Bogen and Woodward (1988), Bogen (2011), Falkenburg (2011), Woodward (2011), Harper (2011): 23-24, 50, 53-65, 114, 116-117, 162, and below: §4.1. (Muller [2005] neglects this distinction).

recognition of the further significance of Kepler's "Areal" Law (law of areas). Kepler determined that the (roughly triangular) area swept by a planet orbiting the Sun is constant, although the planet follows a (very nearly) elliptical orbit, accelerating when approaching the Sun and decelerating when receding from the Sun. This is Kepler's Areal Law:

> The line joining the planet to the Sun sweeps out equal areas in equal times as the planet travels around the ellipse.

Newton realized that this constancy indicates precisely an orbit about the Sun's centre of gravity because an increasing areal rate would place the focal point of the planet's orbit outside and "ahead" of the Sun, whilst a decreasing areal rate would place that focal point outside and "behind" the Sun. The former would result in an expanding, the latter in a contracting orbit; either case represents orbital degeneration rather than stability. Newton's observational data (which included Kepler's and Brahé's) clearly indicated orbital stability. The stability with which planetary orbits satisfy Kepler's areal law indicates that their orbits *measure* precisely an inverse-square acceleration field directed towards the Sun (Harper 2011: 109-120).[6]

This same result – an inverse-square acceleration field – is measured independently by determining whether there is orbital precession, *i.e.*, whether planets follow the same orbit repeatedly, or whether the location of an orbit's aphelion and perihelion (its furthest and closest points to the Sun, called apsides) shift by rotating about the Sun, either "forwards" or "backwards" with respect to the direction of orbital rotation, upon subsequent orbits. Absence of such precession *measures* precisely an inverse square law of acceleration; a different rate of diminution of field strength would produce either positive

[6] An important feature of Newton's justification of universal gravity is that his demonstrations do not assume that orbits are ellipses, but instead uses their shape as measuring the force of gravitational attraction, whereby an ellipse measures precisely an inverse-square power of gravitational attraction (Chandrasekar 1995: 87-88, 93-125; Smith 2002b; *cf.* Harper 2011: 86 n2, 288-289). Hegel understood Newton's *Principia* (Ferrini 1995, 1997) and its modern reconstruction by Bernouli using mathematical analysis very well, though apparently he did not appreciate this feature of Newton's method and proofs (*Enz.*: §270 Anm.). Hegel did, however, appreciate and understand the critical point made by Castel (1724), and later by Whiteside (1970), that Newton cannot prove a *general*, but only a *local* areal theorem because Newton assumes without proof that there is a unique limit, in the form of a curvilinear arc, to his geometrical limit-taking operations (Nasti De Vincentis, 1995, 1998). This defect of Newton's proof is rectified only by refounding his Mechanics upon mathematical analysis, by Bernouli; Hegel's objections to Newton are strictly methodological (Westphal 2008: §2). Hegel analyzed and justified the transeunt causality involved in distance forces (*e.g.*, gravitational, magnetic, electrical or chemical), *inter alia* to support Newtonian dynamics and mechanics (Westphal forthcoming-a). (Why it is only terminologically anachronistic to speak of Newton's gravitational "field" is noted below, in connection with his Definition 6).

or negative orbital precession (Harper 2011: 120-126).[7]

These two crucial steps, undertaken by Newton for the independent cases of six planets and two distinct aspects of their motions, *are* Newton's (initial) deduction from planetary orbital phenomena of the existence of an inverse-square acceleration field radiating from the Sun, in contrast to any other rate of diminution. Extrapolating from these sets of orbital phenomena and their univocal measurement of an inverse-square attractive force to a field of such force radiating from the Sun *is* Newton's "generalization by induction" of the consequences he has deduced from the orbital phenomena (Harper 2011: 44-45, 128-129, 135-146, 257-284).

Harper shows that Newton had additional data on the motions of bodies which provide further precise measurements of the inverse-square attraction of gravity: Comets, the four moons of Jupiter, the Earth's moon, the rotation of Jupiter and the Sun about their common centre of motion, and a vast range of terrestrial phenomena, including pendula, free-fall, and (quaintly enough) floating magnets. Indeed, the entirety of *Principia*, Book 3, Newton's "System of the World," *is* his proof of universal gravitation, all based upon multiple, precise, agreeing measurements of the inverse-square gravitational field provided by many diverse phenomena of celestial and terrestrial motion. All of these were further bolstered in 1759 by Clairaut's successful, precise prediction of the return of Halley's comet.

Harper (2011: 355-368) explains very nicely how Newton's appeal to his First Law can be used to extend his Third Law in order to show that Jupiter's tendency to move toward the Sun – *i.e.*, its tendency to orbit the Sun rather than to move away from the Sun on a tangent – counts as an attraction between Jupiter and the Sun. Newton's First and Third Laws state:

> Law 1 Every body continues in its state of resting or of moving uniformly in a straight line, except insofar as it is driven by impressed forces to alter its state.
>
> Law 3 To an action there is always a contrary and equal reaction; or, the mutual actions of two bodies upon each other are always equal and directed to contrary parts. (Newton 1999: 416-417; 1871: 13-14)[8]

[7] The absence of orbital precession suffices to measure the inverse-square attraction of gravity, despite the fact, unknown to Newton, that our solar system is stable in the cosmological short term; over the course of some 60 million years it is chaotic (Laskar 2011). Prof. Mauro Nasti de Vincentis kindly alerted me to this point.

[8] Law 2 concerns composition of distinct forces (the "Parallelogram of Forces").

Measuring an attractive force between, *e.g.*, Jupiter and the Sun, requires using Newton's definitions of the quantities of motive, accelerative, and absolute centripetal force (Harper 2011: 86-94); these are his Definitions 6-8:

> Def. 6 The absolute quantity of centripetal force is the measure of the same, greater or less in proportion to the efficacy of the cause propagating it from the centre through the encircling regions.[9]
>
> Def. 7 The accelerative quantity of centripetal force is the measure of the same, proportional to the velocity which it generates in a given time.
>
> Def. 8 The motive quantity of centripetal force is the measure of the same proportional to the motion which it generates in a given time. (Newton 1999: 406-407, 1871: 4-5)

Harper (2011: 375-378) shows how Newton identifies systematic dependencies which enable orbital phenomena to provide measurements of the Sun's gravitational field. Each of these measures is supported by Newton's method of successive approximations (*cf.* Smith 2002a, 2002b). Each of Newton's measures begins with an approximation of the physical situation which is used to calculate an approximate measure of the target value. With this approximate result in hand, Newton progressively eliminates approximations by reiterated use of the very same explanatory resources to achieve ever more accurate, ever less idealized measures of the target value. At each stage, divergences between the theoretically-based approximation and the observed phenomena are treated as *theory-mediated secondary phenomena* which are to be explained by using the very same explanatory resources. Reiterated deployment of the same theoretical apparatus produced ever more precise *and* converging measures of the target value, thus supporting very robustly Newton's claim thereby to measure a real value of a real force. That such successive approximations succeed *in each case* of Newton's vast array of *independent* measures of the inverse-square rate of gravitational attraction greatly augments the strength of his conclusions based on the agreement *among* each of these measures of the inverse-square field of gravitational attraction. The wide variety of *agreeing* measures of the inverse-square attraction of gravitational force provides a very robust measure-

[9] Cohen and Whitman understandably use "encircling" to render Newton's "*circuitu*," but it is important not to restrict its sense to two dimensions; "surrounding" better conveys the three-dimensional sense of Newton's definition. Active forces being effective within some region surrounding a material body was common in 18th C. dynamic theories of matter, propelled especially by Newton's chemical researches, even without using the term 'field'. Regarding the legitimacy of using the term 'field' to state Newton's own view of gravity, see Harper (2011).

ment of the power of that force. Harper stresses that this is one of Newton's key ideals of theoretical success, to provide "convergent accurate measurement of causal parameters by the phenomena they are taken to explain" (Harper 2011: 104-107, 194-200).

2.3. This is a vastly stronger ideal of theoretical success than empiricist descriptive, predictive, and retrodictive accuracy (across the set of relevant observational data), for at least four reasons.

Law 3, the equality of action and reaction between two bodies, is required to disentangle the masses of any two celestial bodies from their weights. Disentangling these two characteristics is required in order to use their motions to measure the force of their attraction, whatever it may be. Newton's Law 3 has vastly more empirical support than any assumption that the strength of attractive force varies pair-wise among celestial bodies, mainly because it alone provides for convergent agreeing measures of the relative masses within our solar system.

Second, Newton's gravitational theory famously integrated a vast range of celestial and terrestrial kinematic phenomena within a common, comprehensive, and precise explanatory (causal, dynamic) theory. This explanatory integration provides more than comprehensiveness: By using the same theory to explain this vast range of phenomena, Newton's *Principia* is able to use this vast range of phenomena to provide accurate, convergent, agreeing measures of the strength of gravitational attraction and its inverse-square rate of diminution across our solar system, including some comets. For example, both the orbit of the earth's moon and the length of a terrestrial seconds pendulum near sea level (at a specified latitude) provide accurate agreeing measures of the force of the earth's gravity (Harper 2011: 180-186, 215-217).

Third, using Law 3 also enables Newton to measure the relative masses of celestial bodies with satellites, including the Sun, Earth, Jupiter, and Saturn. Success in solving this very difficult analytical problem provides further confirmation of Law 3 by showing that it is implied by the observed phenomena Law 3 is used to measure (Harper 2011: 355-364). Therefore, Newton's Third Law *is* "deduced" – that is, justified by inference – from the phenomena, though it is inferred from them indirectly rather than directly; it is not simply postulated (*à la* hypothetico-deductive ('H-D') methodology).

Fourth, Newton's progressive elimination of approximations can and often did lead, not only to much greater precision, but in several central cases, Newton's results stand in formal contradiction to his initial approximations. This important feature of Newton's method cannot be explicated by H-D methods (*cf.* Harper 2011: 126-142). Relying upon the empiricist criterion of empirical adequacy in terms of descriptive, predictive, and retrodictive accuracy across the data set (*i.e.*, "empirical adequacy") cannot rule out hypotheses that different material bodies have different powers of attractive force. Nor can it rule out the suggestion that the inverse-square law holds only for those distances and regions of space for which we have observational data. Nor does it suffice to disentangle the masses from the weights of orbiting bodies in ways achieved by Newton's use of Law 3, which is crucial to Newton's entire set of astronomical measures of the inverse-square power of gravitational force. Newton's Law 3 is required to obtain these measurement results.[10]

2.4. Understanding Newton's realism about gravitational force requires distinguishing it from causal agnosticism. According to causal agnosticism, causal structures generate observed regularities, though we cannot know what those causal structures are. This issue was hotly debated by Newton and his contemporaries, especially Leibniz (Janiak 2007). Newton is not agnostic about gravitational force. Newton concludes that "... it is enough that gravity really exists and acts according to the laws that we have set forth and is sufficient to explain all the motions of the heavenly bodies and of our sea" (Newton 1999: 943, 1871: 530, *cf. Opticks*: 401-402). Newton was a realist about gravitational force; he was agnostic only about how gravitational force operates as a physical cause.[11]

2.5. The progressive increase in accuracy required by Newton's ideal of theoretical adequacy significantly exceeds the requirements of other accounts of theoretical adequacy current in philosophy of science. Newton's ideal of theoretical adequacy may recall Glymour's "boot-strap" analysis. However, Harper has shown that Newton's methods and ideal of theoretical adequacy are both stronger and more adequate than Glymour's account and that they overcome problems it confronts.[12] Indeed, Harper (2011: 378-385, 392) shows that Newton's ideal of theoretical adequacy applies to the shift from Classical Mechanics to General Relativity, and on the basis of the relevant evidence and analyses, favors General Relativity (*pace* Kuhn 1970: 94, 102, 107-108). In sum, Newton understood both the demands upon and the achievements of physical science better than have most philosophers and historians of science up to the

[10] For more detailed summary and critical discussion, see Huggett *et al.* (2013).

[11] I neglect an important historical nicety here. Newton defended natural theology on the basis that, if left alone, his "System of the World" would run down, thus requiring God's occasional jiggle to keep it running (Carrier 1999). This feature of his mechanics vanishes when it is reformulated on the basis of mathematical analysis by Johann Bernoulli.

[12] These problems are due to Christensen (1983, 1990); Harper (2011: 113-116) responds on Newton's behalf.

present day. In these regards, Newton's causal realism is empirically supported far more than is empiricist non- or anti-realism, if one insists on treating these two views as "hypotheses."

Bas van Fraassen (2002: 129, 2004a: 130-131), too, hails Newton's Rule 4 – at least occasionally; elsewhere he (2007: 365) he dismisses Rule 4 in the same breath as the traditional empiricist principle of sensory evidence (*sola experientia*). It may be expected that the interpretation and use of Rule 4 shall prove controversial within history and philosophy of science, as empiricists respond to Harper's (2011) extraordinary findings. Here I argue that the cognitive-semantic core of Newton's Rule 4, as Harper understands it (rightly, I submit), is supported directly and decisively by Hegel's semantics of singular cognitive reference, so that objections to Rule 4 based solely upon considerations within history and philosophy of science cannot undermine Harper's interpretation and Newton's use of it.

