Cognitive Semantics & Causal Judgments

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Note: This working paper was delivered as three workshop talks for Kent's 2008 Causality Study Fortnight (CSF). It draws from various pieces of my published research. Requests from interested participants has prompted me to polish up my talks somewhat and post them on the CSF website for use of participants *only*. Please note: this document is *not* fit for publication, certainly not in its present form. It is available for your use within the context of the CSF. Please **do *not* reproduce, cite, quote, excerpt or further distribute this document in any form or by any means whatsoever**. Comments, questions, suggestions and objections *very* welcome, no matter how severe! Thank you very much for your interest! – *KRW*

FOREWORD. This working paper examines what is required to make genuine cognitive judgments about what I shall call (stipulatively) 'determining' causes, causes which produce or generate their effects by natural processes not involving free human agency. Though drawing on historical sources, my discussion is systematic.

One important, though widely neglected factor in such judgments is cognitive semantics: What enables us to refer our concepts of determining causes to actual determining causes in justifiable cognitive judgments about them? Surprisingly, Kant is the first to develop the required cognitive semantics; Hegel adopted and adapted it from him, and by very striking coincidence, Gareth Evans argued independently for some core features of this same semantics in 'Identity and Predication' (1975).

A second important point is that the judgments by which alone we can identify determining causes are discriminatory: we can identify specific kinds of determining causes only by discriminating an actual cause (or causes) from contrasting causal scenarios. Moreover, these discriminatory causal judgments about determining causes are only possible for us regarding spatio-temporal objects. These insights are Kant's.

The causal judgments about determining causes discussed here involve causal realism. A third important point is, on the one hand, to criticize a range of Cartesian and empiricist reservations about causal realism, and on the other, to justify causal realism. I address these points (in Parts II and III) in connection with Newtonian gravitational theory, which suffices to justify causal realism about attractive gravitational force acting at a distance. When properly understood, Newton's methods also suffice to expose some key weaknesses in empiricist non- or anti-realism about causality. Surprisingly, these insights are Hegel's, though only recent Newton scholarship (in particular, by William Harper) has identified precisely how Newton's methods and criteria of theoretical adequacy are superior to those advocated by contemporary philosophers of science. I also indicate how these concerns about dynamic causal distance forces of attraction pertain to causal mechanisms and causal activities.

Finally, examining the requirements for and the possibilities of justifiable cognitive judgments about determining causes illuminates, conversely, in several ways how specious are the causal claims made by causal theorists of the mind and by psychological determinists. Here my critical target is a host of philosophical pseudo-theories, common from Hobbes to the present day.

These four points are developed throughout the following remarks. The development of this account of causal judgment largely follows the order just suggested; the criticisms of causal theories of mind are interlaced throughout. Each of the following three parts begins with an introduction indicating which specific topics are discussed and the order in which they are discussed.

More specifically, my line of argument may be summarized as follows:

1 The realm of causality is much wider than the domain of determinate cognitive judgments about determining causes.

2 By stipulation I understand for present purposes 'determining' to include both stochastic and ergodic causal processes, excluding (though not denying) actions of free agents. By 'determining causes' I mean causes that determine their effects to occur by generating them, either by attractive or repulsive forces or by material causal mechanisms or causal activities. (Perhaps other forms of determining causes are possible, but none have yet been discovered. A key point for which I argue is that it is a grave error to put much weight on such mere possibilities.)

3 Purely causal theories of mind, including psychological determinism and eliminiative materialism, purport that mental events (experiential episodes, decisions, volitions, 'qualia' *etc.*) are produced by determining causes. By 'purely' causal theories I mean those which purport that causality suffices for a complete account of the mental. (My critical target is primarily, perhaps exclusively, a group of purported philosophical theories which have far more credence among philosophers than they merit.)

4 Purely causal theories of the mind are vacuous descriptions and nothing more because:

5 Rational judgment cannot be reduced to purely causal processes. Kant's is right about the autonomy or spontaneity of rational judgment (§2).

6 Determinate cognitive judgments require ascribing characteristics to specific individuals which are identified by localizing them (Kant's semantics of cognitive reference, §11). (Kant's semantics provides a different account for referring to and ascribing intentional phenomena to free agents.)

7 No determinate cognitive judgments using concepts of determining causes are possible regarding mental episodes, that is, regarding intensional phenomena such as experiences, perceptions, thoughts, reasons, decisions, volitions, 'qualia' etc., because about mental episodes we can make none of the discriminatory judgments required for ascribing determining causal characteristics to specific, identified individual objects or events.

8 Regular correlations may be generated by determining causes, but identifying a regular correlation does not suffice to identify a determining cause. Robust regular correlations are only *candidates* for causal inquiry (*pace* Hume).

9 Identifying determining causes of a robust regular correlation requires specifying either distance forces, a causal mechanism or a causal activity which produces that correlation.

10 Distances forces can be identified only by exact agreeing measures provided by a variety of independent measurement techniques (§14). (Newton, cp. Craver)

11 Only when these conditions are satisfied are we within the domain of causal *explanation* (*pace* Davidson).

12 Purely causal theories of the mind must explain how a physical state has representational content; this remains a fundamental mystery.

13 None of these conditions in are remotely satisfied by causal theories of the mind.

14 Unless and until these conditions are satisfied, causal theorists of the mind only use causal locutions but make not even candidate determinate cognitive judgments about mental episodes.

I. Kant *vs* Purely Causal Theories of Mind

1 Are purely causal theories of the mind legitimate?

Can we make legitimate, justifiable causal judgments within the philosophy of mind? The aspects of the mind relevant here are intentional or at least intensional phenomena, including beliefs, thoughts, experiences, motives, reasons, decisions, volitions or 'qualia'. Kant's account of causal judgment (which stands independently of his infamous transcendental idealism) provides considerable reasons to show that we can*not* make such causal judgments legitimately. I speak of 'purely' causal theories of mind to indicate Kant's point that, although various aspects of the mind may be causally structured, a causal account cannot be a sufficient account of the human mind.[1] There are two prongs to Kant's analysis: to highlight why causal considerations do not suffice to account for rational judgment, and to block would-be determining causal judgments about the mental through his account of cognitive semantics and the discriminatory character of cognitive judgments about determining causes.

The first step (§2) is to highlight three aspects of the autonomy of rational judgment required for rational justification:

1) The exercise of judgment is inherently one's own exercise of one's own capacity for judgment. (§2.1)

2) The exercise of judgment is structured normatively, not merely causally. (§2.2)

3) Only by exercising judgment do we *act*, rather than merely behave, because we base our actions on justifying reasons, rather than merely excuses or exculpations. (§2.3)

The second step (§3) is to review four important criticisms Kant makes of purely causal theories of the mind. The third step (§4) is to examine in greater detail Kant's reasons for holding that we can only make legitimate, justifiable causal judgments about spatio-temporal objects or events. The final step (§5) is to consider Kant's case that we cannot identify mental substances among mental phenomena.

2 Rational Judgment, Autonomy and Spontaneity.

The self-conscious 'I think' (to borrow Kant's phrase) that matters most to philosophy is the 'I judge' which is central to rational thought and action in any of its forms. Only a strong sense of 'I judge' which involves critical assessment makes possible thought and reasoning, as contrasted with mere vocables, rhetoric, propaganda or rote following of protocols. Conversely, anyone who can or does engage in genuine inquiry and debate instantiates (more or less adequately) this strong sense of the term. Kant's investigation aims to uncover the transcendental conditions that make self-conscious experience humanly possible (Westphal 2004). My focus here is primarily on the kind of self-conscious judgment required to understand, to appreciate and to *assess* the point of any substantial piece of reasoning.

2.1 My present point concerns the proper understanding of rationally justified and justificatory judgment. To judge rationally is not merely to decide. To judge rationally is to make whatever judgment is best warranted in view of all available relevant considerations, including evidence, counter-evidence, relevant principles of inference, relevant (as contrasted to irrelevant or less relevant) analogies with other examples, cases or domains as well as alternative accounts or assessments of the issue, whether historical, contemporaneous or merely possible. To judge rationally is to assume responsibility for the warrant or justificatory status of one's conclusions. To assume responsibility for making judgments and for making any and every particular judgment is to exercise autonomy. The autonomy of rational judgment consists in regulating one's own thinking, deliberation, assessment and ultimately judgment and conduct in view of the various factors (including those just mentioned) that bear on the identification and justification of the correct, or at least the best justified conclusion about the matter at hand. This kind of 'self-regulation' of one's own thinking literally is a form of 'auto-nomy', of self-governing, self-motivated, voluntary use of rules, principles or laws, in this case, the 'laws' or at least guidelines of cogent justificatory thinking, including the proper use of evidence. Thus one basic sense in which judgment is autonomous is that one forms one's own judgment for considered reasons, rather than merely adopting anyone else's judgment, advice or recommendation

[1] Part I is largely drawn from Westphal (2004), §61. This material originated as Westphal (1995), which was the assigned reading for my first seminar, available on the CFS web page.

(much less: command).
2.2 A second significant sense in which rational judgment is autonomous is that it is guided by the normative considerations of appropriate assessment and use of both evidence and principles of reasoning. If judgment, as a physiological or psychological process is in some way causal, nevertheless it counts as *judgment* only insofar as it responds to such normative considerations, rather than merely to its causal antecedents as such. Judgment is a response to, not merely an effect of, its proper evidentiary and inferential antecedents. If justificatory processes turn out to be causal, they are justificatory not because they are causal, but because they satisfy sufficient normative constraints – defining or at least including *proper* functioning, *proper* inference and *proper* assessment – to provide *inter alia* rational justification. For this reason, Kant held that reason, rational judgment (a pleonasm), is spontaneous (Allison 1997). This point merits closer consideration.
2.3 Only rational spontaneity enables us to appeal to principles of inference and to make rational judgments, both of which are normative because each rational subject considers for him- or herself whether available procedures, evidence and principles of inference warrant a judgment or conclusion. In the theoretical domain of knowledge, *having* adequate evidence, proof or (in sum) justification, requires *taking* that evidence, proof or justification to be adequate; in the practical domain of deliberation and action, *having* adequate grounds for action requires *taking* those grounds to be adequate. We *act* only insofar as we take ourselves to have reasons, even in cases of acting on desires, where we must (*ex hypothesi*) take those desires as – by judging them to be – appropriate and adequate grounds of action. Otherwise we abdicate rational considerations and absent ourselves from what Sellars (1963, 169) calls 'the space of reasons' and merely behave. In that case, as McDowell (1994, 13) says, we provide ourselves only excuses and exculpations, but not reasons or justifications, for believing or acting as we do. (Note that I do not say that taking evidence to be adequate suffices for that evidence to be adequate![2]) Kant's conception of rational spontaneity opposes empiricist accounts of beliefs and desires as merely causal products of environmental stimuli, and it opposes empiricist accounts of action, according to which we act on whatever desires are (literally) 'strongest'. We think and act rationally only insofar as we judge the merits of whatever case is before us. This is the third aspect of rational autonomy.

Kant's 'Incorporation Thesis' (Allison 1990, 5–6, 39–40) is that

> no inclination is a motive unless and until it is incorporated into an agent's maxim by being judged to be at least permissible. (*Religion*, 6:24*n*)

This thesis is thus an instance of the more general principle (and third aspect) of autonomous judgment identified here.

In sum, these are three aspects of the autonomy of rational judgment:

1) One forms one's own judgment for considered reasons, rather than merely adopting anyone else's judgment, advice or recommendation (much less: command).

2) Judgment is a response to, not merely a causal effect of, its proper evidentiary and inferential antecedents.

3) We think and act rationally only insofar as we judge the merits of whatever case is before us, and are not simply caused to believe or to behave as we do.

3 Kant's Critique of Causal Theories of the Mental.

Kant makes four important objections to purely causal theories of the mind. I summarize these briefly in this section and consider one of them in detail in the following section.
3.1 Empiricists continue to rely on a belief-desire model of action that stems directly from Hobbes, apparently without realizing it is a relic of the Seventeenth Century. This simple model may suffice for various branches of economic or sociological theory, but theirs is not the task of providing an adequate

[2] Some epistemologists bridle at the notion that having adequate evidence or grounds for belief requires taking that evidence or those grounds to be adequate. Yet there are many examples of people having memories or perceptions which in fact bear evidentially on a certain belief they hold, though they fail to recognise this evidential relation and so fail to base their belief on that evidence. Basing (or, *mutatis mutandis*, rejecting) beliefs on evidence requires taking that evidence to be both relevant and adequate.

account of individual human reasoning, deliberation and action.[3] That we behave in ways which, when aggregated across groups, can be modelled on the basis of this simple belief-desire model does not prove that this belief-desire model is either correct or adequate as an account of human agency, quite aside from considerations of the extent to which heavily commercialized modern societies induce us to behave as if the belief-desire model is true of us. Behaving in such ways is great for sales, though hardly sufficient for a full human life. That Rawls (1971) elected to argue for his *Theory of Justice* on the basis of an essentially economic, belief-desire model of human agency was a strategic concession to empiricists who were sceptical about the principles of justice Rawls advocated. He sought to derive his Kantian conclusions from their empiricist premises. This is not to endorse those premises, which of course no Kantian would do.

3.2 Causal theories of mind take beliefs to be causal products of environmental or intra-psychic events. To be consistent, causal theorists of the mind would undermine their own claims to justification of their favoured model of human behaviour. This argument is similar to Kant's point in the *Groundwork* (4:446–9) that we can only act if we presume ourselves to be free from causal determination, because only then can we make rational judgments. Yet the present argument is stronger: If psychological determinism, or more broadly, a purely causal theory of the mind were true, we could not know it, because we could not have justificatory grounds of proof for either kind of theory (cf. §2.2).[4]

Causal theories of knowledge at best only provide very rough accounts of co-variance between environmental states of affairs and our beliefs about them. Co-variance is not sufficient to establish causal relations. More importantly, co-variance does not suffice to establish, nor even to define the information channels required for knowledge or for belief (Dretske 1981, 27–39).

3.3 At best, causal theories of the mind and of knowledge are loosely based on scientific causal explanations of natural phenomena. Such 'theories' or accounts are, at best, merely promissory notes for a causal theory their proponents expect ultimately to be provided by natural science.

However, Kant points out that the regulative principle of natural science, always to seek causal explanations of phenomena, does not itself justify a causal description of a phenomenon. A causal description of a phenomenon is only justified by a genuine causal explanation of that phenomenon. Only an empirically justified causal explanation of a phenomenon can justify a constitutive interpretation of causal locutions used to describe and explain the phenomenon in question. Even after a truly marvellous 'decade of the brain' in neurophysiology, it will take many more such decades even to begin to develop plausible causal explanations of mental contents, thoughts, beliefs, desires, reasonings or decisions. Contemporary causal theories of mind are running on unredeemed and, for the foreseeable future, unredeemable promissory notes.[5]

3.4 The use of causal locutions to describe mental processes is unsurprising, but causal theorists of the mind disregard the important question raised by Kant, whether we are entitled to a constitutive construal of our causal locutions in connection with mental phenomena. Kant argued cogently that we are not, because we are only able to make legitimate causal judgments about determining causes in regard of *spatio*-temporal objects and events; hence we can make no legitimate determinate causal judgments about psychological phenomena (Westphal 2004, §§8, 9, 36, 61, 62). This point I discuss in the next section (§4).

3.5 In sum, these are Kant's four main objections to purely causal theories of the mind:

1) The successful use of the belief-desire model in social sciences provides no evidence for a purely causal belief-desire model of individual human agency.

2) Purely causal theories of the mind cannot account for the normative dimensions of knowledge, in particular, for the justification condition of knowledge.

3) The regulative principle of natural science, always to seek a causal explanation of any phenomenon, does not itself justify any constitutive claim that individual agency can be explained in purely causal terms. (Only an actual, adequate scientific theory could do this.)

[3] Yes, economic theory can explain various specific individual actions (Levit & Dubner, 2005), though these explanations only show that in various interesting ways we are not economic fools; these explanations do not contribute to justifying a belief-desire model of individual human action.

[4] Externalist accounts of knowledge are only suited to perceptual situations; they are not suited to the very theoretical issues involved in psychological determinism or causal theories of mind.

[5] For an illuminating attempt to unravel many current confusions about 'naturalism' in these connections, see Rouse (2002).

4) We can make no legitimate (i.e., justifiable) determining-causal judgments about psychological phenomena. (See §4.)

4 Legitimate causal judgments pertain only to spatio-temporal objects or events.

In the 'Analogies of Experience' Kant's argues for these three principles of causal judgment regarding determining causes:

1) Substance persists through changes of state. (B224, '1st Analogy of Experience')

2) Changes of state in any substance are rule-like or law governed. (B232, '2nd Analogy')

3) Causal relations between substances are causal *inter*actions. (B256, '3d Analogy')

The important point here is that each of these principles can only be used in a legitimate – that is, a justifiable – cognitive judgment about determining causes through conjoint use of the other two principles. This is because identifying any one object or event requires being able to track it through some span of time during which we observe it, where 'it' may exhibit any one of three possibilities:

1) It may be an object that is stable spatially and undergoing no transformation, though we may notice or perceive various of its properties sequentially (Kant's house; A190/B235).

2) It may be an object undergoing no transformation, though it moves in space (Kant's ship; A192/B237).

3) It may be an object undergoing a transformation of one or more of its characteristics, regardless of whether it moves.

(An object may, of course, both move and transform.) Kant's point is that identifying any one of these scenarios as the instance at hand requires determining that the present case is neither of the other two. To identify an object that is stable both spatially and transformationally, we must be able to determine that it is not moving, and that it is not undergoing transformation. To determine that an object undergoes transformation, we must determine that what appears to be a transformation is not simply a local motion revealing a previously occluded aspect of the object; we must also determine that the object does not simply move away or vanish, only to be replaced by a different object that slips into the place it previously occupied. Each of these determinations requires that we can identify and *re*-identify something that perdures through the changes we perceive, whether they are real (transformations) or merely apparent (local or relative motions with respect to the perceiver). Reidentification of particulars distinct from ourselves requires their spatiality (O'Neill 1976) and discriminating their causal interactions; hence reidentification is required even to identify particulars distinct from ourselves. Our capacity to discriminate among these three kinds of scenario requires discriminating what does occur in any instance from what might have been occurring on that occasion. In this regard, perceptual judgments require imagination as well as intellectual determination.

Have I just made Kant's point entirely analytically? No. The key question is whether Kant's analysis of the necessarily interdependent use of these three principles of causal judgment holds *of us*. For good reason, Kant rejects the Cartesian-sceptical demand to prove that our cognitive capacities are fit for any possible world before trusting them in our actual world, and attends instead to the much more important and viable task of developing a sound theory of *human* knowledge. To secure Kant's point, that these three causal principles form an integrated set, requires reflecting on counter-factual cases such as these: Could we identify a particular event using only one or two of Kant's three principles? Could we identify any particular event without discriminating its kind from the alternative scenarios mentioned above? What would it take for this to be possible? If it were possible, would it be possible for a human being? Further analysis of Kant's claim is possible, though further analysis does not suffice to answer the crucial question of whether this analysis holds true *of us*. This question can only be addressed by careful reflection on our own cognitive capacities, not on some alleged logically possible set of cognitive capacities.

To ask how we make these discriminations in any particular case is to fall back into the foundationalist trap of trying to respond to sceptical challenges piecemeal, an approach Kant realized was bankrupt. Hence Kant argues instead that we must be able to do this, at least a significant part of the time, if we are to be self-conscious at all (cf. Westphal 2004, §65). Here one may desire more analysis of why the principles of the three Analogies must be used conjointly (see Westphal 2004, §§33–39), but even if such were provided, the question would remain whether this analysis holds true *of us*. To determine this, we must reflect carefully and honestly on our own capacities to identify and discriminate such events.

More formally, Kant argues as follows.[6] The empirical criterion of causal succession is the lack of reversibility of the type of sequence of appearances produced by one or more objects; the empirical criterion of co-existence is the reversibility of the type of sequence of appearances produced by one or more objects. Judging determinately that either co-existence or succession occurs requires judging determinately that the other does not, and both judgments require that we identify objects that persist through both the real and the apparent changes involved in the sequence of appearances at issue. We cannot directly perceive or ascertain either time or space, and the mere order in which we apprehend appearances does not determine an objective order of objects or events (cf. Hume's study). Consequently, the only condition under which we can determinately judge which states of affairs precede, and which coexist with, which others is if there are enduring perceptible substances which interact, thereby producing changes of state in one another. Enduring substances are necessary for us to determine the variety of spatial locations, to determine changes of place, and to determine non-spatial changes objects undergo. To determine whether a change of appearances is a function of one object, previously in view, moving out of view when displaced by another, or instead is a function of one object rotating to reveal a different aspect ('side'), or instead is a function of one spatially stable object undergoing a non-spatial change of state, requires that we are able to identify places, changes of state, and objects that change place or state, and that we are able to distinguish these different kinds of scenario. To make any one such determinate judgment requires joint use of all three of the principles defended in the Analogies. None of the principles defended in the Analogies can stand alone; they all stand together, or they stand not at all. Consequently, if we cannot identify substances in some domain, then we cannot make any causal judgments whatsoever in that domain.[7]

5 Can We Identify Psychological Substances?

In his final Observation on the first edition Paralogisms of Rational Psychology Kant states that only change of determinations, but no determinable object, is knowable within the form of inner sense, which is time.[8] Why justifies this conclusion? Kant's contends that inner sense reveals no 'abiding

[6] Here I summarize Guyer's ground-breaking findings (1987: 168, 212–14, 224–25, 228, 239, 246, 274–75).

[7] In Westphal (2004), §§36–39 I argue that there is much more to the integrity of the three Analogies than even what Guyer has shown. The First Analogy defends the use of substantival concepts as a necessary basis for causal judgments; the Second Analogy defends the rule-governedness of causal relations among states of individual substances; but only the Third Analogy defends the principles needed to make judgments of causal interaction between distinct substances. Kant provides an important clue about this in a note added to the Table of Categories in the second edition: 'by simply combining the concept of a cause and that of a substance, [one does not] at once have an understanding of *influence*, that is, how a substance can be the cause of something in another substance. [For this, ...] a separate act of the understanding is demanded' (*KdrV* B111, 3:96.20–24). Kant is right about this; causal influence, transeunt causal interaction between substances, is a distinct concept from those of substantiality and of causality as rule-governed succession. Seeing this makes plain that the Third Analogy is crucial to Kant's philosophical project, not only as a response to Leibniz and the occasionalists, and not only as a defence of an improved, non-corpuscular Newtonianism, but as a response to Hume and his denial that anything about the cause brings about the effect, that is, to Hume's denial of transeunt causality.