3. *Hegel's Semantics of Singular Cognitive Reference*

3.1. *Avant la lettre*, Hegel's semantics of singular cognitive reference incorporates Gareth Evans' (1975) thesis about predication, which Hegel embeds within a much richer epistemological analysis. Hence we may to begin with the conclusion of Evans' analysis:

> the line tracing the area of [ascriptive] relevance delimits that area in relation to which one or the other, but not both, of a pair of contradictory predicates may be chosen. And that is what it is for a line to be a boundary, marking something off from other things. (Evans 1985: 36, *cf.* 34-37)

It is clearly implicit, and very nearly explicit, in Evans' analysis, that specifying the relevant boundary for the use of any member of a pair or group of contrary (mutually exclusive, though not necessarily "contradictory") predicates is only possible by specifying the region relevant to the manifest characteristic in question, and *vice versa*, and (for reasons Evans provides, concerning the mastery of the relevant predicates of a language) this region will be either co-extensive with or included within the spatio-temporal region occupied by some physical particular. More generally, Evans demonstrated – even if he only implicitly argued – that predication requires conjointly specifying the relevant spatio-temporal region and some manifest characteristic(s) of any particular we self-consciously experience or identify. These conjoint specifications may be rough and approximate; the key point is that the spatio-temporal localization of any particular and ascription of some manifest characteristics to it are *conjoint, mutually interdependent* cognitive achievements. I shall call this "The Evans Thesis."[13]

3.2. Hegel's strictly internal critique of "sense certainty" – of supposed aconceptual knowledge of particulars – refutes (*avant la lettre*) not only Russell's "knowledge by acquaintance," but also Russell's "knowledge by description" (Westphal 2010a). Hegel's critique stresses the spatio-temporal character of human experience, and our ineluctable if implicit use of the concepts 'space' and 'time', in order to justify an important thesis about determinate, specifically *cognitive* reference to any particular we may encounter. Hegel's thesis is that what one can say by using token-indexical expressions and what one can pick out by using ostensive gestures are mutually dependent and succeed as particular acts of reference which pick out particulars to which we refer due to what we intend or mean, where we can mean or intend any one particular only by conceptually informed determinate thoughts about (*inter alia*) the spatio-temporal region it occupies. This holds for objects as well as events (and *mutatis mutandis* also for sense data).[14]

Recent semantic theory has shown that part of the meaning or "character" of a token of an indexical type term is that a specific speaker designates a specific item within a determinate region of space and time.[15] Hegel argues for this thesis, which is the negation of sense certainty. Hegel shows that determining (at least approximately) the origin of the relevant reference system (the speaker) and (at least approximately) the scope of the relevant spatio-temporal region of the designated particular is possible only by appropriately using concepts of 'space', 'spaces', 'time', 'times', 'I', and 'individuation', which can only be properly used by also using concepts of at least some of the designated particular's manifest characteristics (properties designated by tokens of predicates). Hence neither ostensive designation nor singular cognitive reference are possible on the basis of concept-free "knowledge by acquaintance," *i.e.*, "sense certainty" (Westphal 2000).

In the closing paragraphs of "Sense Certainty" (*Phenomenology of Spirit*:

[13] Fault-finding has become such a professional pre-occupation that philosophers tend to miss those rare but important occasions when an author demonstrates something more, other, or more important than s/he claims. This tendency is exacerbated by mistaking merely posing a question for making an objection (an ever more common occurrence, even amongst referees), and thus failing to re-examine a text or an analysis carefully to determine how its author (or how that view) can, would, or might answer the reader's question.

[14] NB: Hegel's critique of "sense certainty," or "knowledge by acquaintance," is entirely epistemological, and so is independent of any ontological or metaphysical issues about the objects of human sensory awareness.

[15] See Evans (1982): chapter 6; Kaplan (1989), Perry (1979).

chapter 1), Hegel criticizes an important, if desperate attempt to avoid admitting predication by using only descriptions but no ostensive gestures to identify and to know particulars. The key problem with this view is the key defect of definite descriptions as an account of human knowledge of particulars. According to the descriptions theory of reference, our statements refer to whatever is described when we analyze the meanings of our terms, phrases, or statements into explicit descriptions. The problem with this approach *within epistemology* is that, no matter how specific or extensive a description may be, no description by itself determines whether it is empty, determinate, or ambiguous because it describes no, only one, or instead several individuals. Which may be the case is not simply a function of the description: it is equally a function of what there is. The inclusion of definite pronouns (such as 'this' or 'the one and only') within an attributive phrase does not, because it cannot, settle this issue because no definite article (nor attributive phrasing) can insure that the phrase in which it occurs is neither empty nor ambiguous; this was, after all, part of Russell's problem (*ca.* 1905) with 'The present King of France'. To *know* any one spatio-temporal particular thus requires both correctly ascribing characteristics to it *and* locating it in space and time (at least approximately). Integrating both of these is required for predication, and also for knowledge of (or even error about) that individual. Only through singular sensory presentation *and* competent (if implicit) use of conceptions of 'time', 'times', 'space', 'spaces', 'individual', and 'individuation', can we locate any object or event within space and time. Only through ostensive designation can we *ascribe* the (token) predicates used in our (perhaps implicit) description *to* any *one*, putatively known particular. Therefore, predication is required for singular *cognitive* reference to any sensed, spatio-temporal particular. Only through this kind of predication can anyone specify (even approximately) the relevant spatio-temporal region (putatively) containing the particular one purports to designate ostensively – by specifying its occupant, the (putatively) known particular. Only in this way can one note, specify, or determine precisely *which* spatio-temporal region to designate, in order to grasp *this* (intended, ostended, presented) particular, and to ascribe to it any manifest characteristics, all of which is required to achieve any knowledge (whether presumptive or actual) of that particular (Westphal 2002-03).

Thus, in brief, does Hegel show that determinately significant cognitive judgments (whether true or false, justified or not) are possible for us only through conjoint spatio-temporal localization and designation of, and predicative ascription of characteristics to, any experienced particular. Recognizing any particular object or event requires conceptually identifying both the region it occupies and at least some of its manifest characteristics. Thus, in brief, does Hegel justify the Evans Thesis. As important as predication is to philosophy of language, analyses of the meanings of our terms or the contents of our concepts or descriptive phrases do not because they cannot suffice for epistemology. (I further corroborate this point below, §10). Following Kant, Hegel recognized that only by analyzing the cognitive dimensions of predication can we understand how the terms or concepts we use in our judgments, claims, or assertions can have specifically *cognitive* significance, in addition to their linguistic meaning or conceptual content (intension).[16] This Thesis is neutral about whether an epistemology is formulated in terms of concepts, statements, beliefs or judgments; it is also neutral about the analysis of conceptual content or linguistic meaning. To summarize this point I state the following:

> Thesis of Singular Cognitive Reference: Terms or phrases have "meaning," and concepts have classificatory content (intension), as predicates of possible judgments, although in non-formal, substantive domains no such statement has specifically cognitive significance unless and until it is incorporated into a candidate cognitive judgment which is referred to some actual particular(s) localised (at least putatively) by the presumptive judge (a cognizant subject, *S*) within space and time. Cognitive significance, so defined, is required for cognitive status (even as merely putative knowledge) in any non-formal, substantive domain.

This Thesis has two important implications for epistemology, including philosophy and history of science.

3.3. One important consequence of Hegel's semantics of singular cognitive reference is that it shows that justificatory infallibilism is in principle *irrelevant*

[16] Implicit here is Hegel's further thesis that our conceptions of 'time', 'times', 'space', 'spaces', 'individual', and 'individuation' are *a priori*. The *a priori* status of these conceptions follows from the fact that any empirical concept must be learned, acquired, or defined on the basis of our experience of relevant spatio-temporal particulars, the identification of which requires possession and competent use of these conceptions. To speak of particulars "causing" our conceptions (or beliefs) cannot be given any justifiable constitutive interpretation (Westphal 2004: §63.1, 2012) and obscures rather than illuminates the central issues, in part because causal *de*scription – widely popular amongst causal theorists of mind, of reference and of action – does not suffice for causal *a*scription, much less does it suffice for *justifiable* causal ascription. These cognitive issues are widely neglected by those same causal theorists. These requirements involve specifically *cognitive* semantics, not only semantics of linguistic meaning and demonstrative reference. The *a priori* status of those conceptions is further bolstered by the failure – on strictly internal grounds – of Hume's account of "general ideas," *i.e.*, determinable concepts (Westphal 2013b). Against such considerations contemporary foundationalists often reply that they are unaware of using these conceptions. The presumption that such unawareness counts as a relevant epistemological premise presupposes Cartesian transparency of self-consciousness and commits a *petitio principii*.

to the non-formal domain of empirical knowledge. Strictly speaking, formal domains are those which involve no existence postulates. Strictly speaking, the one purely formal domain is a careful reconstruction of Aristotle's Square of Opposition (Wolff 1995, 2000, 2009, 2012). All further logical or mathematical domains involve various sorts of existence postulates, including semantic postulates. We may define 'formal domains' more broadly to include all formally defined logistic systems (Lewis 1930, rpt. 1970: 10). Whether we construe formal domains narrowly or broadly, deduction suffices for justification within any formal domain because deduction *constitutes* justification within any formal domain. Indeed, a domain is *formal* only insofar as deduction constitutes justification within it. Only within formal domains is justification constituted by provability.

The relevance of any such logistic system to any non-formal, substantive domain rests, not upon formal considerations alone, but also upon substantive considerations of how useful a specific logistic system may be within a non-formal, substantive domain (Lewis 1929: 298, *cf.* Carnap 1950a). The use of that system within any non-formal domain requires further justificatory resources, not limited to formal deduction. Consequently, within any substantive domain, fallibilism is no skeptical capitulation, not because infallibilist standards of justification are too stringent, but because *in principle* they are inappropriate to any and to all substantive domains. Conversely, within any substantive domain, a mere logical possibility as such has no cognitive status (because it is not referred to any localized particulars) and so cannot serve to "defeat" or to undermine (refute) an otherwise well-grounded line of justificatory reasoning within that domain.

The domain of (putative) empirical knowledge includes spatio-temporal objects and events; accordingly, empirical knowledge is a non-formal domain. Consequently, the Thesis of Singular Cognitive Reference rules out the ideal of infallible justification (*scientia*) across the entire non-formal domain of empirical knowledge. Recognizing that only fallibilist accounts of justification are tenable within the non-formal domain of empirical knowledge is no concession, and certainly no capitulation, to skepticism.[17]

[17] Various attempts have been made to defend infallibilism about empirical justification (*e.g.*, Lehrer and Kim 1990, Merricks 1995, McDowell 2010, 2014). These infallibilist rejoinders, however, chronically commit (implicitly or explicitly) a *petitio principii* by assuming premises fallibilists need not (and should not) accept, or by assuming that the truth condition of knowledge is not met. Any sound fallibilism requires that the truth condition of knowledge be met; it merely denies that the satisfaction of the truth condition need be proven to be satisfied. McDowell stresses that the fallibility of our perceptual-cognitive capacities *qua* capacities does not entail that any (much less every) particular perception is fallible, so that (trivially) when one sees a table, it is that table one sees. He (2010: 253) asserts that such perceptions involve or provide "indefeasible warrant for belief," and that it is sheer

3.4. A second important implication of Hegel's semantics of singular cognitive reference is that it secures the key aim of meaning verificationism *without* invoking meaning verificationism! Hegel's cognitive-semantic thesis holds independently of whether the concepts we use in cognitive judgments are *a priori*, *a posteriori* or mixed. His specifically *cognitive*-semantic point is that, whatever may be the conceptual content or linguistic meaning of our claims, judgments, propositions, or statements, they have no cognitive significance for knowledge of particulars unless and until we refer them to particulars we have located within space and time in candidate cognitive claims, judgments, or assertions. This requirement is a necessary condition for the truth-evaluability of our claims (*etc.*), and it is a necessary condition for us to know enough about our claims – and whatever about which we make those claims – to discover and thereby to determine their truth value. It is also necessary (though not sufficient) for our assessing the justification of our cognitive claims about those particulars. This is the nerve of Kant's and Hegel's critique of prior metaphysics; their Thesis of Singular Cognitive Reference and the *a priori* status of the concepts 'time', 'times', 'space', 'spaces', 'particular', 'I', and 'quantity' (number or plurality) provide *no* haven for *a priori* metaphysical speculation, whether pre-Critical or contemporary.[18] This key point of cognitive semantics has broad

"fantasy" to suppose that anything less than such indefeasible and infallible (2010: 245) warrant can provide for empirical knowledge. McDowell (2010: 245) contends that "an experience in which some aspect of objective reality is there for a subject, perceptually present to her … is a more demanding condition than an experience's being merely veridical," and that "To have an experience describable in those terms is to have an indefeasible warrant for believing that things are as the experience is revealing them to be. If an aspect of objective reality is perceptually present to someone, there is no possibility, compatibly with her experience's being as it is, that she might be wrong in believing that things are the way her experience is revealing them to be …." What more stringent conditions, requirements, or achievements are involved in perceptual presence, beyond veridicality, McDowell does not make clear (here or elsewhere). Directly in this connection he (2010: 245) avows: "I think the idea that experience at its best makes aspects of objective reality present to us is completely natural and intuitive." It is precisely such "natural ideas" about knowledge (and other matters) which Hegel (1807) recognized must be carefully scrutinized philosophically and phenomenologically. In the present case, there is no valid inference from 'it is a table I see' to 'it cannot possibly be other than a table I see'; cognitive, justificatory necessity (infallibilism) cannot be pulled out of assertoric ('factive') premises. If it is a table I see, then a table there is, and I see it; but what is the situation if, like Austin's (1965: 354) apparent goldfinch, what I see does "something outrageous (explodes, quotes Mrs. Woolf, or what not)"? Rather than grounds for skepticism, precisely the corrigibility involved in the open texture of our empirical concepts, *and* in our specific use of them on any occasion, is a crucial cognitive, justificatory, and also epistemological resource (Will 1997: esp. *xxi-xxii*, *xli-xlii*, *li*, 10-12, 129, 159, 170-171). For further discussion of McDowell, without reference to open texture, see Burge (2011); for further discussion of the chronic problem (in non-formal domains) with infallibilism, see Westphal (2013d): esp. §3.2.

[18] For concise discussion of Hegel's sophisticated views about rational justification, see Westphal (2013a).

and important anti-Cartesian implications for empirical knowledge, including natural science.

4. *Hegel's Cognitive Semantics and Newton's Rule 4* contra *Cartesianism*

4.1. Understanding the significance of Hegel's cognitive semantics for scientific knowledge requires noting and revising an expository simplification in the preceding section. For ease of expression I have so far formulated Hegel's Thesis of Singular Cognitive Reference in terms of localized spatio-temporal perceptible "particulars."[19] The term 'particulars' commonly connotes individual physical objects or events, though its use can be much broader. Hegel's cognitive semantic point pertains to spatio-temporal particulars construed very broadly, to include any kind of particular we may locate within space and time, whether these be individual physical objects such as planets, a solar system of orbits, fields of force (such as gravity), or any distinct, identifiable natural phenomenon or process, *e.g.*, an aurora borealis. This is important to Newton's gravitational theory, because he sought to explain, not individual facts about (nor individual observations of) various motions of any one celestial body, but the general phenomenon of regular orbital motions, of the rate of free fall near the earth's surface, tides, the periodicity of pendula, and the uniformity of gravitational attraction throughout our solar system – and presumptively throughout the universe until proven otherwise (*per* Rules 3 and 4).[20] All of these general natural phenomena can be and have been located within space and time; so doing was the achievement of Kepler's and Galileo's kinematics (and maritime tide logs).[21] Hence these general kinematic phenomena, both terrestrial and celestial, satisfy the key requirement of Hegel's semantics of singular cognitive reference, which allows sensory presentation via observational instruments.[22] How, then, is Hegel's cognitive semantics relevant to Newton's Rule 4?

[19] For brevity, I will often refer to this Thesis by the phrase 'cognitive semantics'.

[20] Rule 3 states: "Those qualities of bodies that cannot be intended or remitted and that belong to all bodies on which experiments can be made should be taken as qualities of all bodies universally" (Newton 1999: 794-795, 1871: 387).

[21] On the frequently neglected distinction between observations or data and the phenomena – natural regularities – investigated and often explained in the sciences, see the references at the end of note 5 (above).

[22] Newton's *Opticks* does not employ the method of the *Principia* because optics first requires its counterpart to kinematics; only then can any dynamic explanation of regular optical phenomena be sought. (Rule 4 holds also of kinematic laws).

4.2. Newton's Rule 4 embeds the core point of Hegel's semantics of singular cognitive reference. Newton's main point in Rule 4 is to distinguish between hypotheses which do and those which do not compete with, or provide an *alternative* to, an established theory or law. In making this distinction, however, Rule 4 also distinguishes between hypotheses with cognitive standing and those lacking such standing, which count instead as suggestions, proposals, or as yet untested suppositions. I don't wish to be stipulative, but philosophers, especially those favouring H-D methods, tend to use the term 'hypothesis' promiscuously, so that almost any idea about how an event might occur is called an 'hypothesis'. Such promiscuity was also common to Seventeenth and Eighteenth Century scientists, many of whom described both Newtonian gravitational theory and Cartesian celestial vortices as scientific "hypotheses." The specific contrast Newton's Rule 4 draws between competing and non-competing scientific hypotheses is rooted in a more general contrast also implied by Rule 4. Because Rule 4 requires of any competing hypothesis that it have evidence in its favour, it requires a competing hypothesis to be referred to localized, identified physical particulars; without such reference, there can be no evidence supporting that hypothesis. *Per* above (§3), without such reference to localized particulars, no hypothesis is so much as a candidate for truth-evaluation, nor for evaluation of its accuracy, nor it merits as an approximation, nor of the plausibility or strength of the evidence bearing upon it, whether *pro* or *contra*. Because Rule 4 thus requires competitor hypotheses to *be* referred to some localized particular(s), it requires that scientific hypotheses have cognitive standing, by being more than mere logical possibilities, by having at least some favorable empirical evidence. Consequently, Newton's Rule 4 rules out Cartesian epistemology, which restricts rational justification to logical deduction from premises which survive scrutiny by the *malin génie*, *i.e.* infallibilism (*scientia*). Precisely for this reason, Rule 4 and Harper's interpretation of it will be contested by philosophers of science who presume infallibilism about empirical justification. This includes contemporary empiricists (see below: §§5, 6). Hence it is important to see that Newton's rejection of infallibilism about empirical justification, implicit in Rule 4, is sound.

It is shown to be sound by Hegel's semantics of singular cognitive reference. Obviously, nothing about the extent of evidence sufficient to justify a scientific hypothesis, nor to justify its status as a competitor to an established law or theory, is implied by Hegel's semantics of singular cognitive reference. However, because Rule 4 requires that there *be* positive empirical evidence for a competing hypothesis, it embeds the core point of Hegel's cognitive semantics: to *be* a *cognitive* claim – also within the natural sciences – requires referring that claim to localized spatio-temporal particulars, which alone can provide any relevant truth-value or merit as an approximation, and any relevant evidence (*pro* or *contra*). This reference to spatio-temporally localized particulars which alone can provide a truth-value and any empirical evidence for an hypothesis is required by the central point of Rule 4, that this evidence must differentially favour the proposed competitor. (Otherwise the evidence cited in its support would equally well support the established theory or law, and so would provide no evidence specifically favouring a proposed theoretical alternative; so far as that evidence would show, that proposal is no *alternative*). Hence Hegel's cognitive semantics directly supports the requirement embedded in Rule 4 that to *be* a competing scientific hypothesis requires having at least some positive evidence in its favour, which requires that the hypothesis be referred to at least some particulars which have been localized within space and time. Without such evidence, the proposed empirical alternative merely states a proposal with no cognitive standing because it is not referred to identified, localized particulars; it would be merely a proposal, a suggestion, and not a scientific hypothesis with cognitive standing.

To this sound point of cognitive semantics Newton's Rule 4 adds the altogether credible methodological requirement that a *competing* scientific hypothesis have sufficient differential evidence favouring it either to render an established law or theory either "more exact," or to restrict its scope by demonstrating specified "exceptions" to it. Newton's justification for his Rule 4 is methodological: the *Principia* shows that, by adopting this methodological rule, unprecedented advances in natural science can be achieved.[23] This is not trivial: Newton's *Principia* is *inter alia* a sustained treatise on measurement theory, and on actual measurements of gravitational forces of attraction.

By anchoring one core point of Newton's Rule 4 in a sound semantics of singular cognitive reference, Hegel's cognitive semantics shows that Newton's Rule 4 cannot be countered simply on grounds specific to history and philosophy of science. Instead, criticizing or rejecting Newton's Rule 4 and his use of it requires the much more ambitious task of criticizing and rejecting a central cognitive-semantic precondition of natural science and also of commonsense knowledge, and hence a central epistemological precondition of any sound philosophy of science.

[23] Harper (2011) explicates brilliantly Newton's use of Rule 4 in the *Principia*. I submit that Newton's use of Rule 4, as explicated by Harper, provides ample scientific, methodological justification for Rule 4. However, philosophers in the empiricist tradition will ask, not what follows from, nor what can be based upon, Rule 4, but rather, what if anything justifies Rule 4 antecedently? To this question I have not found an answer in Harper's research, and accordingly offer the present answer.

4.3. Harper rightly notes that Newton's Rule 4 directly opposes Cartesian physics, which restricted itself to logically possible explanations, *e.g.*, cosmic vortices, to account for planetary orbits. In its condemnation of Copernicus, the Roman Church decreed that natural scientists could only propose *possible* explanations of natural phenomena, not actual explanations. Descartes complied and officially regarded his explanatory models as merely possible explanations of natural phenomena. Newton's Rule 4 rejects merely possible explanations as scientifically irrelevant; this is one key point of his infamous *hypotheses non fingo*. Newton's examples of the mere "hypotheses" he condemns and rejects make plain that here he rejects mere proposals lacking specific empirical evidence, even of the purported explanatory particular (*e.g.*, cosmic vortices). Merely possible alternative accounts defeat justification only if justification consists solely in strict logical deduction (*scientia*). Newton's Rule 4 rejects the infallibilist justificatory ideal of *scientia*, and thus also the sufficiency of a mere logical possibility to defeat the cognitive justification of any evidentially well-grounded scientific law or theory (or of one of its components).

Hegel's semantics of singular cognitive reference shows that Newton's rejection of infallibilism about scientific justification is a corollary to the general rejection, entailed by Hegel's semantics of singular cognitive reference, of infallibilism about cognitive justification within the non-formal domain of empirical knowledge, both commonsense and scientific. Hegel's cognitive semantics entails that any empirical judgment or proposition can have determinate, cognitively legitimate significance only when referred to spatio-temporally localized particulars. *Voi là!* The direct implication is that the mere logical consistency of a presumed alternative to any empirical claim, including any natural-scientific theory or law, does not secure its *cognitive* status. To be cognitively legitimate, to have cognitive standing at all (within the non-formal domain of empirical knowledge), an alternative must also be referred (and not merely be 'refer*able* in principle') to one or more spatio-temporally localized particulars. Only when so referred is any empirical statement, judgment, or claim so much as a candidate for truth-evaluation; this is one necessary condition for knowledge, and so for cognitive standing. Hegel's cognitive semantics thus rules out the infallibilist model of *scientia* for cognitive justification within the entire non-formal domain of empirical knowledge. It thus rules out mere logical possibilities as counter-examples to, or as justificatory defeaters of, empirical claims, including in the natural sciences. Newton's Rule 4 thus embeds a second sound insight in semantics of singular cognitive reference.[24]

[24] These points from Hegel's semantics of singular cognitive reference strongly suggest elements of a "relevant alternatives" account of empirical justification; Hegel developed such a view.

4.4. It is important to note, however, that neither Hegel's semantics of singular cognitive reference nor Newton's Rule 4 reject H-D methods of inquiry or explanation. They do, however, set an important condition for the cognitive standing of any specific use of H-D methods: until positive evidence is provided to justify an hypothesis, at least partially, that hypothesis has no cognitive standing, and so cannot defeat the justification of any evidentially supported theory within its domain. Newton's Rule 4 further requires of any presumptive alternative hypothesis – whether derived in accord with his own ideal of multiple independent agreeing measures, or by using H-D methods – that to be an *alternative* hypothesis, a hypothesis must either improve upon the precision of the relevant established law or theory, or it must delimit its scope by demonstrating specified exceptions to it.

5. *van Fraassen's Constructive Empiricism*

5.1. In *The Empirical Stance* (2002) and more recently in *Representing Science: Paradoxes of Perspective* (2008), Bas van Fraassen renewed his efforts, inaugurated in *The Scientific Image* (1980; '*SI*'), to expound and recommend his philosophy of science, designated "Constructive Empiricism," an anti-realist position defined by two central theses:

1) Science aims to give us theories which are empirically adequate;
2) acceptance of a theory involves as belief only that it is empirically adequate (*SI*: 12).

Constructive Empiricism emphasizes the pragmatics of language and a key distinction between believing a scientific theory to be true, and merely accepting a theory in view solely of its empirical adequacy, insofar as it implies with sufficient accuracy all the observable events within its domain.[25] He himself calls his position "anti-realist" (*SI*: 12); its fundamental principles remain constant (see below: §§6, 7, 9, 10). I reconsider van Fraassen's original (1980) exposition of Constructive Empiricism because it contains both its primary justification, and four fundamental, neglected flaws, both substantive and methodological, which undermine Constructive Empiricism in all its versions (including his 2008).