[8] 'If we compare the *doctrine of the soul* as the physiology of inner sense, with the *doctrine of the body* as a physiology of the object of the outer senses, we find that, although in both much can be learnt empirically, there is yet this remarkable

object' or anything analogous to the 'extended impenetrable being' found in outer sense. Such an object is a substance, and identifying substances is necessary for using legitimately any of the principles of causal judgment defended in the Analogies (§4). The implications of this for empirical psychology are direct: If we cannot identify substances within inner sense, that is, among psychological phenomena, then we cannot make any causal judgments about those phenomena. One primary conclusion of the Paralogisms is that we cannot identify substances among psychological phenomena.

The main target of Kant's Paralogisms is traditional rationalist psychology,[9] but even in stating this, Kant indicates an empirical aspect of his criticism: the concept of a simple nature cannot be a predicate in an objectively valid experiential judgment.[10] Kant quickly elaborates the empirical aspect of his criticism by criticizing *any empirical use* of the category of substance in application to the self: The only empirically serviceable concept of substance is the permanence of an object given in experience, but no such permanence can be demonstrated in the case of the 'I'.[11] Kant's argument goes far beyond refuting only traditional rationalist doctrines of the soul. His argument aims to show that there can be no synthetic *a priori* principles about the soul *at all*, *of any kind*. Thus there can be no immanent rational doctrine (no 'critical metaphysics', if one will) of the soul, and no empirical *science* of the soul, either. What remains is only to chronicle the content of inner experience.[12] Kant speaks explicitly of the *content* provided by possible inner experience. That is pointedly *not* an issue of the form, principles, or conditions of possible inner experience, but only an issue of empirical data or *evidence* provided by introspection. Any rational doctrine of the soul, whether *a priori* or empirical, purports to make synthetic judgments, including causal judgments. Such judgments require intuitions as a judgmental connecting link, but there are no suitable intuitions to be found in inner experience.[13] In particular, unlike the case of corporeal nature, there is no intuition of anything permanent or abiding in inner sense.[14] Consequently, rational psychology exists, not as a

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difference. In the latter science much that is *a priori* can be synthetically known from the mere concept of an extended impenetrable being, but in the former nothing whatsoever that is *a priori* can be known synthetically from the concept of a thinking being. The cause is this. Although both are appearances, the appearance to the outer sense has something constant or abiding which supplies a substratum as the basis of its transitory determinations and thus supplies a synthetic concept, namely, that of space and of an appearance in space; whereas time, which is the sole form of our inner intuition, has nothing abiding, and therefore enables us to know only the change of determinations, but not to know any determinable object' (A381, 4:238.35–239.13). *Cf.* A349–50, A361, A366, A398–99, A402–03; 4:221.1–15, 227.21–28, 230.18–28, 248.28–249.11, 251.12–20. Although the passage just quoted was omitted from the second edition of the first *Critique*, Kant added another to the same effect: 'in order to understand the possibility of things in conformity with the categories, and so to demonstrate the *objective reality* of the latter, we need, not merely intuitions, but intuitions that are in all cases *outer intuitions*' (B291, 3:200.6–9); *cf.* B420, 3:274.15–24.

[9] Even in defining the properly rational doctrine of the soul, Kant notes how easily it can slide into an empirical psychology (*KdrV* A342/B400, 3:263.16–20, A347/B405–06, 3:266.16–25).

[10] (*KdrV* A361, 4:227.21–28).

[11] 'But what use shall I make of this concept of a substance? That I, as a thinking being, *persist* for myself, and do not in any natural manner *either arise or perish*, can by no means be deduced from it. Yet there is no other use to which I can put the concept of the substantiality of my thinking subject, and apart from such use I could very well dispense with it.

'So far from being able to deduce these properties merely from the pure category of substance, *we must, on the contrary, take our start from the permanence of an object given in experience as permanent. For only to such an object can the concept of substance be applied in a manner that is empirically serviceable.* Now in the above proposition, however, we have not taken as our basis any experience; the inference is merely from the concept of the relation which all thought has to the 'I' as the common subject in which it inheres. *Nor should we, in resting it upon experience, be able, by any sure observation, to demonstrate such permanence.* The 'I' is indeed in all thoughts, but there is not in this representation the least trace of intuition which distinguishes it from other objects of intuition. Thus one can indeed perceive that this representation is invariably present in all thought, but not that it is a constant and abiding intuition, wherein the thoughts (as transitory) change' (A349–50, 4:220.28–221.15; emphasis added).

[12] *KdrV* A382, 4:239.29–32.

[13] *KdrV* A398–99, 4:248.28–249.11, A356, 4:224.24–36, B421–22, 3:275.13–20.

[14] *KdrV* A366, 4:230.18–28; *cf.* A349–50, 4:221.1–15, A361, 4:227.21–28; A381; A398–99; A402–03, 4:251.12–20; B420, 3:274.15–24.

doctrine, but only as a discipline setting limits to our cognitive aspirations.[15]

Kant's thus opposes causal explanations in psychology, not because they are false, but because we can make no legitimate, justifiable causal judgments within that domain. Kant does not simply deny that we can determine which specific psychological states cause which others. Kant argues repeatedly in the Paralogisms that we cannot identify (*phenomenal*) psychological substances. Kant remarks in the Second Analogy that

> Causality leads to the concept of action, this in turn to the concept of force, and thereby to the concept of substance. (*KdrV* A204/B249, 3:176.19–20)

This inferential link works *modus tollens*, too. If we cannot identify psychological substances, then we cannot validly judge psychological phenomena in substantial terms. Consequently, we cannot validly judge psychological phenomena in causal terms, either. Kant's principles are formulated at the broad categorial level of the validity of making certain kinds of judgments altogether. Thus his principles preclude the knowability of psychological determinism. The more restricted thesis, that we cannot determine which specific psychological antecedents have which specific psychological consequences, follows as a corollary. Kant recognizes two basic kinds of knowledge, historical knowledge based on empirical data, and rational knowledge based on principles.[16] Cast in these terms, Kant's view is that psychological knowledge can only be historical, not systematic, and so not scientific. It cannot be scientific, because it cannot be explanatory or causal.

In the Preface to the *Metaphysical Foundations of Natural Science* (*MAdN*) Kant merely states the implications of the Paralogisms for psychology as a science. A science, properly speaking, must be organized on rational principles. Any proper science has a pure rational *a priori* part, its metaphysical foundation.[17] But there can be no such part to psychology; accordingly, psychology can at best aspire to be an historical natural doctrine of the inner sense; it cannot be a causal investigation.[18] Psychology can at best be an orderly natural history, but not a science, not even an empirical science. Though here in the *MAdN* Kant apparently stresses methodological reasons barring psychology from scientific status, the first and main reason for denying scientific status to psychology is the very same Critical reason for holding this, namely, that no causal principles can be applied in psychology. Kant refers to this Critical doctrine in the following statement from the Preface of the *MAdN*:

> The reason for this [sc., the limitation on this extension of cognition in psychology] lies in the fact that the pure internal intuition in which the soul's appearances are to be constructed is time, which has only *one* dimension. (*MAdN* 4:471.19–22)

This sentence directly recalls Kant's statement to the same effect in his Observation on the Paralogisms. Kant's point, here again, is that to have only one dimension is not to have three, and three dimensions are necessary for occupying space (as opposed to simple spatial location, which even non-extended points have), that is, for spatial extension. If spatial extension is required for us to make determinate judgments about substances (as Kant repeatedly insists), then we can make no determinate judgments about substances within the form of inner sense, time, which is the sole domain of psychology. If determinate causal judgments require determinate judgments about substances (according to the integrity of the three Analogies as a set of principles), then no causal judgments can be made about the objects of inner sense, that is, about any psychological phenomena.[19]

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[15] *KdrV* B421, 3:274.36–275.4; *cf.* B420, 3:274.24–26, *KdU* §89, V 460.20–32.

[16] *KdrV* A835–36/B863–64, 3:540.30–33; *MAdN* 4:467.18–68.16.

[17] *MAdN* 4:469–70.

[18] *MAdN* 4:471. Subsequent to the *MAdN* Kant avidly followed the chemical revolution initiated by Lavoisier; see Friedman (1992), 264–90.

[19] In the *MAdN* Kant remarks that the 'I' designates (in a logical sense, as a subject of all predicates) a substance of which we have no concept (4:542.35–543.1; *cf. KdrV* A682–83/B710–11, 3:449.28–450.11). If we have no concept of this 'substance' or this 'subject of all predicates', then we cannot make determinate judgments about it.

In sum, though we can think of the human mind in causal terms, as Kant himself did, it is a further question whether we can make determinate, justifiable causal judgments about psychological phenomena, and yet another question whether determinate, justifiable causal judgments can suffice to explain the mind. Writing promissory notes on 'the ultimate psychological science' does not answer these questions. Kant provides considerable reasons not to be sanguine about the many promissory notes being written today by causal theorists of the mind.

I conclude by noting that an important, indeed I shall argue decisive, semantic point undergirds these considerations. Before considering Kant's semantics of cognitive reference (below, §11), it is important to understand and expose a number of empiricist qualms about causal realism which impede understanding the causal realism Kant defends, especially regarding gravitational force. Understanding Newton's justification of causal realism about gravitation force helps expose the vacuity of pseudo-causal claims made by causal theories of the mind.

II. Interpreting and Misinterpreting Newtonian Gravitation

6 Introduction.[20]

Despite certain precautions Newton took, he was a realist about gravitational force and this realism was (and remains) justified by his methods, theory and data. Yet Newton's theory has been understood by empiricist philosophers of science from Hume to Bas van Fraassen in non-realist terms. Two broad alternatives can be identified within Newton interpretation (also among eighteenth-century physicists) which may be designated 'realist' and 'positivist'. Obviously there are many versions of either kind of view, but all these views contrast in a characteristic way: Realists contend that gravitational force is genuine characteristic of matter and that Newtonian gravitational theory justifies ascribing gravitational force to matter. In contrast to this, positivists or empiricists (broadly speaking) reject realism about gravitational force and stress Newton's exacting, highly integrated quantitative descriptions, predictions and retrodictions of terrestrial and celestial motions.[21]

Empiricist scepticism about causal forces (or at least about our knowledge of causal forces) directly generates problems for understanding Newton's realism about gravitational force, including these two common tendencies:

1) The tendency to drop Newton's claims about 'absolute' forces and to focus solely on his quantitative analysis of motions.

2) The tendency to treat Newton's definitions of the *quantities* of motive forces as definitions of motive forces *per se*.

The problems which engender these two tendencies, and those which they in turn engender, obscure Newton's own realism about gravitational force as well as the ultimate commitment of Newtonian gravitational theory to this same realism.

7 Examples of these Tendencies.

These problems about scientific realism are nicely illustrated by some oddly contrasting, indeed

[20]§§6–9 draw from Westphal (2008), §7.

[21]For those unfamiliar with Newton's *Principia*, the Appendix contains my review of DeGandt (1995), which provides a brief conspectus of some of Newton's key issues and strategies (§17) and a list of Newton's key definitions, laws and corollaries (§18).

conflicting passages found in Jammer (1957), *Concepts of Force*.[22] Some of these passages illustrate Newton's realism – and certainly the realism involved in Newtonian theory, once it is put on a sound analytical footing (*viz.*, calculus) – though another passage illustrates the instrumentalist or positivist (mis-)interpretation of Newtonian mechanics.

Consider first three passages from Jammer which express Newton's realism about gravitational force. They concern Newton's Definitions 6–8, which are:

> Def. 6. The absolute quantity of centripetal force is the measure of this force that is greater or less in proportion to the efficacy of the cause propagating it from a centre through the surrounding regions. (Newton 1999, 406)
>
> Def. 7. The accelerative quantity of centripetal force is the measure of this force that is proportional to the velocity which it generates in a given time. (Newton 1999, 407)
>
> Def. 8. The motive quantity of centripetal force is the measure of this force that is proportional to the motion which it generates in a given time. (Newton 1999, 407)

Jammer states that these definitions

> ... define the absolute, accelerative and motive quantities of centripetal forces. (Jammer 1957, 122)

In this regard, Jammer accurately reports Newton's (1999, 407) own view of these definitions; they are definitions of *quantities* of force.

7.1 *Realist Interpretations.*

In this context, Jammer quotes this passage from Newton regarding 'absolute force':

> 'I refer', [Newton] says, 'the absolute force to the centre, as endued with some cause, without which those motive forces would not be propagated through the spaces round about; whether that cause be some central body (such as the magnet in the centre of the magnetic force, or the earth in the centre of the gravitating force), or anything else that does not yet appear'. (Newton 1760, 5; *cf.* Newton 1999, 407; Jammer 1957, 122)[23]

In this same apparently realist vein, Jammer observes that

> Newton refers to 'the accelerative force to the place of the body, as a certain power diffused from the centre to all places around to move bodies that are in them' (Newton 1760, 5; *cf.* Newton 1999, 407), words which seem to suggest that Newton already was thinking of force in the conception of a field. (Jammer 1975, 122–3)

In a similarly realist vein, in the *Opticks* Newton states that:

> It seems to me farther, that these Particles have not only a *Vis inertia*, accompanied with such passive Laws of Motion as naturally result from that Force, but also that they are moved by certain active Principles, such as that of Gravity, and that which causes ... the Cohesion of Bodies. These Principles I consider, not as occult Qualities, ... but as general Laws of Nature, by which the Things themselves are form'd; their Truth appearing to us by Phænomena, though their Causes be not yet discover'd. For these are manifest Qualities, and their Causes only are occult. (Quæry 31; Newton 1979, 401)

Note Newton's inclusion here of cohesion as an 'active principle'; presumably an attractive one. Analogously, I. B. Cohen says the following about Newton's method and his realism about forces:

> He [Newton] was able to make use of Hooke's suggestion of a central force and later to develop the

[22] Jammer (1957), chapter 7, was the assigned reading for this seminar. Its on the CFS website as 'Jammer57'.

[23] I have retained Jammer's own translations of his quotations from Newton (1760), whilst providing the corresponding pages in Newton (1999).

mathematical properties of such forces in *De Motu* – and ultimately to produce the *Principia* – without having to be deterred by the disdain he continued to feel for long-range forces of attraction. How could he have done so? I believe the answer has two parts. No doubt his general belief that there 'really' are forces in nature, and the corollary that forces are fundamental concepts in natural philosophy, received strong support from (and even may have originated in) his studies of Alchemy. But an analysis of the actual structure of the *Principia* shows also that Newton developed a 'style' – both in precept and in example – that enabled him to explore freely the properties of a kind of force which his contemporaries banned from natural philosophy. This force was of a kind that even Newton could not fully approve without assigning some underlying 'cause' or mode of action. The Newtonian style ... is independent of Newton's own strong belief in the reality of forces of attraction – in particular, the force of universal gravity. The Newtonian style constituted a mode of discourse which could enable him to develop the properties of such a force without need to discuss either whether forces of that sort are good science or how these forces act to produce their effects. (Cohen 1999, 63–64)

These passages all appear to show that Newton clearly understood accelerative gravitational forces to result from absolute gravitational forces inherent in matter, on the basis of which alone accelerative gravitational forces between bodies occur and can be measured.

7.2 *Non-realist interpretations.*

However, Jammer also expresses a positivist (instrumentalist or at least non-realist) view of Newton's gravitational theory:

In fact, Newton says: 'Wherefore the accelerative force will stand in the same relation to the motive, as celerity does to motion' (Newton 1760, 5; *cf.* Newton 1999, 407). Needless to say, little use is made of the concept of absolute force, since its intensity is ascertainable only by accelerative or motive forces. Indeed, Newton seems to have already discarded this notion altogether in his own work. (Jammer 1957, 123)

The question is whether Newton 'discarded' the concept of absolute force (as Jammer here claims), or merely set it aside to concentrate on his quantitative analysis of gravitational attractions (as Cohen claims). Newton's paragraph, in which he defines the three quantities of force just quoted, concludes with the remark:

This concept [*viz.*, absolute force] is purely mathematical, for I am not now considering the physical causes and sites of force. (Newton 1999, 407)

Through this and many similar remarks, Newton opened the door to enormous and enduring controversy about the extent to which his gravitational theory is merely quantitative or is also explanatory (because gravity is a real force).

Both the merely quantitative-descriptive and the explanatory-realist views of Newtonian gravitational theory are reported by Jammer. Jammer's closing contention, that 'Newton seems to have already discarded this notion [of absolute force] altogether', raises two fascinating questions:

Q: To what extent do non-realist interpretations of Newtonian gravitational theory require or rest on interpreting the formula, '$f = ma$' (and likewise *Principia*, Definitions 6–8), as defining *force*, rather than as defining the *quantity* of force (and likewise quantity of matter, quantity of acceleration), as Newton expressly states?

Q: To what extent does Newton's realism about 'absolute' force get lost in the fixation on the quantitative determination of motive forces, whether by Newton or by positivist Newtonians?

In this vein, Jammer quotes Cassirer's characterisation of this strictly quantitative approach to forces and causal interactions:

> The concept of relation [in mathematical physics] requires the concept of force, as it were, to come forth out of itself and to convert itself into a purely mathematical proportion.[24]

Cassirer's statement epitomizes the almost irresistible tendency, on the part of physicists and philosophers of science alike, to treat the quantitative relations among physical phenomena specified by a physical theory as purely formal quantitative relations and nothing more. Newton himself encouraged this tendency by often asserting, throughout his life, out of deference to the Cartesian tradition he opposed and in accord with the corpuscular tradition to which he adhered, that 'gravity' was only a mathematical, and not a physical, characteristic of matter.[25] This strategy allowed him, as Cohen indicates, to explore gravitational attraction whilst evading criticism and doubt (including his own) about the legitimacy or the occurrence of forces acting at a distance. Positivists succumbed to this seductive tendency, running through the entire empiricist tradition up to Bas van Fraassen, to focus solely on the quantified relations among manifest motions whilst discounting or dismissing the underlying natural ontology – the fundamental force of gravity – which alone generates those manifest motions.

8 Mathematical *vs* Physical Problems.

The problem is that substituting purely quantitative relations among observed motions replaces genuinely physical problems with purely mathematical ones – and directly obviates any explanatory character of a physical theory because the purely quantitative descriptions lack physical meaning. Focussing solely on description, prediction and retrodiction reduces Newton's dynamic (causal) theory to mere kinematics. Significantly, in his second edition, Cassirer revised the statement quoted by Jammer as follows:

> The concept of relation, which is now the predominant viewpoint [of the exact sciences, beginning with Kepler and Gilbert] recognises 'forces' only to the extent that they conform to a purely mathematical proportion.[26]

Cassirer's revision carefully avoids stating that physical theory replaces 'forces' with purely mathematical proportions, instead pointing out (rightly) that mathematical formulability is a necessary condition for admitting any alleged 'force' as scientifically legitimate.

Though Ernst Mach often slips into a formalist, positivist, merely mathematical-descriptive view of physical laws of nature (*e.g.*, Mach 1933, 473), he often rightly and emphatically distinguishes between genuine physical and merely mathematical problems (*ibid.*, 182–3, 473, cf. 282). Indeed, he goes so far as to state:

> ... the most important result of our considerations is that even the apparently simplest mechanical propositions 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 assessment (*Erfahrungskontrolle*).[27]

Here Mach clearly recognizes that treating laws of nature as purely quantitative relations fails to treat laws of nature as solutions to specifically physical problems. This is precisely what positivist views

[24] 'Der Relationsbegriff ist es, der den Kraftbegriff nötigt, gleichsam aus sich selber herauszutreten und sich in einer reinen mathematischen Proportion zu beugen' (Cassirer 1922, 1:278; quoted by Jammer 1957, 91; my tr.).

[25] Koyré (1965), Hall & Hall (1960).

[26] 'Der Relationsbegriff, der jetzt der vorherrschende Gesichtspunkt ist, erkennt »Kräfte« nur insoweit an, als sie sich in einer reinen mathematischen Proportion bezeugen' (Cassirer 1999, 2:304; my tr.).

[27] Mach (1933), 231, my tr.; the original is almost entirely italicized; cf. *ibid.*, 182–3. I cite Mach in the original because the translation is often unreliable. Corresponding to the three passages cited here are Mach (1893/1960), pages 597, 289–90, 230–31, respectively.

of all stripes fail to do. 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 investigated and often explained by the natural sciences. The quantitative laws of Newtonian mechanics are instantiated in nature, not simply because they are quantitative, but because they quantify actual natural phenomena, namely gravitational phenomena. Accordingly, in the concluding General Scholium Newton observes:

> ... 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)

In contrast to his cautionary note about his definitions, in which Newton says that at that stage he only considers gravity 'mathematically' (above, §2.2), here he recognizes that the mathematical theory is only justified because it solves the physical problems posed by terrestrial and celestial motions which result from gravity which 'really exists'.

Newton knew what he was doing. Newton constructs his theoretical apparatus in Books I and II of the *Principia*. This undertaking is entirely mathematical. Only in Book III does he use that theoretical apparatus to explain the behaviour of our solar system, some comets and an astonishing range of terrestrial phenomena, including (famously) the tides. Only in Book III does Newton provide his quantitative theoretical apparatus with a dynamic explanatory interpretation by measuring actual gravitational forces acting within our solar system, including orbital and tidal phenomena. Newton's cautionary note about the quantitative character of his definitions expresses no reservation about their dynamic, explanatory interpretation in Book III.

Newton's clarity about this point corroborates Mach's distinction between merely mathematical and genuinely physical problems. It also corroborates Cohen's understanding of 'the Newtonian style'. Examining this issue properly requires exacting analysis of Newton's *Principia* and also a broad swath of history and philosophy of science, which cannot be undertaken here, though it has been by William Harper (forthcoming), whose analysis shows just how, and how well, Newton used orbital information to measure gravitational forces between planets, where such measurements require the definitions of quantities of force provided by Newton's Definitions 6–8. To treat Newton's Definitions as defining *forces* rather than *quantities* of force is to seriously misread Newton's *Principia* and to seriously misunderstand its explanatory tasks, methods and achievements. *Pace* Jammer (1957, 123), Newton did not discard his notion of 'absolute force'; as Harper shows, with enormous ingenuity and effort, Newton devised analytical methods for using the phenomena of planetary motions to measure with increasing precision the strength of the gravitational field produced by each planet. (This is the topic of Part III below.)