The Thesis of Singular Cognitive Reference refutes infallibilism (*scientia*) about cognitive justification in non-formal domains (§§3, 4) This result may ap-

[25] I discuss van Fraassen (2002) in Westphal (2006): §4. (The quotation on 138-9 of my (2006) is cited incorrectly; I have not yet relocated its source, though the passage formulates the attitudes, values, and beliefs van Fraassen (2002: 37, 47; *cf.* 62, 152) ascribes to the empirical stance).

pear to have no bearing on Constructive Empiricism, because, *e.g.*, van Fraassen (2002: 1-30) so often stresses scientific caution about the truth of theories. However, van Fraassen's core distinction between merely accepting a scientific theory and believing it to be true is an instance of a common epistemological strategy of regarding a weaker belief as better justified than a stronger one, if they are based on the same evidence (*etc.*):

> the assertion of empirical adequacy is a great deal weaker than the assertion of truth [...] (*SI*: 69)

Van Fraassen repeatedly appeals to this premiss to justify his rejection of scientific realism, both about any one scientific theory and within philosophy of natural science generally.[26]

5.2. Van Fraassen's core argument may be put thus:

1) 'Empirical adequacy' is adequacy to describe, predict, retrodict (and systematize) the observable events within the domain of a scientific theory, throughout the history of the universe (*SI*: 12, 45, 2008: 317).

2) Any belief that an empirically adequate scientific theory is also true can only be justified by whatever observations justify that theory's empirical adequacy.

3) The Logical Law of Weakening: If (A ⊃ B), then ((A & C) ⊃ B).

∴ 4) If two beliefs are based upon, are equally adequate to, and are justified by the same evidence, the stronger of those two beliefs is *less* well justified by that evidence than is the weaker (less committal) belief.

5) To be true, a scientific theory's fundamental concepts, principles, laws or explanatory model(s) refer to and accurately describe actual structures or aspects of nature, including any (putative) unobservables within its domain.

6) Realism regarding any scientific theory is the claim that the theory is (very nearly) true about the objects or events within its domain, whether observable or unobservable.

[26] This principle is presupposed by and evident in, *e.g.*, van Fraassen's remark: "As presented, however, Vaihinger's view differed from Rutherford's by being logically weaker – it only withheld assent to an existence assertion. It follows automatically that Vaihinger's view cannot be a priori less plausible than Rutherford's" (*SI*: 36).

7) Empirical adequacy is much weaker than and does not involve the (putative) truth of any scientific theory, law, explanation or hypothesis regarding (putative) unobservables within its domain.

∴ 8) Unless the domain of a scientific theory contains only observables, realism about any empirically adequate scientific theory is always and in principle a much stronger claim than is the claim that the theory is empirically adequate.[27]

∴ 9) Constructive Empiricism is better justified than Scientific Realism, as an interpretation of any particular scientific theory which includes nonobservables within its domain, and as an interpretation of natural science generally.

This line of reasoning has become familiar to the point of appearing to many to be self-evident. I shall argue to the contrary that several of van Fraassen's premises are erroneous; I refer to them by number as I proceed.

6. *van Fraassen's Covert Infallibilism*

6.1. Van Fraassen's justification of Constructive Empiricism appeals centrally to what he calls "the Law of Weakening" (here Premiss 3). Indeed, he argued that this contrast in strength or weakness of beliefs is simply a matter of logic.[28] In connection with the "Law of Weakening" van Fraassen noted that

> the 'if ... then' [in English] is not correctly identified with any of the sorts of implication traditionally discussed in logical theory, for those obey <u>the Law of Weakening</u>:
>
> 1. If A then B; hence: if A and C then B.
>
> But our conditionals, in natural language, typically do not obey that law:
>
> 2. If the match is struck it will light; hence (?): if the match is dunked in coffee and struck, it will light;
>
> the reader will think of many other examples. The explanation of why that 'law' does not hold is that our conditionals carry a tacit *ceteris paribus* clause:
>
> 3. If the plant had not been sprayed (*and all else had remained the same*) then it would not have died.

[27] The parenthetical qualification is required because if a scientific "hypothesis is solely about what is observable ... empirical adequacy coincides with truth" (*SI*: 72).

[28] He identifies "Weakening" as a "logical law" like Contraposition (*SI*: 118).

The logical effect of this tacit clause is to make the 'law' of Weakening inapplicable (*SI*: 114-5; brackets and italics original, underscoring added).

NB: *The* ceteris paribus *clause, tacit in any causal-explanatory conditional statement, entails that van Fraassen's logical "Law" of Weakening is irrelevant to* all *explanatory domains*. As van Fraassen here notes, because the logical "Law of Weakening" holds *only* of systems of strict conditionals, it is therefore irrelevant to any domains which employ *ceteris paribus* clauses (whether explicitly or implicitly). His illustration is truth-functional for ease of presentation, but he correctly notes (as quoted) that *none* of "the sorts of implication traditionally discussed in logical theory" correctly capture our ordinary language conditionals. Hence the logical law of weakening is *irrelevant* to issues about scientific explanation, because causal explanations employ, ineliminably if implicitly, *ceteris paribus* clauses (Goodman 1946, Hempel 1988).[29] Nor does restricting one's commitment to a theory's empirical adequacy dispense with *ceteris paribus* clauses (see further below: §10.3). Thus van Fraassen's appeal to the logical Law of Weakening (Premiss 3), involved in his key distinction between accepting a scientific theory and believing it to be true, is based upon an infallibilist presumption about empirical justification, namely, that whatever is required for justification within a logistic system holds as such also in non-formal domains. Such infallibilist presumptions are exposed as *irrelevant in principle* to the non-formal domain of empirical knowledge by the Thesis of Singular Cognitive Reference, by Newton's Rule 4, *and* by the *ceteris paribus* clauses implicit (if not explicit) in any causal-explanatory conditional statement. Consequently, van Fraassen cannot use the "logical" Law of Weakening to justify his Constructive Empiricist account of any particular scientific theory, nor to criticize any realist interpretation of a scientific theory. Nor can van Fraassen use his logical law of weakening to justify his Constructive Empiricism in general, nor to justify his rejection of scientific realism in general.

6.2. Note further that van Fraassen's "Law of Weakening" is not a principle of formal *logic* because logical relations either hold or fail to hold, they do not come in degrees or 'strengths', whether distributively or collectively. "Weakening" pertains to degree, strength, or kind of justificatory support.

[29] The familiar notion that in "mature" (physical) sciences causal locutions are replaced by transformations (whether strict or statistical) neglects the distinction between the formulation of laws of nature and their use in explaining any phenomenon, and that such use reintroduces *ceteris paribus* clauses and, in many typical cases, specific causal relations, in addition to initial conditions and parameters (or boundary conditions) of the relevant physical system. By themselves, laws of nature explain nothing; see below: §9.

6.3. Appreciating the character and scope of this result requires distinguishing van Fraassen's claim about conditional statements in explanatory contexts from what might be thought to be a similar result reached by Brandom (1981), who demonstrated this semantic paradox of material implication: Determining the truth-values of all conditional sentences within a truth-functional language *also* determines all the truth values of all of the simple (categorical) sentences of that language. This result is absurd, because merely conditional truths should not determine categorical truths. Consequently, material implication cannot render 'if… then' in ordinary usage. Brandom (1981: 130) notes that modal forms of conditional sentences, such as C. I. Lewis' strict implication, do not generate this paradox. His result about material implication and his observation about modal conditionals are correct. However, van Fraassen makes a different, very important point about modal forms of conditional sentences (all of which are strict logical implications): that *no* logic of conditionals can capture 'if ... then' in explanatory contexts (whether commonsense, scientific or forensic), because explanatory usage of 'if ... then' presumes at least implicitly a *ceteris paribus* clause (*cf.* Goodman 1946, Hempel 1988), so that even modal forms of conditional statements (such as strict implication) cannot correctly render uses of 'if ... then' within explanatory contexts.

6.4. Van Fraassen's "Law of Weakening," as a (purported) *logical* principle (*SI*: 118), pertains as such only to strictly formal domains. However, the "beliefs" relevant to Premiss 4 are scientific beliefs, either about the empirical adequacy or the truth of scientific theories. Van Fraassen uses Premiss 3 (the Law of Weakening) within the non-formal domain of philosophy of science to justify his Premiss 4. Accordingly, Premiss 4 is not, and cannot be, justified simply by logical principles alone; certainly not by simple instantiation of Premiss 3. This is a key example of an infallibilist presupposition, of presuming that what is either required, or sufficient, for justification within strictly formal domains holds as such also in non-formal domains. Infallibilist assumptions appear in all criticisms of, and all alternatives to, realism – both commonsense and scientific – which appeal to "logical gaps" between evidence and any relevant realist claim or view, as if logical gaps automatically are cognitive gaps because they are justificatory gaps. To the contrary, logical gaps as such count as justificatory gaps only within strictly formal domains, domains which can be defined by the sufficiency of strict deduction for justification within those domains (above: §3). However, empirical knowledge, both commonsense and scientific, is a non-formal domain. Consequently, logical gaps *per se* are not justificatory gaps within the domain of empirical knowledge.[30]

6.5. There is, of course, an important rule of evidence, most familiar as Ockham's Razor, according to which, of two explanations equally adequate to the same phenomenon, the less ontologically committal is better justified than the more ontologically committal explanation. This is the principle of simplicity, or of explanatory parsimony. It is not, however, a principle of logic, nor can it be justified simply by principles of logic. How and when the principle of simplicity can be used to assess competing causal explanations is a complex and delicate matter (Sober 1975), but one point is uncontroversial: The principle of explanatory parsimony becomes relevant only *subsequent* to determining that two alternative causal explanations are equally adequate to the relevant domain and evidence. Explanatory parsimony pertains to competing *explanations*; as such it does not pertain to the distinction between any one scientific explanation and its empirical adequacy. Van Fraassen cannot support his Constructive Empiricism by independent appeal to the principle of explanatory simplicity – in effect, treating Premiss 4 as a statement of Ockham's Razor – because explanatory parsimony pertains to two otherwise equally adequate explanations of some domain. Harper has shown, however, that "empirical adequacy" is insufficient for disentangling the masses from the weights of planets in the ways central to the achievements of Newton's mechanics (above: §2.3).[31] Consequently, scientific realism and Constructive Empiricism do not appeal simply to the empirical adequacy of scientific theories (Premises 2, 5; above: §5.2). These are serious flaws in Constructive Empiricism; they are further corroborated by Hegel's semantics of singular cognitive reference in ways I now elaborate (§§7, 9, 10).

7. *Is Constructive Empiricism 'empirically' Adequate?*

7.1. Van Fraassen repeatedly claims that empirical adequacy – even for Newton – only concerns actual natural phenomena (appearances which can be observed):

[30] I discuss this point in greater detail in Westphal (2010-11); I develop the positive alternative in Westphal (2011a) and (2013d). I critically examine global perceptual scepticism in Westphal (2004: §§62-3, 2011b).

[31] For more general critique of "empirical adequacy" as the goal of physics, see Hüttemann (1997). Harper (2011: 389-94) shows that Laudan's confutation of convergent realism does not hold against Newton's methodology.

When Newton claims empirical adequacy for his theory, he is claiming that his theory has some model such that *all actual appearances are identifiable with (isomorphic to) motions* in that model. (This refers of course to all actual appearances throughout the history of the universe, and whether in fact observed or not) (*SI*: 45, *cf.* 46, 2008: 317).

Remember that empirical adequacy concerns actual phenomena: what does happen, and not, what would happen under different circumstances (*SI*: 60, *cf.* 61).

[T]he precise definition of empirical adequacy [...] relates the theory to the *actual* phenomena (and not to anything which *would* happen if the world *were* different, assertions about which have, to my mind, no basis in fact but reflect only the background theories with which we operate) (*SI*: 64[32]).

7.2. However, regarding, *e.g.*, the stability of the apsides of each planetary orbit, where any rotation of the apsides (precession) would indicate some rate of diminution of attractive force other than an inverse square ratio to distance, Newton stressed quite the opposite. That the gravitational force between any primary planet and our Sun varies by the inverse square of the distance between them is stated in Proposition 2, Theorem 2, of *Principia*, Book III, as follows:

The forces by which the primary planets are continually drawn away from rectilinear motions and are maintained in their respective orbits ... are inversely as the squares of their distances from its center (Newton 1999: 802; 1871: 395).

Concerning his justification of this second part of the theorem, the inverse square power law, Newton states:

[T]his second part of the proposition is proved with the greatest exactness from the fact that the aphelia are at rest. For the slightest departure from the ratio of the square would (by book 2, prop. 45, corol. 1) necessarily result in a noticeable motion of the apsides in a single revolution and an immense such motion in many revolutions. (Newton 1999: 802; 1871: 395; *cf.* Harper 2011: 116).