9 Newton's Rule Four and Causal Realism.

Put more generally, adequate scientific explanation provides the sole and sufficient grounds for determining the fundamental characteristics of the objects and events in nature, and does so through maximally precise, quantified specification of their constitution, parameters and relations. Why ascribe forces to material phenomena? So far as logical or metaphysical necessities are concerned, natural phenomena could instantiate any mathematical function whatsoever, various mathematical functions on different occasions, or *no such function at all*. Positivist, purely quantitative accounts of scientific theories fail to account for this – a very steep price to pay for empiricist reservations about causal powers.[28]

The fact that a natural phenomenon exhibits a mathematical function indicates, as nothing else can, that something in that phenomenon is structured in accord with the mathematical function it

[28]Empiricist reservations about causal powers cannot be further discussed here. Elsewhere I have argued in detail that both Kant and Hegel developed sound criticisms of empiricist epistemology which undermine such reservations (Westphal 1989, chapter 4; 1998a, 2000, 2002, 2003c, 2004a, 2004b, 2005, 2006b, 2007); empiricist reservations about explanation and causal powers are discussed in Westphal (2006b).

exhibits. That 'something' is the causal structure of the force(s) which generate that phenomenon. Of course we can be mistaken about the laws governing the causal structure of phenomena, but that is a matter to be determined by empirical investigation, not by metaphysical speculation nor by epistemological scepticism.

This is the point of Newton's Rule Four of (experimental) philosophizing:

> 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)

Newton adds:

> This rule should be followed so that arguments based on induction may not nullified by hypotheses. (*ibid.*)

Newton's Rule Four is anti-Cartesian because it rules out as scientifically illegitimate merely logically possible alternative 'hypotheses' by requiring any genuinely scientific competing hypothesis to have, not merely empirical evidence, but sufficient evidence and precision either to make an accepted scientific theory or law 'more exact' or to qualify or restrict it by demonstrating actual 'exceptions'.

The anti-Cartesianism of Newton's Rule Four may appear simply to repudiate rationalism and to advocate empiricism about natural science. Empiricists generally tend to regard physical theories as involving only maximally precise measurements and precisely formulated mathematical descriptions of natural regularities, though without commitment to any specific causal ontology which generates measured regularities. Even the neo-Kantian Ernst Cassirer mistook the Newtonian method of John Keill in this way.[29] However, Newton's Rule Four is equally anti-empiricist, in part because empiricists have been far more Cartesian than they have realized. This can be seen by attending to two important epistemological points. One concerns cognitive justification, the other concerns the semantics of cognitive reference.

10 *Scientia* and Relevant Alternatives.

One conception of knowledge seeks to justify specific claims solely by deducing them from first principles, preferably, self-evident first principles. This is the ancient Greek model of science strictly speaking, called '*scientia*' by the Latins. In attempting to out-wit the Evil Deceiver, Descartes sought to assimilate our empirical knowledge to this deductivist model of *scientia*. The key point of *scientia* is its model of justification by deduction, which, if achieved, provides *infallible* justification for specific claims. It's a lousy model for empirical justification, though this didn't prevent empiricists from trying to satisfy it too, by trying either to deduce all our knowledge from sense-data, or to reduce all the objects of our knowledge to sense-data. Despite these 20th-century resurgences of *scientia*, one might think we've gotten past all that. If only we had! The infallibilist ideal of *scientia* still lingers among philosophers, including especially empiricist philosophers, who still commonly regard a logically possible alternative to any line of justificatory reasoning as sufficient to block that line of reasoning. Put briefly, the mere logical possibility of an alternative account is still widely taken to be sufficient to *block* or to *defeat* cognitive justification, even of empirical claims.[30]

This deductivist account of justification is expressly rejected by epistemologists who adopt a *relevant alternatives* account of justification and by those who adopt *fallibilist* accounts of justification. Usually, these two views come together. As regards empirical knowledge, Kant and Hegel already advocated both fallibilism and a relevant alternatives account of justification. Yet they were not the first: Newton took precedence.

In its condemnation of Copernicus, the Church decreed that natural scientists could only

[29] See Cassirer (1971, 2:405–6), Keill (1725, 8/1726, 6–7).

[30] I discuss these points further in Westphal (2006).

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 Four rejects merely possible explanations as scientifically irrelevant; this is the point of his infamous *hypothesi non fingo*: I do not frame [mere] hypotheses. Newton's Rule Four rejects the deductivist justificatory ideal of *scientia*, and with it the sufficiency of a mere logical possibility to defeat cognitive justification of a scientific theory. Newton's Rule Four requires, in addition to the logical coherence of a competing hypothesis or theory, that there be positive evidence for the competing account, indeed, sufficient evidence to make the original theory 'either more exact or liable to exceptions' (Newton 1999, 796) by identifying specific limits or qualifications of the original theory.

This is an extremely important methodological principle of natural science, and is central to the justification of scientific explanations and theories. Newton's justification for his Rule Four is, in effect, pragmatic: the *Principia* shows that, by adopting this rule, unprecedented advances in natural science can be achieved. Significantly, Newton's Rule Four is supported by Kant's semantics of cognitive reference.

11 Kant's Semantics of Cognitive Reference.

In his penetrating critique of Quine in 'Identity and Predication', Gareth Evans argues for the following conclusion:

> ... 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)

Evans' analysis shows that specifying the relevant boundary for the use of either member of a pair (or set) of mutually exclusive predicates is only possible by specifying the region relevant to the manifest characteristic in question, where this region will be either co-extensive with or included within the spatio-temporal region occupied by some particular physical object or event. More generally, Evans proves that predication requires conjointly specifying the relevant spatio-temporal region and some manifest characteristics of any particular object or event we self-consciously experience or identify. These conjoint specifications may be rough and approximate; the key point is that spatio-temporal designation of any particular object or event and ascription of manifest characteristics to it are *conjoint, mutually interdependent* cognitive achievements. I shall call this the 'Evans thesis'.

Arguments for the Evans Thesis can be made on semantic grounds, as Evans does, at least in response to Quine's views on reference. Sound arguments for this conclusion can also be made on epistemic, indeed on transcendental grounds, as Kant and Hegel did.

Kant's arguments for the Evans Thesis are both semantic and epistemic (Westphal 2004, esp. §§7–9, 33, 62–63.2). Kant's semantics of conceptual meaning is a two-stage theory. According to Kant, concepts have 'meaning' or content as predicates of possible judgments (as determinables), and yet no concept has fully determinate meaning unless and until it is referred to some actual particular(s) in a candidate cognitive judgment, whether about an object or an event. Kant's moral theory provides one set of conditions for referring our concepts to particular rational agents in judgments about them *qua* rational agents. These judgments cannot use the concept of determining cause. Kant's epistemology provides a different set of conditions for referring our concept of determining cause to particular objects or events in cognitive judgments about them *qua* causal events or activities. Kant argues that we can only refer our concept of determining cause in legitimate (justifiable) cognitive judgments about particular *spatio*-temporal objects or events. Consider, briefly, why this is so.

Long before Russell developed his theory of definite descriptions, and long before Russell's theory was turned into a general theory of reference, Kant (through his critique of Leibniz) knew the key mistake of this entire approach to reference. The basic idea of a descriptions theory of reference is that our statements refer to whatever they describe, or whatever is described when we analyse the implicit 'meanings' of our terms into explicit descriptions. The problem with this approach is that, no matter how specific or extensive a description may be, no description by itself determines whether it is empty, determinate or ambiguous. A description is 'empty' if no individual answers to the description; it is 'definite' only if just one such individual exists; it is 'ambiguous' if more than one such individual existed. Which of these may be the case is not simply a function of the description: it is equally a function of the contents of the world. To *know* any one particular spatio-temporal object requires both describing it correctly and specifying it ostensively, thus locating it in space and time. Only through singular sensory presentation can we locate any object or event in space and time. Only through ostensive designation can we *ascribe* the predicates used in the description *to* any *one*, putatively known particular. Therefore, predication is required for singular cognitive reference to any sensed, spatio-temporal particular. Only through predication can anyone specify (even approximately) the relevant spatio-temporal region that (putatively) contains the object or event one purports to designate ostensively – by specifying its occupant, the (putatively) known particular. Only in this way can we note, specify or determine precisely *which* spatio-temporal region to designate, in order to grasp *this* (intended, ostended) individual.

Thus, in brief, does Kant show that genuine, determinately meaningful cognitive judgments are possible for us only through conjoint spatio-temporal designation of, and predicative ascription of characteristics to, any experienced particular. Recognising any particular object or event requires conceptual identification of both the region it occupies and of at least some of its manifest characteristics. Thus, in brief, does Kant justify the Evans thesis.

Kant's semantics of cognitive reference dove-tails with his account of the discriminatory character of causal judgments: we can only make legitimate cognitive judgments using concepts of determining causes only in circumstances in which we spatio-temporally localize the putative causes and effects in question, *per* Kant's semantics of cognitive reference, which are the only circumstances in which we can satisfy the requirements for discriminating an actual causal scenario from its empirically possible alternatives.

Note too that Kant's semantic account of spatio-temporally locating particulars does not limit us to macro-level, 'hands on' phenomena; on his view various kinds of observational instruments can enable us to localize micro-level phenomena spatio-temporally.

12 Empiricist Qualms about Causal Realism are Cognitively Transcendent, Idle Speculations.[31]

Kant's semantics of cognitive reference has important implications for judgments or propositions formulated with empirical concepts: to have determinate and cognitively legitimate meaning, they too require being referred to spatio-temporally identified (located) 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 hypothesis, does not suffice for its cognitive legitimacy! To be cognitively legitimate, an alternative must also be referred (and not merely be 'refer*able* in principle') to spatio-temporally identified (located) particulars. Kant's cognitive semantics thus rules out the deductivist model of *scientia* for empirical justification, and so rules out mere logical possibilities as counter-examples to empirical claims. Newton's Rule Four thus embeds a sound insight in semantics of cognitive reference.

The standard objection to causal realism in the natural sciences is that the 'underlying' causal factors which produce any natural regularity, however precisely measured and described mathematically, may be structured very differently than is stated or suggested by our formulation of natural laws. This is Cartesianism speaking, pure and simple! Yes, there's a 'logical' gap between any statement of a law of nature and whatever generates the regularity specified by that statement.

[31]This section is based on Westphal (2009), §5.3.

However, this logical gap does not entail a *cognitive* gap – a justificatory gap – between a well-grounded causal law and the causal structure generating the regular natural phenomenon described by that law. To suppose that a 'logical' gap entails a cognitive gap unCritically presupposes the pre-Newtonian, Cartesian deductivist ideal of justification as *scientia*, by presuming that mere logical possibilities suffice to defeat justification. To the contrary, any discrepancies between our best-justified causal laws and the actual causal structure(s) of natural phenomena can only be discovered by extended scientific investigation, just as Newton's Rule Four requires. Deductivist cavils of empiricist philosophers who trade in mere logical possibilities are, Kant's cognitive semantics shows, cognitively transcendent idle speculations.

To mistake the *proportions* stated in Newton's Definitions 6–8 for identities, and to mistake the absolute, motive and accelerative *quantities* of force they define for definitions of *force* as such, insures mis-reading Newton's *Principia* as an elegant mathematical device for describing, predicting and retrodicting mere motions of bodies, with no explanatory and certainly with no dynamic (causal) import. Such misreadings reduce Newton's *Principia* to an exercise in kinematics and scrap his dynamics altogether. Such misreadings only widen and highlight the 'logical gap' between data and theory which looms so large to deductivists, including empiricists, who by virtue of their implicit deductivist presumptions really belong to the camp of sceptics, at least about natural science. Yes, some philosophers think there is nothing more to scientific 'explanation' than description, prediction and retrodiction of natural phenomena. However, such philosophers fail to understand the difference between merely mathematical and genuinely physical problems; they settle for kinematics (motions and sequences) when natural science provides genuine dynamics (causal structures and relations). Fortunately, natural scientists do not err in this regard. Empiricist notions of 'empirical adequacy' in terms of descriptive, predictive and retrodictive accuracy are not empirically adequate to the phenomenon of natural-scientific causal explanation, beginning already with Newton's.

As for the empiricist qualm that causality or causal relations cannot be 'seen', I reply that for good reason introspection was ejected from philosophy at the start of the 20th Century; why the putative introspective report that 'I just *see* extant objects, but not causality' should carry any cognitive or philosophical weight I do not fathom. To the contrary, Kant, Hegel, and even before them Hume himself showed that unless we make correct causal judgments we cannot at all perceive nor re-identify individual objects.[32] Empiricists have not studied their Hume well enough.[33] More importantly, our inability to sense causal forces as such does not prevent us from *measuring* causal forces. This is the key to Newton's causal realism about gravitational force (Part III).

Empiricist confusion about what can and cannot be 'seen' reached its nadir in van Fraassen's (2001, 151–3) fixation on an apparatus which demonstrates that we cannot observe light. Briefly, the apparatus consists in a black tube with a beam of light entering at one end and an observation hole in the side of the tube. Yes, we can't perceive light as such, and it's a good thing, too. Light serves as one of the media through which we receive information about our surroundings; in this regard, light is part of one of our perceptual information channels. Something can be an information channel only if it is quiescent, that is, only if it does not itself generate information by occupying different states (Dretske 1981, Part I). If we could see light itself, we could not see our surroundings! It is crucial to vision that we perceive opaque objects, colours of light and relative degrees of illumination (light and shadow). Analogously, it is very fortunate for us that we cannot see air nor smell water, which alone allows either medium to convey to our senses much important information about our surroundings. In this connection, van Fraassen's empiricist fixation on what we allegedly 'cannot see' led him into serious misunderstanding.

In Part III I epitomize, clearly and briefly, the central role of precise quantification in identifying extant causal forces by measuring them, and how Newton's unprecedented success in this regard justifies his realism about gravitational forces. Recognizing the centrality of precise quantification in identifying extant forces will underscore again how utterly vacuous are the claims of psychological

[32] Westphal (1998), §4.

[33] See Westphal (1989), ch. 4, (1998), (2005), (2006), §4.

determinism and purely causal theories of the mind.

III. Measuring Real Gravitational Force: Newton's 'Deductions from the Phænomena'.

13 Introduction.

Recent scholarship, especially that of William Harper (forthcoming), has shown that Newton was significantly more sophisticated about scientific method than contemporary philosophers of science, that his standards of theoretical adequacy justified his realism about gravitational force and that these standards *do* apply to the shift from Newtonian to Einsteinian mechanics. All of this we cannot cover today. Instead we shall focus on one key issue and one especially important instance of it. This will enable us to grasp the key insight of Newton's criterion of explanatory adequacy, and how it supports his causal realism about gravitational force.[34]

I shall conclude with some brief remarks about the significance of these findings about dynamic (causal) forces and causal mechanisms and about the pseudo-scientific status of causal theories of mind.

14 Induction and 'Deduction from the Phænomena'.

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; General Scholium; cf. *Opticks*, 401–2)

This passage has been persistently misread by generations of philosophers – starting at least with Berkeley and Hume – for two reasons. First, they assume that by 'deduction' from the phenomena Newton means 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, they assume that by 'induction' Newton means simple numerical induction. Both assumptions are false.

No natural scientist has ever used simple numerical induction, which has been known since Aristotle to be insufficient to justify universal or even general empirical claims, a point reiterated by Francis Bacon at the outset of the scientific revolution. Hume's infamous 'Problem of Induction' holds only of simple numerical induction. Hume seized upon simple numerical induction because it alone might be supposed to fit the deductivist ideal of justification, *scientia*. Philosophers accepted Hume's Problem of Induction because they were as besotted as he with *scientia*, with a purely deductivist account of rational justification, even for empirical knowledge. The 'Problem of Induction' is yet another hang-up and hang-over of Cartesianism (see Part II).

Natural science never has been 'deductivist' in this infallibilist sense; it never could be. Newton uses the term 'deduction' in a broader sense roughly equivalent to 'justify'. 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 Stein's concern that Newton assumes as an hypothesis, as a theoretical postulate – rather than

[34] Readers unfamiliar with Newton's *Principia* should please refer below to the Appendix, §§17, 18.

proves on the basis of phenomena – that the inverse-square law of mutual gravitational attraction holds generally, and not merely for those few spaces in the cosmos occupied by our solar system (Harper 2002a, 72a, 75d, 85e).[35] There are three aspects of Stein's concern:

1) To show that gravitational attraction holds between celestial bodies, rather than other causal agents which might produce the same observed astronomical motions.

2) To show that the variation of gravitational attraction is exactly inverse-square, rather than any other rate.

3) To show that gravitational attraction holds throughout the space surrounding a massive body, and not just across those spaces actually occupied by surrounding bodies.

I shall focus on the latter two of these aspects of Stein's problem.

Harper's answer to this problem has three key components:

1) Newton's method seeks converging measurements by various means of causal parameters which explain – because they generate – the phenomena in question.

2) This feature of Newton's method highlights the importance of the links between Newton's three ways of measuring centripetal force and acceleration fields.

3) Newton's Rules of Philosophizing – especially our friend, Rule Four – support generalizing the causal parameters thus measured. (72b)

I shall focus today on the first two components of Harper's answer.

The first step in Harper's answer is to explain 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 – that is, its tendency to orbit the Sun rather than to move away from the Sun at a tangent – counts as an attraction between Jupiter and the Sun (84e ff., §III). Newton's First and Third Laws are these:

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 an equal reaction; or, the mutual actions of two bodies upon each other are always equal and directed to contrary parts.

(To recall, Newton's Second Law concerns the composition of distinct forces, the so-called '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 (85b); these are his Definitions 6–8 (discussed above, §7):

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.

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.

A key component of Stein's problem is to understand the answer to this question:

[35] Otherwise unattributed parenthetical page references in the text are to Harper (2002a); suffixes 'a'–'e' indicate approximate location on the printed page (think of Plato's dialogues). The ensuing discussion summarizes some key findings of Harper's brilliant analysis; none of it is mine. Harper (2002a) is available on the CFS web page.

> What, if anything, justified Newton's treatment of gravitational attraction as a *field* of force radiating in all directions from any centre of mass, when Newton's data only concern specific locations of specific mass centres, namely the Sun, the six planets then known, the earth's moon and the four Galilean moons of Jupiter?

Harper points out that Newton identifies systematic dependencies which enable orbital phenomena to provide measures of the Sun's gravitational field (86c). Kepler determined that the (roughly triangular) area swept by a planet orbiting the Sun is constant, even though the planet follows an elliptical orbit, accelerates when approaching the Sun and decelerates when receding from the Sun. This is Kepler's Second or 'Areal' Law (law of areas):

> 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 precisely indicates 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 (note 19). 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 clearly indicated orbital stability. The stability with which planetary orbits satisfy Kepler's areal law indicates that their orbits measure an inverse-square acceleration field directed towards the Sun (86c).

This same result – an inverse-square acceleration field – is measured independently by determining whether there is orbital precession, that is, whether planets follow the same orbit repeatedly, or whether the location of an orbit's aphelion and perihelion (its most distant and closest points to the Sun) shift by rotating about the Sun, either 'forwards' or 'backwards', with subsequent orbits. Absence of such rotation or precession measures an inverse square law of acceleration; a different rate of diminution of field strength would produce either positive or negative orbital precession (86c, n21; *Principia* 1.45 & Cor. 1).

These two crucial steps, undertaken by Newton for the independent cases of six planets and two distinct aspects of their motions, *are* Newton's 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 (87a).

As Harper notes (88–9), Newton has 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 on multiple, precise agreeing measurements of the inverse-square gravitational field provided by many diverse phenomena of motion. All of these were further bolstered in 1759 by Clairaut's successful and precise prediction of the return of Halley's comet.

So far I have highlighted the wide variety of agreeing measures of the inverse-square attraction of gravitational force. Each of these measures is further supported by Newton's method of successive approximations (Smith 2002a, 2002b, Harper 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. That reiterated deployment of the same theoretical apparatus produces ever more precise and converging measures of the target value provides strong support of Newton's claim thereby to measure a real value. 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 bolsters the strength of his conclusions based on the agreement *among* of each of these measures of the inverse-square field of gravitational attraction. This is Newton's key criterion of empirical adequacy:

> .... convergent accurate measurement of causal parameters by the phenomena they are taken to explain. (Harper 2002a, 95e, cf. 100b)

This is a vastly stronger criterion of empirical adequacy than empiricist descriptive, predictive and retrodictive accuracy.

Law 3, the equality of action and reaction, or the mutual equality of attractions, between two bodies, is required to disentangle the weights and masses of any two bodies. 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 Third Law has vastly more empirical support than any assumption that the strength of attractive forces varies pair-wise among bodies, mainly because it alone provides for convergent agreeing measures of the relative masses of our solar system (96bc).

Furthermore, Newton's gravitational theory famously integrated a vast range of celestial and terrestrial phenomena, previously thought to have nothing in common, within a common, comprehensive explanatory theory. This explanatory integration provides more than just 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. For example, both the orbit of the earth's moon and the length of a terrestrial seconds pendulum near sea level provide accurate agreeing measures of the force of the earth's gravity (96–7).

Relying on the empiricist criterion of empirical adequacy in terms of descriptive, predictive and retrodictive accuracy cannot rule out hypotheses that different material bodies have different powers of attractive force. Nor can it rule out Stein's hypothesis that the inverse-square law holds only for those distances and regions of space for which we have observational data. Nor can it disentangle the weights and masses of bodies in ways achieved by using Newton's Law 3, which is crucial to Newton's entire set of astronomical measures of the inverse-square gravitational force. Using Newton's Third Law provides for converging measures of one and the same attractive force among celestial and terrestrial bodies, *and* provides grounds for seeking to explain deviations from their predicted motions by using the very same theoretical and observational resources to search for other bodies affecting their motions. This strategy is central to Newton's extremely successful method of progressive elimination of initial idealizations, which results in convergent agreeing measures of the inverse-square power of gravitational attraction. As both Stein and Harper emphasize, Newton's method of successive approximations allows him to achieve results which are formally inconsistent with his initial approximations and serve to correct them by replacing them with far more accurate descriptions, measures and explanations of the relevant phenomena.