As Harper repeatedly and rightly stresses, Newton's causal-explanatory gravitational theory gives pride of place to precisely specified subjunctive conditional statements. Such subjunctive conditionals are central to Newton's methodology of devising analyses of motions which enable those motions to measure the strength of a force, which requires distinguishing the actual value measured

[32] Likewise van Fraassen states: "My view is that physical theories do indeed describe much more than what is observable, but that what matters is empirical adequacy, and not the truth or falsity of how they go beyond observable phenomena" (*SI*: 64); "... we must define empirical adequacy directly, without an empirical detour: all the actual observable phenomena fit the empirical substructures in a certain one of these models" (*SI*: 84).

from other (physically specified, observable) values. Having noted van Fraassen's infallibilist fallacy (§6), it is important to stress that the systematic dependencies Newton formulates as subjunctive conditional statements, are formulated as mathematically and physically precise continuous functions. That Newton's functions are continuous is not the key point here, but rather that his subjunctive conditionals are mathematically and physically defined: they are not creatures of modal logic, and are not subject to the vagaries of ill-defined 'accessibility relations' between possible worlds, nor of philosophers' "modal intuitions," including their not infrequent "modal scepticism."[33] Newton's gravitational potential is a physical capacity; its modality is not confined to his theoretical model.

7.3. In defense of an improved Constructive Empiricism, Muller (2005) aims to show that Constructive Empiricism can account both for 'observability' and for the modal claims made within many scientific theories.[34] His analysis is rich and informative, though not ultimately successful, for reasons which illuminate the present issues. Muller appeals to scientific research on human perception to specify what counts for us as visible. This is important, but he omits to consider whether Constructive Empiricism can adequately account for the scientific findings about human perception to which he appeals, for these findings report various features of light and of human vision, none of which count as "observable" according to Constructive Empiricism: *e.g.*, "rods" or "cones" in our retinas; the frequencies, periods, wave-lengths, and propagation speed of electromagnetic radiation; the molecules in the surface of a tomato and other "chemical substances" (78), which objects are black bodies (79), a "gas of photons in thermal equilibrium," Avogadro's number (79), or signals in the optic nerve (81); according to Constructive Empiricism, all of these are as

[33] This is also to say, the points made here are more basic than those debated by Ladyman (2004) and Dicken (2007), though the present considerations undermine the latter's empiricist rejoinder; natural science is not hostage to philosophical allegations about its metaphysical (mis)fortunes; if anything, metaphysics ought to be hostage to natural sciences (*cf.* Ladyman, *et al* 2007). In "Force and Understanding" (*Phenomenology of Spirit*: chapter 3) Hegel removes a major prop of causal agnosticism and causal scepticism by disambiguating the chronic conflation of two distinct senses of 'intrinsic' or 'internal', used to classify characteristics of particulars. According to one sense of these terms, a characteristic is 'intrinsic' or 'internal' if it is solely contained within that particular, and so is non-relational. According to another sense of these terms, a characteristic is 'intrinsic' or 'internal' to a particular if it is essential to it. Conflating these two senses of these terms entails that causal relations cannot be 'essential' to (or: constitutive of) particulars. Disambiguating these distinct senses of those terms is crucial to understanding how causal characteristics, which are relational, can be constitutive of physical particulars (Westphal forthcoming-a).

[34] In particular, Muller (2005) aims to improve upon Monton & van Fraassen (2003); all otherwise unattributed parenthetical page numbers in this sub-§ are to Muller (2005).

unobservable as are electrons and E.coli (75). Muller claims that the speed of propagation of the electromagnetic field *c* is "demonstrable"; supporting Constructive Empiricism, however, requires showing that *c* is demonstrable solely upon the observation basis allowed by Constructive Empiricism. It far from evident that Constructive Empiricism suffices to account scientifically for what is "observable" to us as normal human percipients.

Second, Muller uses extensional logic to define 'observable'. His definitions are (in fact) versions of Carnap's (1936-37) reduction sentences, though about observations rather than about, *e.g.*, solubility; Muller's account is a tidy, scientifically informed version of Carnap's (1949) more commonsense account of perceptual "confrontation." Muller's definitions specify that, if a normal human percipient occupies specified circumstances, and if there is a specified kind of object or event in front of that person's open, alert eyes, then (*if* s/he sees that object or event, *then* that object or event is visible). Alternatively, his definitions specify that, if a normal human percipient occupies specified circumstances, and if there is a specified kind of object or event in front of that person's open, alert eyes, then (*if* s/he does not see that object or event, *then* that object or event is not visible). In effect, Muller defines 'is observed' and 'is not observed', and only defines them within certain specified circumstances. Whenever those circumstances do not obtain, Muller's definitions are as undefined as Carnap's dispositional terms. Moreover, Muller's definitions can only specify 'is not observed' for circumstances where some scientific technique other than direct observation is used (and is sufficient and reliable) to know that a relevant kind of particular is before the alert, open, attentive normal eyes of a test subject.

Muller's account does not define 'observ*able*', certainly not in the sense in which Newton specifies, *e.g.*, that orbital precession is observable, though not observed. Muller's explication of various modal notions is subtle and instructive. However, the meaning of any statements using the modal notions so specified can only be partially specified observationally by Muller's reduction sentences for 'is observed' and 'is not observed'. Consequently, Muller's treatment of modality is not adequate to Newton's mechanics. Muller contends that

> Experimental research is fundamentally incapable of discerning between unreal observable, unreal unobservable and real unobservable objects, because in all three cases we see nothing (Muller 2005: 85).

As noted, this central claim of Constructive Empiricism appears to undermine appeal to the science of human perception to account for, or to specify, what we can(not) observe. More specifically, Muller's list of options (quoted here) is either incomplete or faulty, because, as Harper details, Newton's dynamics rigorously defines orbital motions which would occur if the attractive forces due to gravity were proportional to the distance between two bodies at any rate other than the inverse square power, so that Newton's mechanics can use actual measured orbital phenomena to measure precisely the inverse-square rate of gravitational attraction. Accordingly, Newtonian mechanics *is* able to discriminate between unreal observable and real observable gravitational forces of attraction, where "gravitational force" according to Constructive Empiricism counts as *un*observable. Muller's Constructive Empiricist explications of 'observable' and of modality are not adequate to Newton's mechanics.

Van Fraassen's empiricist focus upon solely what is observed to occur in nature, and his rejection of counterfactuals about what would happen *in nature* under specified, identifiably different physical conditions, is inconsistent with Newton's mechanics. Whereas van Fraassen (1989: 214; *cf.* Monton & van Fraassen 2003: 5) only countenances modality within scientific models (or perhaps theories), but denies there is any modality in nature, Newton's dynamics identifies the causal modality of gravitational force by measuring it. In this crucial, basic regard, van Fraassen's Constructive Empiricism is plainly *in*adequate to its purported domain, which includes, centrally, Newton's classical mechanics. N.B.: In *Representing Science* (2008: 317-319) van Fraassen reaffirms exactly the same Constructive Empiricism, and does so directly in connection with Newton's classical mechanics; in *Representing Science* he restricts and revises Constructive Empiricism only to accommodate statistical theories.[35] This fundamental inadequacy of Constructive Empiricism should not have been neglected for thirty three years. (Placing modality into the "model" of a scientific theory is misplacing it; see below: §9).

8. *Newton's Mechanics: Dynamics or Kinematics?*

8.1. The tendency to reduce Newton's dynamics to kinematics, *i.e.*, to only a precise description (prediction, retrodiction) of various observed motions, has been characteristic of empiricism from Berkeley and Hume down to van Fraassen.[36] It is worth considering a subtle and influential instance of this

[35] Note further that Monton and van Fraassen (2003: 418) refer to and endorse relegating modality to our pragmatic context of theorizing (*SI*: chapter 5); van Fraassen's treatment of the "pragmatics" of explanation is discussed below (§10). For further critical reflections on van Fraassen (2008), see Okruhlick (2009). Fortunately, much of van Fraassen's *Representing Science* is, by design (2008: 3), independent of his Constructive Empiricism.

[36] Some key instances are discussed in Westphal (forthcoming-a): §7.

pervasive tendency. In *Foundations of Space-Time Theories*, Michael Friedman claims that

Newtonian gravitation theory can be formulated within the framework of either of our two versions of Newtonian kinematics (Friedman 1983: 93).

He further claims that such formulations show that

it is possible to "geometrize away" gravitational forces in the context of Newtonian theory by incorporating the gravitational potential into the affine connection (Friedman 1983: 95).

Whilst literally true, this statement is seriously misleading, because Friedman neglected the question, Which aspects of Newton's dynamic theory can be represented (or "formulated") merely kinematically, and which cannot? In this crucial regard, Friedman neglected the important point made by Kaplan, that modeling a domain properly requires carefully distinguishing genuine features of the domain so modeled from mere artefacts of the model.[37] This point is so basic, so important, and so often neglected that it deserves a name; I shall call it 'Kaplan's *Caveat*'.[38]

Friedman's (1983: 97) reformulation of Newton's gravitational theory neither eliminates nor relativises "the notion of acceleration." Acceleration, however, is a kinematical relation (change of velocity over time). Newton's gravitational theory (his mechanics) provides a dynamic, *i.e.* causal explanation of the kinematics of acceleration within our solar system (and throughout the universe, until demonstrated otherwise in precise detail, *per* Rules 3, 4). That Friedman's reformulations of Newtonian theory are merely kinematic – and not dynamic, causal or explanatory – is indicated, *inter alia*, by how Friedman (1983: 99) eliminates reference to mass in his equation (49), thus making reference to mass in his equations (34), (41) and (42) irrelevant, despite Friedman's recognition that in his "Newtonian gravitation theory (§III.3),"

the spacelike vector field on the right-hand side of equation (34) is tied to the mass of bodies by equations (41) and (42) (Friedman 1983: 119-20).[39]

[37] Kaplan (1975: 722) notes, "When we construct a model of something, we must distinguish those features of the model which represent features of that which we model, from those features which are intrinsic to the model and play no representational role. The latter are artifacts of the model." Although he makes this point in connection with formal models within possible-worlds semantics, his point holds generally about formal modeling, including mathematical modeling.

[38] Kaplan's *Caveat* is an important case in point of Lewis' (1930) point, noted above (§3), that non-formal considerations are required to use any formal logistic system within any non-formal domain.

[39] Friedman's §III.3 is on (1983: 92-5); his equations (34), (41) and (42) appear on (1983: 92-3). It suffices for present purposes to track the order of Friedman's formulae, to note that mass drops out of

Reference to mass is important in Newton's dynamics because the strength of a body's gravitational force is proportional to its mass. Incorporating Newtonian "gravitational potential" (Friedman 1983: 95; quoted above) into Friedman's "affine connection" only preserves Newtonian kinematics and provides only a regularity account of 'Newtonian' motions – *i.e.*, only a kinematics – because it fails to formulate, to represent, or hence to *measure* gravity as an explanatory, causal (dynamic) force (*per* Harper 2011; above: §2).

This subtle, unwitting substitution of merely descriptive, quantitative kinematics for explanatory dynamics occurs again when Friedman (1983: 123) "replace[s] (41) of §III.3 with (89)" – where (89) is a successor to the strictly kinematical (49) previously mentioned; "*F*" (purportedly designating 'force') in Friedman's equation (90) is only kinematically defined. This is the error noted earlier (§2.2), of mistaking Newton's Definitions 6-8 of (three different) *quantities* of accelerative forces – and their *measures* – for definitions of *forces*. Consequently, Friedman's final "action-at-a-distance theory (90), (91)," which he claims "is better than either of our two field theories" (1989: 124), defines 'action' only kinematically, not dynamically (not causally). Hence Friedman's preferred "action-at-a-distance theory" only *re*-presents Newton's kinematics, but not Newton's explanatory dynamics, which is the heart of his mechanics, and which alone affords his improved kinematics.[40]

8.2. Assimilating Newton's dynamics to descriptive kinematics may satisfy the very weak requirements of a regularity notion of causality, but Newton's dynamics is much more stringent and much more successful than this, in part because Newton's *explananda* are periodic motions within our solar system, both terrestrial and celestial, rather than the individual events central to regularity theories, upon which alone Friedman's (1983) analysis ultimately focuses. Whereas regularity theories of causality purport to "explain" individual events by subsuming them under a general regularity, Newton's theory of gravity aims to explain kinematic regularities dynamically, by developing quantitatively exact measurements of dynamic – specifically gravitational – forces which causally govern motions of physical bodies within our solar system, under specified initial conditions. Limiting Newton's dynamics to what can be represented kinematically voids his entire explanatory undertaking. This is a fundamental

his merely kinematical 'Newtonian' theory. For critical assessment of Friedman's (1992) view of Kant, see Westphal (1995), Ospald (2010).

[40] Whether Friedman (1983) aims to reformulate Newtonian mechanics so as to facilitate comparing it with General (or with Special) Relativity is beside the point. That aim requires accurately reformulating Newton's mechanics, which for reasons given here Friedman's reformulations fail to do.

error in Friedman's (1983) modeling. Neglecting Kaplan's *Caveat* generates obfuscation rather than insight.

Indeed, the fundamental problem lodges already in Friedman's phrase "affine connection." To have any physical significance, Friedman's affine geometry needs the term 'connection', but to "geometrize away" gravitational force, Friedman must only use relations defined within a specific kind of affine space. Define a *mathematical* space however one will, nothing in or about that mathematical space entails or explains anything about the structure or behavior of any natural system. Mathematical *relations* at most describe, but neither constitute nor explain, physical *connections*. In "The Theory of the Affine Field," Einstein (1923) carefully delimits his analysis to specifying an affine space within which it is possible to combine the quantitative laws characteristic of gravitational attraction and of electromagnetic phenomena. Einstein neither mistakes nor substitutes his mathematical analysis for a physical analysis. Friedman, like van Fraassen, purveys merely mathematically-descriptive Ptolemaic philosophy of physics – in this day and age!

8.3. The problem with 'positivism' – broadly construed as favouring quantitative-descriptive regularities and dispensing with dynamic-explanatory (causal) laws and forces – is that substituting purely quantitative relations among observed phenomena replaces genuinely physical problems with purely mathematical-descriptive ones – and directly obviates any explanatory character of physical theory because the purely quantitative descriptions lack specifically physical meaning.

Although Mach (*e.g.*, 1933: 473) often appears to express a formalist, positivist, merely mathematical-descriptive view of laws of nature, he often rightly and emphatically distinguished between genuinely physical and merely mathematical-descriptive problems:

In two instructive writings (*Kepler's Lehre von der Gravitation*, Halle, 1896; *Die Gravitation bei Galileo und Borelli*, Berlin, 1897) E. Goldbeck investigates the early history of the doctrine gravitation in connection with Kepler on the one hand and Galileo and Borelli on the other. Despite his adherence to scholastic, Aristotelean notions, Kepler has sufficient insight to conceive the planetary system as a physical problem [*sic*]; the moon, in his view, is *swept along* by the earth, and on the other hand it *pulls* the tide toward itself, just as the earth attracts heavy bodies. He also sought the planets' source of motion in the sun, from which extend immaterial levers which rotate with the sun, moving distant planets more slowly than the near ones. By taking this view, Kepler can surmise that the period of rotation of the sun is less than 88 days, the period of one orbit of Mercury. Occasionally he also represents the sun as a revolving magnet, across from which are the magnetic planets. In Galileo's world view the formal-mathematical-aesthetic viewpoint predominates. He rejects any assumption of attraction and even scoffed at Kepler's notion of some such attraction. For Galileo the orbital system is not yet a genuine physical problem (*kein eigentlich physisches Problem*) [*sic*]. Nevertheless, like Gilbert he assumed that an empty geometrical point cannot effect anything [...] (Mach 1933: 182-183; 1893/1960: 532-533; tr. emended).

Here Mach clearly recognizes that treating laws of nature as purely quantitative relations (descriptions of regularities, however precise) fails to treat laws of nature as solutions to specifically *physical* problems.[41] This is precisely what positivist views of all stripes fail to do, including van Fraassen's Constructive Empiricism. This contrast between merely mathematical-descriptive and physical-explanatory problems is stressed by Mach again in his emphatic summary of his main finding in *Mechanik*:

the most important result [*sic*] of our considerations is that even the apparently simplest mechanical principles have a complex nature, that they rest on uncompleted, indeed on incompletable [series of] experiences, that practically they are sufficiently secured, in view of the sufficient stability of our environment, to serve as a basis for mathematical deduction, but that they cannot at all themselves be regarded as mathematically established truths, but rather as propositions which are not only capable of, but indeed require a continued experiential testing (*Erfahrungskontrolle*) (Mach 1933: 231, tr. *KRW*; the original is almost wholly italicized[42]).

Here again, and more emphatically, Mach recognizes that treating laws of nature as purely quantitative relations (descriptions of regularities, however precise) fails to treat laws of nature as solutions to specifically *physical* problems. Regularity theories of causality and the covering-law model of explanation substitute purely quantitative problems of description, prediction, and retrodiction of events for the physical problems of causation investigated and often explained in natural science.

Whether or how mathematical functions are instantiated by physical systems and their behavior was repeatedly highlighted by von Pfleiderer (1804), Hegel's instructor. This point is central to Hegel's criticism of Kant's *Metaphysical Foundations of Natural Science*, and to Hegel's re-analysis of causal forces and relations in "Force and Understanding" (*Phenomenology of Spirit*: chapter 3), in support of Newton's dynamics and of distance forces generally (Westphal 1998b, forthcoming-a). Van Fraassen is mistaken that Newton's mechanics is merely descriptive rather than causal-explanatory, and that Newton

[41] Galileo expressly restricts his theory to kinematics at the start of Day 3 of his *Dialogues*, claiming (rightly) that causal inquiries are premature until the properties of motions are rightly understood.

[42] Corresponding to the passage cited here is Mach (1893/1960: 237-8); the translation is unreliable.

accepted his theory merely because and insofar as it is empirically adequate (*SI*: 112, 2008: 317-319; *cf.* above: §5.2). The physical issue of whether or how the quantitative relations specified in a scientific theory are instantiated by any natural (sub)system is an important reminder that, even if "mature" quantitative theories often omit causal locutions and specify only transformations, this surface grammar does not show that causation is neglected by, nor irrelevant to, such theories.

9. *The Semantics of Scientific Theories*

As regards the semantics of scientific theories, van Fraassen maintains:

> The notions of empirical adequacy and empirical strength, added to those of truth and logical strength, constitute the basic concepts for the semantics of physical theories (*SI*: 68).

To the contrary, we have seen that "logical strength" is a serious misnommer (§6.2), although Hegel's semantics of singular cognitive reference (§3) also belongs to the basic semantic concepts of physical theory, as is implicitly though correctly implied by Newton's Rule 4 (§4). This is no trivial addition. Hegel's cognitive semantics has a further important implication for understanding physical theory and explanation. Nancy Cartwright (1983) contends that the laws of physics literally "lie," including, *e.g.*, Newton's three laws of motion (above: §2.2). To *lie*, Newton's laws as such must make a claim to truth. This they could do only insofar as they were (purported to be) true simply as descriptions. Cartwright is correct that they are not true simply as descriptions, because they are idealized in such a way that no natural system instantiates only those laws and no other causal or physical constraints. What is known as 'the semantic interpretation' of scientific theories – prominently advocated by Suppes, Cartwright, and van Fraassen – implicitly presumes an inadequate descriptions theory of reference (*per* above: §3), insofar as theoretical statements (including statements of physical laws) taken as descriptions specify appropriate data models of that theory.[43]

Hegel's semantics of singular cognitive reference shows that linguistic meaning (or, analogously, conceptual content or Carnapian intensions) as such are in principle insufficient for epistemology (§3), including that branch of epistemology which is history and philosophy of science (§§2, 4). Merely as sentences,

[43] The derivation of the model-theoretic interpretation of scientific theories, including van Fraassen's Constructive Empiricism, from Russell's theory of definite descriptions, is detailed very nicely (if implicitly) by Demopoulos (2003); *cf.* van Fraassen (2006): 541-2, 545.

statements of physical laws make no cognitive claim, whether true or false, accurate or inaccurate, justified or not (or only partially). As with synthetic statements generally, theoretical statements in physical theory obtain specifically *cognitive* status only by being referred to particulars we have localized within space and time. This alone makes theoretical statements either true, false, accurate or inaccurate; this alone makes them evaluable either as true or false, or as approximations; this alone affords them any possibility of cognitive justification and also any assessment of their cognitive justification. In short, Book III of Newton's *Principia*, his "System of the World," *is* the cognitive semantics required by, and required for, his mathematical-causal explanatory theory of gravitational force developed in Books I and II. This is how (*inter alia*) Rule 4, and this is how Harper's masterful reconstruction of Newton's *Principia* (which focuses on Book III), are to be understood. This is the cognitive-semantic point of Newton's contrast between the "mathematical" theory developed in Books I and II and the "philosophical" – *i.e.*, natural philosophy, or scientific – theory developed in Book III, to which Newton draws attention in the Preface to Book III (1999: 793, 1871: 386; *cf.* Harper 2011: 84-6*ff*).

In connection with the model-theoretic "semantic interpretation" of scientific theories, Brading and Landry (2006) rightly stress the crucial, ineliminable role of an *empirical theory* of the relevant natural phenomena for connecting any model-theoretic formalization of a physical theory to any actual empirical events:

> without an (empirical) theory of the phenomena, one cannot speak of 'the structure of the phenomena', for example, one cannot characterize the structure of the phenomena in terms of the shared structure of its models (Brading and Landry 2006: 575).

> [W]ithout a[n empirical] theory of the phenomena one cannot formalize (again, by model theoretic methods) the treatment of the structure of the phenomena in terms of data models alone, and so one cannot use the semantic view's account of shared structure between models to fully account for the applicability of a theory to the phenomena and, thereby, to establish a theory-world connection (Brading and Landry 2006: 575; *cf.* Demopoulos 2003: 387-401).

Put in these terms, Book III of Newton's *Principia* provides his empirical theory of the natural phenomena of motion, which provides his dynamic (causal) theory in Books I and II with their specifically cognitive status. Note further, that Newton's dynamic theory in Books I and II thus obtains its cognitive status, including its reference to specific natural phenomena, without any unnecessary detour through model-theoretic semantics. Model-theoretic formalizations of physical theories can be very useful heuristically, but such formalizations are neither theoretically nor semantically, and certainly not cognitively, necessary.

In response to Demopoulos (2003), van Fraassen (2006) tries to improve his Constructive Empiricism, but neither there nor in *Representing Science* (2008) does he address Brading and Landry's important point about how any model-theoretic semantics for a scientific theory requires an empirical theory of the phenomena in order to be linked to actual natural phenomena. Nor, accordingly, does he recognize the point made here (and implicitly by Harper (2011), whose study requires neither use nor mention of formal model theory), that such an empirical theory of the relevant phenomena renders the model-theoretic formalization cognitively otiose. Nor does van Fraassen (2008) recognize that by defining 'empirical adequacy' solely in terms of actual appearances of nature, his Constructive Empiricism cannot account for the systematic causal dependencies among naturally occurring motions, all formulated subjunctively, which are identified by Newton's gravitational theory, and which are preserved – also in subjunctive, mathematical-physical form – by Einstein's general theory of relativity (Smith 2007).[44]

Insofar as Hegel's semantics of singular, specifically cognitive reference is embedded centrally in, and also strongly supports, Newton's Rule 4, Hegel's cognitive semantics contributes decisively to justifying Newton's causal realism regarding gravitational force. Constructive Empiricism provides no sound basis for rejecting Newton's causal realism. Though General Relativity dispenses with gravity as a *force*, it nevertheless preserves *all* the systematic dependencies Newton identified in the *Principia* (Smith 2007), and it preserves Newton's correct emphasis upon the mass of mutually gravitating bodies, which (unbeknownst to him) accounts for the circumambient, proportional curvature of space-time responsible for orbital phenomena. The extent to which such circumambient curvature of space-time, proportional to the mass of bodies, is itself a causal phenomenon, and not merely an artefact of measurement conventions, remains debated (Redhead 1998). Accordingly, Newton's causal realism about gravitational force is not ruled out by contemporary physical theory, which recognizes gravity as a fundamental force. A very basic reason for van Fraassen's failure to appreciate the explanatory power of Newton's mechanics is examined in the next section.

10. *Philosophy of Language* versus *Epistemology?*

Although he recognizes that, "[i]n some sense, semantics is only an abstraction from pragmatics" (*SI*: 89), van Fraassen stresses the pragmatics of lan-

[44] Newton's methodology, and centrally Rule 4, expressly allow for approximate truth, in reference to actual physical forces, bodies, systems and phenomena (*cf.* above: §2).

guage and especially the pragmatics of explanation, and many regard this as the cornerstone of his Constructive Empiricism. Van Fraassen "transpose[s]" Charles Morris' distinctions between the syntax, semantics, and pragmatics of language, "from words and statements to theories" (*SI*: 89). Such a transposition can be made, but the critical questions are how well, and how illuminating so doing may be. Unfortunately, van Fraassen's transposition is faulty and obscures rather than illuminates the central issues.

10.1. Van Fraassen grants that scientific theories may be context-free, and hence free from "pragmatics," but contends that explanation, and hence scientific explanation, is radically context-dependent and pragmatic:

Semantic properties and relations are those which concern the theory's relation to the world, or more specifically, the facts about which it is a theory. Here the two main properties are truth and empirical adequacy. Hence this is the area where both realism and constructive empiricism locate a central aim of science. [...] Scientific theories can be stated in context-independent language, in what Quine calls 'eternal sentences'. This [...] may be true of those products of scientific activity which we call theories. It is not true of other parts of that activity [...] specifically I hold that

(a) the language of theory appraisal, and specifically the term 'explains' is radically context-dependent;
(b) the language of the use of theories to explain phenomena, is radically context-dependent (*SI*: 89-90).