Use of Law 3 also enables Newton to measure the relative masses of bodies with satellites, including the Sun, the Earth and Jupiter. This success – and the problem is not at all a simple one – provides further confirmation of Law 3 by showing that it is implied by the observed phenomena Law 3 is used to measure (101b). Therefore, Newton's Third Law *is* 'deduced from the phenomena', though it is deduced *in*directly rather than directly from them; it is not simply postulated (93–4). Thus does Harper resolve Stein's problem.

Some Implications of Harper's Analysis. Understanding Newton's realism about gravitational force requires distinguishing it from causal agnosticism. Some contemporary philosophers of science advocate causal agnosticism, according to which there are causal structures which generate observed regularities, though we cannot know what those causal structures are. Indeed this issue was hotly debated by Newton and his contemporaries, especially Leibniz (Janiak 2007). Newton is not a causal agnostic about gravitational force. As noted again at the outset, 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; General Scholium; cf. *Opticks*, 401–2)

Newton is a realist about gravitational force; he is agnostic only about the way in which gravitational force operates.[36]

The progressive increase in accuracy required by Newton's standards of theoretical adequacy significantly exceeds the requirements of other accounts of theoretical adequacy current among philosophers of science. Newton's criterion of theoretical adequacy echos Glymore's 'boot-strap' arguments. In his forthcoming book on Newton, Harper shows that Newton's methods and criteria of adequacy are both stronger and more adequate than Glymore's and that they overcome problems confronting Glymore's account.[37] Indeed, Newton's standards of theoretical adequacy apply to the shift between Newtonian and Einsteinian mechanics, and on the basis of the relevant evidence, favour Einsteinian mechanics. In brief, Newton understood both the demands on and the achievements of physical science better than have philosophers and historians of science up to the present day.

The superiority of Newton's own methods and criteria of empirical success deserve special emphasis because they reveal how van Fraassen's constructive empiricism underrates natural science. Although van Fraassen (2002, 129; 2004, 131) stresses Newton's Rule Four of Philosophizing, he espouses the empiricist criterion of empirical success in terms of accurate description, prediction and retrodiction of natural phenomena. He (2002, 253 note 10) hails Glymore's (1980) analysis of boot-strap arguments in science as the best available, if imperfect. In view of his empiricist criterion of empirical success he distinguishes between 'accepting' a scientific theory or hypothesis in contrast to 'believing' it to be true. The point of mere 'acceptance' of a theory or hypothesis is, in a word, to underwrite an entirely instrumental, non-realist interpretation of it. Distinguishing between 'acceptance' and 'belief' in this way illustrates perfectly the conversion of a logical gap into a cognitive gap, and indeed, one based on an antecedent empiricist rejection of causal realism.[38]

Harper's brilliant analysis of Newton's methods and criteria shows that neither empiricist notions of empirical (descriptive) adequacy nor even Glymore's genuinely impressive analysis does not capture the full robustness of sound scientific method and achievement, and thus reveals how misleading is van Fraassen's facile distinction between 'accepting' and 'believing' a sound scientific theory. I grant that this distinction may be important when first developing and seeking to confirm a scientific theory or hypothesis, but van Fraassen does not so limit the scope of his distinction. By insisting on empiricist criteria of empirical adequacy and the mere acceptance of scientific theories, van Fraassen misunderstands and underrates Newton's anti-Cartesian, also anti-empiricist Rule Four of Philosophizing. Van Fraassen's empiricist stance – to give it its proper name – simply is not the empirical stance created and occupied so brilliantly by Newton.[39]

15 Dynamic Forces and Causal Mechanisms.

My presentations have sought to explain what is required, and what can be provided, as evidence of the existence and the effectiveness of dynamic (causal) forces, specifically the attractive force of gravity. The same methodological points hold also for other kind of distance forces, such as

[36]I am neglecting an important historical nicety here. Newton was happy to defend 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 physical theory vanishes once it is reformulated on the basis of analysis, as it must be. On this last point, see below, §17.

[37]These problems are due to Christensen (1983, 1990); Harper (forthcoming, chapter 3 §IV.4–5) responds on Newton's behalf.

[38]This is a perfect illustration of Hegel's point that scepticism ultimately rests on self-alienation from our own knowledge, both of ourselves and of our world; see Westphal (2009). Though it is uncommon to think of them in this way, Hegel is right that, like moral philosophy, epistemology concerns self-knowledge and reflects our self-understanding as much as they concern the substantive principles and accounts they provide.

[39]I discuss van Fraassen's view further in Westphal (2006), §4.

attractive forces of cohesion, magnetism, electrostatics, or chemical bonding, as well as for repulsive forces. Much of natural science concerns, not distance forces, but rather causal mechanisms or causal activities. How central, then, are these considerations about dynamic distance forces? They are centrally relevant also to causal mechanisms and causal activities. The only causal mechanisms or causal activities worth considering are those which persist for some relevant period of time. Causal mechanisms or substrates of causal activities persist and continue to function through time due to the integrity of their materials and component parts (if any). The integrity of materials or of component parts and their mechanical connections is a function of the cohesive or bonding forces of the materials of which they are composed; cohesive bonding forces are dynamic, attractive forces. Whilst it may be possible, even germane, to attend to the causal activities or functioning of causal mechanisms without attending to the engineering concerns about the stability of their structure or substrate, these engineering concerns *are* required for any comprehensive explanation of how a causal mechanism works or how a causal activity occurs, or fails to occur when a mechanism or substrate breaks down, as in cases of disease. Moreover, many kinds of biological mechanisms work due to attractive molecular forces, as in all cases of hormone or neuro-transmitter receptors.

16 Psychological Determinism and Causal Theories of Mind, one last time.

I have emphasized Newton's methods, criteria of adequacy and physical results in order to highlight what is required to establish an attractive force as an actual causal factor which explains a range of phenomena: only exact measurement, of the kinds Newton provides, provides sufficient justification for accepting the existence of a dynamic distance force. These considerations hold for any causal forces acting between distinct objects (of whatever scale).

The problem confronting would-be causal theories of the mind, including psychological determinism, is that they can only appeal, vaguely and blandly, to 'some putative cause or other' of any particular mental episode.[40] They cannot specify the causal event, nor can they specify the kind of causal power linking that event to its alleged mental effect, the mental episode in question. Much less can they even propose how to measure any such power. Modelling mental causality on dynamic physical causes is no more than a pipe-dream. No such causal concepts can be used in determinate cognitive judgments about mental episodes because we cannot identify any particular mental episodes correctly or even plausibly characterized in dynamic (determining) causal terms.

The case is no more favourable if we consider instead alleged causal mechanisms which generate mental episodes or alleged causal substrates of allegedly causal mental activities. No such causal concepts can be used in determinate cognitive judgments about mental episodes because we cannot identify any particular causal mechanisms or causal substrates of mental episodes which can be correctly or even plausibly characterized in such causal terms.

Kant's semantics of cognitive reference shows that these alleged causal 'theories' of the mind are mere descriptions lacking any determinate cognitive reference to particular mental events and their alleged particular causes touted by determinists and causal theorists of the mind. Kant's semantics of cognitive reference and his account of the discriminatory character of legitimate cognitive judgments about determining causes entail that we cannot make any such judgments about mental phenomena (of the sorts indicated previously). In this regard, Kant, Tanney (2008) and I agree that our locutions for expressing, discussing, or describing mental phenomena are not referring expressions of the sorts highlighted by Carnap, Quine, Davidson or (I add) the Evans Thesis.

This is why psychological determinists and causal theorists of the mind must and can only appeal to the general principle of scientific explanation, to seek causal explanations of any and every phenomenon. Yet this regulative principle does not justify and *constitutive* claims that some range of phenomena *are* causally structured. Only an actual, adequate scientific explanation can do that. No psychological determinist and no causal theorist of the mind has proffered even a candidate causal explanation of a single mental episode. Like Hobbes, they assume universal causal determinism,

[40] See Tanney (1995), (2008), §II.

dress their descriptions of our mental lives in causal idioms and fool themselves into thinking they have thereby made determinate cognitive judgments. Kant's semantics of cognitive reference reveals how specious such claims are.

The correlations revealed by neuro-surgery and recent imaging techniques between either physical stimuli to the cortex or physical arousal of specific sectors of the brain and specific mental (experiential) episodes are genuinely fascinating and revealing. However, correlations by themselves are not causal relations, though they may be grounded in causal relations. Robust correlations are *candidates* for causal inquiry and, with luck and ingenuity, causal explanation. But no such causal explanation is in the offing until either a dynamic force or a causal mechanism or activity is identified which generates the correlation in question (*pace* Hume and regularity theories of causality).

Consider Davidson's statement:

> {Er, it is among the slides Julia used in her third seminar; I have not yet relocated it. The passage revealed Davidson's assumption that if we are considering causal phenomena we are within the domain of causal explanation.} (Davidson 1980, *)[41]

Kant's cognitive semantics and analysis of (determining) causal judgment shows that Davidson is mistaken to suppose that, if we are considering (putative) causal phenomena, we are automatically within the domain of causal *explanation*.

Paul Churchland (1992) proposed to explain away propositions and propositional attitudes by appeal to 'activation vectors in the brain'. Unless and until he can account for his own literary production, its readership and its discussion, he has no adequate theory. Once his presumed theory can account for these literary phenomena, he must explain why and how his theory explains *away* propositions and propositional phenomena, rather than explaining how propositionally structured thought is neuro-physiologically possible. He doesn't find objections like this persuasive, because he's got the unshakable faith that someday in the future science shall do better and differently than now. This is the whole of his eliminativist position. I'm perfectly happy with philosophers immersing themselves in, e.g., cognitive psychology and the neurosciences; but betting on the 'ultimate' outcomes of the sciences is simply non-sense and non-philosophy.

As Aristotle pointed out – and as Bill de Vries reminds me in connection with philosophy of mind – we should not expect greater precision from an inquiry than the subject-matter allows. Yet we should also demand no less precision than the topic allows, and where none is possible we should refrain from pseudo-inquiry. Churchland's eliminativist position is nothing more than pseudo-scientific rhetoric. The problem with philosophizing in this way is that philosophers lightly take recourse to mere logical possibilities or to the apocryphal 'future' or 'end' of science in the way Marx thought German historians take recourse to pre-history:

> Here we recognise immediately the spiritual ancestry of the great historical wisdom of the Germans, who, when they run out of positive material and when they can serve up neither theological nor political nor literary rubbish, assert that this is not history at all, but the 'pre-historic era'. They do not, however, enlighten us as to how we proceed from the nonsensical 'prehistory' to history proper; although, on the other hand, in their historical speculation they seize upon this 'prehistory' with especial eagerness because they imagine themselves safe there from interference on the part of 'raw facts', and, at the same time, because there they can give full reign to their speculative impulse and set up and knock down hypotheses by the thousand. (Marx 1977, 49)

By this point we should know, as Newton knew, that natural science progresses and achieves genuine knowledge by adhering to his Rule Four of Philosophizing, that no alternative hypothesis is acceptable merely because it is logically consistent, but only if and when it is referred to actual phenomena in ways which generate sufficient empirical support for it either to make an established theory or law more precise or to show that it has limits or exceptions. Newton's methodological Rules are, of course, designed for experimental philosophy, but they together with the crippling

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[41] I thank Julia Tanney for bringing this passage to my attention.

problems of *scientia* suffice to show that trading in mere logical possibilities is philosophically unbecoming because it is philosophically unproductive. As for psychological determinism, purely causal theories of the mind and eliminativist materialism, so beloved of many contemporary philosophers of mind, they are indeed the cognitively transcendent, idle speculations Kant knew them to be.