The problem for explanation and for realism about causal-explanatory factors, according to van Fraassen, is that they (or the claims they involve) involve counterfactuals, and all the relevant counterfactuals are radically context-dependent, and so are merely "pragmatic." In this connection he states, *e.g.*:

the counterfactuals single out all the nodes in the causal net on lines leading to the event [...], whereas 'because' points to specific factors that, for one reason or other, seem especially relevant (*salient*) in the context of our discussion.

That much context-dependence everyone will have to allow. But I think that much more context dependence enters this theory through the truth-conditions of the counterfactuals themselves. So much, in fact, that we must conclude that there is nothing in science itself—nothing in the objective description of nature that science purports to give us—that corresponds to these counterfactual conditionals (*SI*: 115-6).

Furthermore:

The description of some account as an explanation of a given fact or event, is incomplete. It can only be an explanation with respect to a certain *relevance relation* and a certain *contrast class.* These are contextual factors, in that they are determined neither by the totality of accepted scientific theories, nor by the event or fact for which an explanation is requested (*SI*: 130).

What holds counterfactual conditions constant in any *ceteris paribus* clause, van Fraassen contends, is only the mind of whomever poses or answers an explanatory question:

Consider again statement (3) [above: §6] about the plant sprayed with defoliant. It is true in a given situation exactly if the 'all else' that is kept 'fixed' is such as to rule out death of the plant for other reasons. But who keeps what fixed? The speaker, in his mind. There is therefore a contextual variable – determining the content of that tacit *ceteris paribus* clause – which is crucial to the truth-value of the conditional statement (*SI*: 116).

Yes, inquirers often select features of objects, situations, events, or processes into which they inquire, and they also often consider some (purportedly) relevant features fixed for the purposes of inquiring into others. However, in scientific inquiry – and in diagnostic inquiry more generally – the considerations of the inquirer are not the sole "determinant" of the success of the inquiry, nor of the truth of the relevant counterfactuals, nor of which counterfactuals and *ceteris paribus* clauses are relevant. Scientific and diagnostic inquiry concern causal processes, their initial and boundary conditions, and various events or factors which may alter, interfere with, facilitate, or disrupt that process. That there is "a" contextual variable, in the form of the inquirer's terms of reference (whatever s/he considers relevant counterfactual states of affairs), does not entail that this is the only kind of relevant counterfactual or *ceteris paribus* clause. A major aspect of scientific observation and experiment is the physical isolation of the relevant instruments or apparatus from unwanted causal influences. It is not only the minds of scientists which hold those factors constant (to the extent they can be held constant), it is their material procedures, informed and guided by knowledge of causal, counter-factual relations among natural phenomena (including the natural phenomena of human vision).

Throughout his account of explanations as answers to why-questions, van Fraassen contrasts scientific "descriptions" with anything beyond the empirical adequacy of a theory which might constitute its explanatory character.[45]

[45] Most forcefully, he states: "It would seem that if either Hempel's or Salmon's approach was correct, then there would not really be more to explanatory power than empirical adequacy and empirical strength. That is, on these views, explaining an observed event is indistinguishable from showing that this event's occurrence does not constitute an objection to the claim of empirical adequacy for one's theory, and in addition, providing significant information entailed by the theory and relevant to that event's occurrence" (*SI*: 108-9); also: "the search for explanation is valued in science because it consists *for the most part* in the search for theories which are simpler, more unified, and more likely to be em-

This focus on nothing but empirically adequate description of actual appearances in nature is the key premiss presupposed by his radically contextualist, anti-realist account of counterfactuals, *ceteris paribus* clauses, and of scientific explanations as nothing more than merely pragmatic answers to speaker-specific questions. That is why above (§5.2) I characterized his key argument for Constructive Empiricism as focused upon the defense of empirical adequacy against scientific realism (of whatever forms). As we saw, van Fraassen's account of empirical adequacy is not at all adequate to, nor for, Newton's mechanics, centrally because it is insufficient for disentangling the masses from the weights of orbiting celestial bodies in the ways Newton achieved (§2.3). To the contrary of Constructive Empiricism, Newton's use of natural phenomena of motion to measure the strength of gravitational attraction as proportional always and exactly to the inverse-square of the distance between any two bodies identifies physically specific, observable, counter-factual relations which, if observed, would measure a different field strength (§§2, 7). Van Fraassen claims:

> Newton's theory of gravitation [...] did not (in the opinion of Newton or his contemporaries) contain an explanation of gravitational phenomena, but only a description (*SI*: 112, *cf.* 94; 1991: 372, 2008: 317).

This is a serious misunderstanding of Newton's theory, and Newton's claims for his theory. As noted above (§§2.2, 2.4), Newton claimed that his mechanics provides a dynamic, causal explanation of celestial and terrestrial kinematics; he refrains only from explaining the cause of gravitational force itself. Newton's theory identifies causal processes generated by the force of gravitational attraction.

10.2. Consider van Fraassen's conclusion regarding Salmon's account of explanation by reference to macroscopic causal processes:

pirically adequate. This is not because explanatory power is a separate quality *sui generis* which, mysteriously, makes those other qualities more likely, but because having a good explanation *consists* for the most part in having a theory with those other qualities" (*SI*: 93-4); once more: "There would of course be a difference between *believe* (to-be-true) and *accept* (believe-to-be-empirically-adequate) but no real difference between be-entitled-to believe and be-entitled-to-accept. A realist might well dispute this by saying that if the theory explains facts then that gives you an *extra* good reason (over and above any evidence that it is empirically adequate) to believe that the theory is true. But I shall argue that this is quite impossible, since explanation is not a special additional feature that can give you good reasons for belief in addition to evidence that the theory fits the observable phenomena. For 'what more there is to' explanation is something quite pragmatic, related to the concerns of the user of the theory and not something new about the correspondence between theory and fact" (*SI*: 100, *cf.* 124).

the type of explanation characterized by Salmon, though apparently of central importance, is still at most a subspecies of explanations in general (*SI*: 122-123).

The problem here is methodological. Van Fraassen replies to Salmon the way Socrates reportedly replied to Meno about the virtues: naming several virtues fails to address the question, what virtue is. Van Fraassen seeks one single – 'one size fits all' – account of explanation:

The discussions of causality and of why-questions seem to me to provide essential clues to *the* correct account of explanation (*SI*: 129; emphasis added).

Likewise, van Fraassen regards Salmon's restriction of his account of causal processes to macroscopic phenomena as a serious limitation:

This limitation is serious, for we have no independent reason to think that explanation in quantum mechanics is essentially different from elsewhere (*SI*: 129).

What sort of "independent reasons" these might be, he does not indicate. What is indicated, is van Fraassen's disregard of Dewey's (1938) point that knowledge results from inquiry, but effective cognitive inquiry requires not prejudging by rigidly preconceiving the possible or likely results: successful inquiry may involve reconceiving the relevant concepts, principles, and phenomena. Within philosophy of science, van Fraassen antecedently demands a uniform account of scientific explanation, rather than examining what kinds of explanations various sciences devise for various domains, and whether or how these kinds of explanation may be combined for various purposes in various circumstances. Before appeal to Wittgensteinian family resemblances, it is important to consider Aristotelian *pros hens* (focal) meaning (or meanings) of 'explanation' within scientific contexts. Yes, at the general level of answering questions of the form, 'Why did *x* happen?', there is a large role for "merely" pragmatic, questioner-relative factors. However, this role is delimitable and defeasible: questions and their presuppositions can legitimately be dismissed once a superior understanding of the relevant processes and events is achieved. Sometimes, indeed often, why-questions are answered by explaining that the relevant phenomenon does not occur in the way the questioner presumes. Neither the truth nor the truth conditions of the counterfactuals relevant to such explanatory answers are set by (nor restricted to) the questioner's merely "pragmatic" presuppositions.[46]

[46] Caution is in order regarding van Fraassen's use of examples of scientific theories, which are often textbook examples and insufficiently characterised. *E.g.*, he discusses the warping of a lateral bar, a conductor in a power plant, when subjected accidentally and "momentarily" to 10^6 Amperes (*SI*: 102). Van Fraassen presents the calculation of the magnetic field generated by that current flow

10.3. Note that van Fraassen's focus upon empirical adequacy cannot avoid appeal to counter-factual conditionals regarding causal processes: Even in his lowly example of the plant unfortunately sprayed with defoliant, it is relevant to understanding the specific demise of that specific plant that (perhaps unwittingly) it was sprayed with *defoliant*, a chemical which kills plants. Even if "empirical adequacy" concerns all relevant observable instances of a law of nature – which typically are stated as conditionals, if perhaps implicitly so in the case of "transformations" – throughout the history of the universe, *which* (observable) natural events fall within the scope of that law, and *how* they fall within it (to the exclusion of other events) depends upon whether other potentially disturbing factors occur, or do not occur, and how significant are their effects. In principle empirical adequacy always confronts the *Aristotelian* problem of "induction," namely, whether various particulars are appropriately included within, or excluded from, the scope or domain of the law in question.[47] Answering this question requires assessment of the *ceteris paribus* clause(s) relevant to that law and its instantiations, *i.e.*, to the occurrence and significance of other causal factors which could affect the process in question. Van Fraassen provides no sound reasons to suppose that Salmon's explication of 'causal process' is not the focal meaning of 'explanation', which Newton's methodology augments by showing how to measure distance forces among orbiting bodies accurately and robustly.

10.4. The problem with van Fraassen's appeal to "pragmatic" contextual factors is a problem characteristic also of neo-pragmatism (and of the original Strong Programme in sociology of knowledge), which presume that issues about truth are exhausted by semantics, but semantics does not exhaust issues about knowledge, so that appeal must be made to "pragmatics," which by

through the conductor, and the consequent lateral force on the bar due to the Earth's magnetic field. Whilst relevant to the bar's warping, also relevant are how fixed are the bar's endpoints (mounts), how ductile it is, its thermal expansion rate and how much it is heated by that surge of current. The magnetic force upon the bar should account, at least in part, for the direction of the warping (downward), whereas warping due to thermal expansion may be lateral or upwards, unless the bar is made very hot, in which case it would tend to sag due to gravity. How much warping occurs also depends upon the duration of the surge; 'momentary' is too imprecise: recall Newton's Rule 4. Finally, the lateral orientation of the bar requires considering whether the current passing through it was direct or alternating; an alternating lateral magnetic field would effect less warping. In each of these regards, knowledge of various relevant causal processes is used to understand the particular warping of that bar on that occasion due to that surge. *Caveat emptor!* Much better examples of scientific inquiry and explanation are provided by Conant (1957).

[47] *Posterior Analytics*: 2b7, 92b; *Topics* 8.2: 157a23-34. Goodman's "riddle" of induction is a temporally dramatic form of Aristotle's point, though his appeal to terminological conservatism is inadequate; see Bartels (1994), DiSalle (2002).

default must be non-cognitive. Van Fraassen categorically distinguishes pragmatic from epistemic considerations:

the question what it is to accept a scientific theory [...] has an epistemic dimension (how much belief is involved in theory acceptance?) and also a pragmatic one (what else is involved besides belief?) (*SI*: 4; *cf.* 2000: 273-274, 2007: 337, 340, 349; 2008: 3, 17, 25, 82, 136).

Morris studied language, not epistemology. Injecting his three-fold linguistic distinction into history and philosophy of science is an instance of a basic aspiration of analytic philosophy, to resolve philosophical issues, including epistemological issues, through proper analysis of language. Van Fraassen still follows Carnap in aiming to replace epistemology with applied logic and empirical psychology.[48] Van Fraassen is frank:

As to knowledge, all the philosophical puzzles that pertain to it specifically seem best transposed to philosophy of language, to investigation of the grammar, the logic, and most of all the pragmatics rather than [*sic*] semantics, of the term 'know' (van Fraassen 2007: 346; *cf.* 2000: 275).

Van Fraassen neglects Kant's (1781, 1786) and Dretske's (1981) point that sensory qualities manifest in "unaided act[s] of perception" (*SI*: 15) do not exhaust the information about worldly circumstances and events encoded in sensations, and that sensory perception often functions as information channels, which scientists – unlike empiricists – sagaciously decode, assess and exploit successfully to understand and to explain various natural causal processes and events. Van Fraassen (2001) thinks it extraordinary and epistemologically important that light itself cannot be perceived. Only because it cannot, can light serve as a quiescent information channel conveying information about other circumstances encoded in its various modifications (*e.g.*, color, intensity, polarization), some of which are perceptible even to unaided human eyes. In connection with sense perception and scientific instrumentation van Fraassen (2001: 154-155) asks, "Window or Engine?" This is a false dichotomy and skeptical trap,[49] obscuring the many ways in which both sense perception and scientific instrumentation function – or can be made to function – as reliable, sufficiently quiescent information channels.[50]

Van Fraassen's unCritical appeal to Morris's distinctions, on the basis of

[48] Carnap (1930-31): 133, 137, 143-4; (1931): 23, 38; (1932-33b): 215, 228.

[49] As is Davidson's claim (above, note 5) that only beliefs can justify beliefs, whilst sensation merely causes beliefs.

[50] Muller (2005: 75) appears to make the relevant distinction in his gloss on his (19), by contrasting light emitted or reflected by a macro-scale particular, to any light merely transmitted by it.

which he relegates all relations between any scientific theory and any person to the "merely" pragmatic, defaults on the single most important lesson of Gettier's (1963) classic paper, that understanding human knowledge – and in particular: cognitive justification – requires taking a person's actual cognitive processes and circumstances into account. (All of Gettier's examples turn on such factors.) On van Fraassen's unCritical appeal to Morris's distinctions, any such justificatory factors are merely pragmatic and contextual, *rather than* cognitive. Van Fraassen's dichotomy requires tendentiously stressing "merely." To the contrary, most factors relevant to the justificatory status (or justifiedness) of someone's beliefs, judgments, or knowledge are specific to individual people and their social and natural context. (They need not be limited to individual people; this is no expression of cognitive individualism; see Westphal 2011a, 2013d.) This is an important reminder of why philosophy of language – and, analogously, philosophy of mind – can contribute to and can augment epistemology, but cannot supplant it. It is also a very basic epistemological reason why "objectivity" cannot be identified with context-independence *tout court*.[51] Muller (2005: 66, 90) recognizes that van Fraassen's (*SI*) and Monton and van Fraassen's (2003) context-independent notion of objectivity is both untenable and unnecessary; that the key point is public verifiability or confirmability of scientific observations. This is correct, but is only part of the correction required to van Fraassen's decidedly non- or even anti-cognitivist views of what counts as (merely) "pragmatic."

Doubtless van Fraassen would claim that, insofar as justification is involved in assessing or accepting scientific theories, this can only be a matter of assessing their empirical adequacy. This contention, as we have seen (§§5, 6), rests upon a fundamental, implicit, erroneous infallibilist presupposition about empirical justification, and about the scientific adequacy of "empirical adequacy" (§§7-9). Though van Fraassen (2000) claims (in his title) to expose "the false hopes of traditional epistemology" (*cf. idem*. 2001: 165, 167), he has expunged far too few of those traditional epistemological hopes – and presuppositions – from his Constructive Empiricism. The single most important lesson of the pragmatists (Peirce, James and Dewey) is that our intellectual activities and accomplishments, whether cognitive or moral, can only be properly understood by understanding them as rooted in and growing out of human practices within the natural and social world. Like Kant and Hegel, pragmatism is committed *avant la lettre* to externalist aspects of conceptual content, linguistic meaning, and cognitive justification, none of which can be properly appreciated by ascent to a meta-language, unless that ascent is complemented by a concerted *descent*

[51] This epistemological reason complements Muller's (2005) reasons for rejecting this identification, *contra* van Fraassen (*SI*: 82), Monton and van Fraassen (2003).

into our actual activities within the actual world, within which alone explicated terms, phrases, or principles have their basic usage. This is a key lesson implicit in Carnap's (1950b: 1-18) distinction between conceptual analysis and conceptual explication, though it has been widely neglected (Westphal 2010-11). This lesson entails that legitimate philosophy of science must be history and philosophy of science, of a kind which gives priority to actual science.[52]

Van Fraassen (2002: 82-83, 109-110; 2007: 346, 366) exhibits typical neo-pragmatist misunderstanding of pragmatism, and unCritical commitment to philosophy of language superceding epistemology. Perhaps van Fraassen is correct, that "the epistemic commitment of" scientists discussing, *e.g.*, why the hydrogen atom only emit photons with frequencies in the general Balmer series, "is not to be read off from their language" (*SI*: 151). However, neither can their "epistemic commitment" be properly read by Constructive Empiricism.[53] As useful as it is to scrutinize various cogent uses of the term 'know', philosophy of language and philosophy of mind can augment epistemology, though they cannot supplant it, because they do not suffice to understand specifically *cognitive* reference, nor do they suffice to understand cognitive justification. The transposition of epistemological issues into philosophy of language, which "seem[s] best" to van Fraassen (2007: 346; quoted above), is an illusory appearance, of just the kind Hegel (1807) analyzed as apparent forms of knowledge, about which he inquired searchingly, whether or in which regards any of them may be genuinely cognitive.[54]

10.5. My surmise is that the basic errors identified herein are due to fixation upon six views characteristic of the empiricist stance:

1. The objects of scientific inquiry and explanation are individual events, observations, or data.

[52] In addition to Harper (2011) and Smith (2002a, 2007), see, *e.g.*, Bartels (1994, 1996), Essfeld (2012), Falkenburg (2007), Falkenburg and Morrison (2014), Johansson (2007), Scheibe (1997, 2007) and Howard Stein (*cf.* Malament 2002).

[53] Van Fraassen (*e.g.*, 2002: 86-90) has become fond of quoting voluntarist passages from James, neglecting that as scientist James (1907: 216-217) understood that "... in the choice of these man-made formulas [*viz.*, quantitative laws of nature] we can not be capricious with impunity any more than we can be capricious on the commonsense practical level. We must find a theory that will work; and that means something extremely difficult; for our theory must mediate between all previous truths and certain new experiences. It must derange common sense and previous belief as little as possible, and it must lead to some sensible terminus or other that can be verified exactly. To 'work' means both these things; and the squeeze is so tight that there is little loose play for any hypothesis. Our theories are wedged and controlled as nothing else is."

[54] An excellent entré to pragmatic realism, in connection with both epistemology and history and philosophy of science, is Will (1997).

2. Observational evidence (greatly) "under-determines" physical theory.

3. Disregard (merely) "theoretical" content of scientific theories; focus solely upon a theory's "empirical content" (*e.g.*, *SI*: 64, quoted above: §7.1).

4. Theories are to be used only for, and assessed only in terms of, description, prediction, retrodiction (and systemization) of observations.

5. Causality consists only in regularity.

6. Explanation is only of individual events by appeal to a relevant covering law.[55]

The problem of underdetermination of theory by evidence is a serious, though not insuperable problem for H-D methods (Gemes 2005). Empiricist pre-occupation with sensory observations, however, has long tended to disregard complex, significant distinctions and relations between sensory observations, empirical data, and scientific evidence.[56] More importantly, Harper (2011: 126-42, 194-219, 238-256, 372-378) shows that Newton's much more robust methodology (summarized above: §2) vastly reduces the underdetermination of theory by observational data. In contrast to empiricist preoccupation with individual events, Newton's causal-explanatory dynamic aims to explain (and to correct and to improve upon, *per* Rule 4) Kepler's celestial kinematics and Galileo's terrestrial kinematics by explaining them and a surprising range of further kinematic regularities, such as tides. Regularity theories of causality, and likewise the "covering law" model of explanation, cite natural regularities in order to explain individual events, though such explanations do no more than classify an event as an instance of an observed natural regularity. (Great shades of Aristotelian induction!) Newton's mechanics instead aims to explain the kinematics of natural regularities dynamically, by identifying, measuring and justifying his physical claims about the existence and causal action of gravitational forces of attraction.

11. *Conclusions*

Van Fraassen noted that "the major questions of epistemology" cannot be settled "*en passant* in philosophy of science" (*SI*: 19). Indeed not. Yet developing a philosophy of science on faulty epistemological preconceptions is ill-fated

[55] *Cf.* Maxwell (1957): 159; Schlesinger (1957): 324-326; Hempel (1965), Beauchamp and Rosenberg (1981).

[56] *Cf.* Bogen and Woodward (1988), Radder (2006) and further references provided above: note 5.

from the outset. For reasons presented herein I conclude that this is the misfortune of van Fraassen's Constructive Empiricism, whether in 1980 or in 2008. That the fundamental flaws in Constructive Empiricism identified here (§5-7, 9, 10) have gone unnoted for thirty three years indicates that much contemporary philosophy of science requires fundamental re-examination of its central epistemological presuppositions. Van Fraassen seeks to retain what is sound in logical empiricism (2007: 337-338); that is important, but van Fraassen unwittingly seeks instead to promulgate some of its basic errors. Worth retaining is Carnap's semantics, which largely survives the demise of semantic atomism, and his method of explication, and explications writ large as linguistic frameworks, the use *and* the assessment of which is linked to their facilitating the activities within which their terms or phrases were originally embedded.[57]

It is understandable, of course, that Twentieth Century empiricists took Kant at his word, that his transcendental analysis of the necessary conceptual, intuitive, and judgmental conditions of empirical knowledge requires his Transcendental Idealism. Empiricists rejected both by rejecting 'the' synthetic *a priori*. One of Kant's key questions was, How is pure natural science possible? (*KdrV* B20). Transcendental Idealism, however, did not help to answer this question; nor did most of Kant's *Metaphysical Foundations of Natural Science*, as he himself later recognized.[58] However, strictly internal critique of Kant's Critical philosophy shows that, and how, it is possible to disentangle Kant's insightful epistemology and theory of cognitive judgment from his Transcendental Idealism. So doing was one of Hegel's great achievements, which reveals one of Kant's great achievements: his semantics of singular cognitive reference, which has such basic and important implications for our understanding of empirical knowledge, including natural science. Five of these implications are:

1. In non-formal domains, mere logical possibilities as such have no cognitive and hence no scientific status, not even as justification defeaters.
2. By so strongly supporting the cognitive-semantic core of Newton's methodological Rule 4 of experimental philosophy, Kant's and Hegel's semantics of singular cognitive reference contributes to showing that Newton is entitled to his realism about gravitational force; neither Constructive Empiricism nor any other form of empiricism can show otherwise.

[57] I develop these points in Westphal (forthcoming-b).

[58] See Westphal (2004): §§30-59. The one tenable part of Kant's *Metaphysical Foundations*, he realized, is chapter 1, "Phoronomy," which concerns motions and their combination. Kant's results there are not trivial; they suffice to dispense with Newtonian "absolute" space by showing that arbitrarily large reference frames can be constructed for any relative motions we may wish to investigate (Carrier 1992).

3. Philosophy of language and philosophy of mind may augment epistemology, though they cannot supplant it, because their resources do not suffice to understand specifically *cognitive* reference, nor do they suffice to understand cognitive justification.

4. Answering the question, 'How is natural science possible?', requires understanding the natural sciences as they are, in their own terms and methods, rather than trimming one's philosophical picture of science to fit one's philosophical predilections.
   Empiricists have been doing this for far too long. Hegel, to the contrary, argued cogently and *en detail* – in 1807! – that any sound epistemology must take the natural sciences into very close consideration, which he himself did (Renault 2001; Morreto 2004; Ferrini 2009; Westphal 2008, forthcoming-a).[59] Newton's methodology and ideal of explanatory success remain important, not only for understanding Classical Mechanics and General Relativity, but also (*e.g.*) contemporary physical cosmology (Harper 2011: 394-396).

5. Kant's and Hegel's semantics of singular cognitive reference points the way forward in history and philosophy of science by providing the basis of a sound cognitive-semantic interpretation of scientific theories.

Hegel's epistemology remains important today because, by augmenting Kant's, Hegel's critique of Cartesianism and his constructive alternative to it are more incisive and cogent than contemporary anti-Cartesianism,[60] because so much of analytic philosophy – especially in Anglophone circles – remains pre-Kantian.[61] Under the banner of "the empirical stance" van Fraassen has instead purveyed the empiricist stance. We shall not properly understand empirical knowledge, and especially not the natural sciences, until we rescind the faulty presumption that empiricism has a monopoly upon the empirical.[62]

[59] Hegel also argued for and developed the complementary point about the fundamental significance of social sciences, and in particular, political economy, for moral philosophy.

[60] Compare, *e.g.*, Westphal (2005) to Alston (2005), 204-10; or Westphal (2004) to Burge (2010). Also see Bird (2006), Haag (2007), Westphal (2013d).

[61] The boom in analytic Kant scholarship not withstanding; *e.g.*, the entire discussion of 'analytic transcendental arguments' is fundamentally Cartesian; see Grundmann (1993), Hanna (2001), Westphal (2004, 2010b).

[62] Predecessors of this paper were presented to the Philosophy Department, University of Western Ontario (Feb. 2009), to the joint meeting of the UK Kant Society and the Hegel Society of Great Britain (Sept. 2010), to the Zentrale Einrichtung für Wissenschaftstheorie und Wissenschaftsethik (ZEWW), Universität Hannover (Nov. 2012), and to the Departments of Philosophy at the Universität Bielefeld (Jan. 2013) and at the Vrije Universiteit Amsterdam (June 2013), with comments delivered on the latter occasion by Hans Radder and by Christian Krijnen. I benefitted from the ensuing discussions on each occasion, and especially from remarks by Bill Harper, Kathleen Okruhlick and

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