Appendix

This Appendix contains three items of background material:

§17. Westphal, review of De Gandt, *Force and Geometry in Newton's Principia.*
§18. Newton's Definitions, Axioms and Corollaries.
§19. Harper's references (omitted from the initial print run).

* * *

17 Book Review

De Gandt, François. *Force and Geometry in Newton's Principia.* Curtis Wilson, trans. Princeton: Princeton University Press, 1995. xiv + 296 pp. (*Review of Metaphysics* 51.4 (1998):923–26.)

Kenneth R. Westphal

This book simply must be read, not only by historians of modern science, but also by historians of modern philosophy and by philosophers concerned with science, both its development and assessment. *Force and Geometry in Newton's Principia* is a pleasure to read and a greater pleasure to ponder; it is a perfect example of the genetic method at its best. De Gandt explicates in detail Newton's first successful effort to determine planetary orbits as a product of inertia and centripetal force in his 1684 *De motu.* This sketch delighted Halley and provided the kernel of the vastly more comprehensive *Principia.* De Gandt has the gift to trace the historical development of Newton's theory, including its terms and methods, in order to highlight and clarify the conceptual and mathematical innovations Newton developed while devising the *Principia.* De Gandt's study is rich and rewarding throughout, a genuine *tour de force.* High marks must also go to the translator, Curtis Wilson. One delight in reading foreign languages is enjoying the expressive power of another diction. Wilson often captures much of this flavour while rendering De Gandt's French into elegant English. This is especially important in a work which repeatedly attends to the subtle ambiguities and shifts of semantic meaning which generate scientific problems or solutions. The translation obviously owes much to close collaboration (xii).

De Gandt aims to make Newton's challenging *Principia* accessible to a wide general readership by showing how Newton developed, out of a plethora of earlier hints, hypotheses, and mathematical techniques, a specifically geometrical theory of forces to explain planetary motions. Two problems were posed by Christopher Wren and Edmond Halley: Given a trajectory, find the law of force, and more importantly, Given a law of force, find the trajectory. Robert Hooke claimed to have the solution in terms of a motion directed on the tangent of an orbit and an attraction towards a central body. But Hooke never delivered proof. Newton sketched the requisite mathematical proof in *De Motu.* This involved generalizing Galileo's law of free fall to regard the deviation of an orbit from its tangent as an indicator of centrally directed force, where the extent of deviation is proportional to the square of the time. Since the motion in question is orbital, the direction of deviation from a tangent is directed towards a centre, and so is not constant. Since the orbit is elliptical, the force which produces the deviation varies with the distance from the centre (by an inverse square proportionality). These facts require incorporating time in the geometrical calculations. Newton included time by generalizing Kepler's law of areas; the time elapsed when traversing a given arc of its orbit is proportional to the area of the sector swept out by a radius from the centre point to the orbiting body. Because the direction of motion changes continuously, the geometrical calculations must be restricted to very small or nascent motions. Combining these factors required sophisticated mathematical analysis which eluded Wren, Hooke, and Halley. Newton provided its germ in *De Motu*.

De Gandt explicates and traces the development of these basic ideas into the elaborate mathematical physics of the *Principia*. De Gandt's Preamble sets the backdrop of Newton's problem; chapter 1 explicates *De Motu* in fascinating detail. Chapter 2 explores previous notions of force in Kepler, in the Galilean and Cartesian traditions, and in Newton's work on circular motion before the *Principia*. Chapter 3 explicates Newton's innovative mathematical methods in Book I of the *Principia*. De Gandt points out how Newton developed a plethora of geometrical techniques to analyse vanishing quantities ("ultimate ratios," Newton called them), which is essential to the physics of curvilinear motions. (Contrary to Newton's own retrospective claim, the *Principia* was not first written with "fluxions" or calculus.) De Gandt's focus throughout is on the nature and the role of Newton's unique and innovative geometry; he discerns the essential features of Newton's problems and solutions. Newton's mathematics requires geometrical intuition; de Gandt conveys the nature and role of those intuitions clearly to non-specialists. He also shows that ultimately Newton's geometry is not equal to the task of determining the orbit on the basis of the law of force. This required calculus and was achieved by Johann Bernoulli.

The insights of De Gandt's book cannot, regrettably, be conveyed by any summary because they lie in his illumination of specific mathematical problems and solutions. The translator's introduction and the author's Preface provide very clear guides through the book.

Though centrally a work in history of science, there are at least four good reasons for philosophers to study *Force and Geometry in Newton's Principia*. Modern philosophy began in response to the new mechanical science which sharply posed the question of the human mind and its place in nature by banishing the Aristotelian perceptual 'species' elicited by things, by which things can be perceived and known, as it were, unproblematically. Anyone interested in the historical and conceptual origins—the original stimulus—of modern philosophy will find no better single source than De Gandt's book. Any instructor who wishes to include background on modern science in courses on modern philosophy (using, for example, Michael Matthews, ed., *The Scientific Background to Modern Philosophy* [Indianapolis: Hackett, 1989]) will find no better "teacher's guide," so to speak, than De Gandt's book. Second, for those who brave the thickets of Newton's *Principia*, De Gandt's book provides the key to Book I (and the proper propaedeutic to S. Chandrasekhar, *Newton's Principia for the Common Reader*; Oxford: Oxford University Press, 1995).[42]

Third, in many philosophical discussions, "scientific theories" have been reduced to thumb-nail sketches of their main principles, whereupon it becomes difficult—especially after Kuhn and Rorty—to distinguish scientific theories from story telling. De Gandt's book provides a much-needed corrective to this corrosive tendency, for it provides a sustained meditation on a very important theme. This theme was well put by a founder of pragmatism: "... 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." This is very tough-minded talk from that supposed tender-hearted philosopher, William James (*Pragmatism*, ch. 6); it should be taken seriously, especially by devotees of the wilder edges of science studies.

The difficulty in devising a theory that "works," as James puts it, lies in devising a quantitative theory of natural regularities, a theory that "can be verified exactly" and that is more than simply a device for calculating observations. The mathematical formulae must describe not only possible, but plausible natural means or mechanisms which produce the observed phenomena. As Kant remarked, "in any particular doctrine of nature only as much science *properly* speaking is found, as *mathematics* is found in it" (*Metaphysical Foundations of Natural Science*, Preface; Ak 4:470). The use of mathematics to discover and to describe natural regularities was and is central to modern science, and mathematical analysis was and is used (with methodological and more general rational or "metaphysical" considerations playing a supporting role) to determine the very terms or factors into which to analyse some complex natural phenomenon. The use and centrality of mathematics in modern science was misunderstood by empiricists and rationalists alike (including Kant), and it is often still misunderstood.[43] *Force and Geometry in Newton's Principia* provides the best place to begin correcting this

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[42][This was written before the appearance of Densmore (2003) and of Cohen (1999), both of which are essential for moving beyond DeGant into the structure and details of Newton's *Principia*.]

[43][This point is discussed in Westphal (2006) and in Parts II and III of this working paper.]

misunderstanding. In discussing the relevance of the almost purely mathematical framework Newton develops in *Principia* Books I and II to his "system of the world" (Book III), De Gandt puts the point this way: "The solidity of the inductive fabric is due to its mathematical framework, which makes it possible to establish an extremely tight network in which observation and theory advance on and regulate each other" (267). Borrowing terminology from logical empiricism, this might suggest that Newton's mathematics forms the "correspondence rules" between his theoretical and observational language. That is too glib. Newton's mathematical framework is constitutive for his theoretical postulates and, as De Gandt explains, for the mutual regulation of theory and observation. This mutual regulation defies the essentially deductivist model of rationality common to empiricism, rationalism, logical positivism, and falsificationism. This mutual regulation is fundamentally pragmatic—in the naturalistic sense of "pragmatism" found in classical American philosophy.

Fourth, in his "Conclusions," De Gandt points out that the mathematical theory of orbital motion forges an important kind of autonomy from metaphysical and physical questions about the ultimate nature of space, time, or gravity. His discussion of this issue is of particular importance to issues of scientific realism. If Newton's theory is representative, scientific theories may be adroitly agnostic about many if not most of the issues involved in "scientific realism." If so, it is no wonder that those issues have not been resolved by appeal to natural science.

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18 Newton's Principles

BOOK I: DEFINITIONS:

1. The quantity of matter is the measure of the same, arising from its density and magnitude conjointly. {Mass ∝ density x volume.} (Trans. by Densmore (2003); formulae are my insertions.)

2. The quantity of motion is the measure of the same, arising from the velocity and quantity of matter conjointly. {Momentum ∝ velocity x mass.}

3. The *vis insita*, or inherent force of matter, is the power of resisting, by which every body, as much as in it lies, continues in its state either of rest or of moving uniformly in a straight line.

4. Impressed force is an action exerted upon a body for changing its state either of rest or of moving uniformly in a straight line.

5. Centripetal force is that by which bodies are pulled, pushed, or in any way tend, towards some point from all sides, as to a centre.

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.

7. The accelerative quantity of centripetal force is the measure of the same, proportional to the velocity which it generates in a given time.

8. The motive quantity of centripetal force is the measure of the same proportional to the motion which it generates in a given time.

AXIOMS, OR LAWS OF MOTION:

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 2. The change of motion is proportional to the motive force impressed, and takes place following the straight line in which that force is impressed.

Law 3. To an action there is always a contrary an equal reaction; or, the mutual actions of two bodies upon each other are always equal and directed to contrary parts.

COROLLARIES:

Cor. 1. A body [urged] by forces joined together, describes the diagonal of a parallelogram in the same time in which it describes the sides separately.

Cor. 2. And hence is evident the composition of a direct force AD from any oblique forces you please AB and BD, and, in turn, the resolution of any direct force you please AD into any oblique ones whatever AB and BD. This composition and resolution is, moreover, abundantly confirmed from mechanics. {Newton's 'parallelogram' of combined forces.}

Cor. 3. The quantity of motion that is obtained by taking the sum of the motions made in the same direction, and the difference of those made in opposite directions, is not changed by action of the bodies among themselves.

Cor. 4. The common centre of gravity of two or more bodies does not change its state either of motion or rest by actions of the bodies among themselves, and for that reason the common centre of gravity of all bodies acting mutually upon one another (external actions and hindrances being excluded) either is at rest or moves uniformly in a straight line.

Cor. 5. The motions of bodies contained in a given space are the same among themselves, whether that space be at rest, or whether it moves uniformly in a straight line without circular motion.

Cor. 6. If bodies be moved in any manner whatever among themselves, and be urged by equal accelerative forces along parallel lines, everything goes on moving in the same manner among themselves as if they had not been impelled by those forces.

BOOK III: RULES OF [EXPERIMENTAL] PHILOSOPHIZING.

Rule 1 That there ought not to be admitted any more causes of natural things than those which are both true and sufficient to explain their phenomena.

Rule 2 Accordingly, to natural effects of the same kind the same causes should be assigned, as far as possible.

Rule 3 The qualities of bodies that do not suffer intensification and remission, and that pertain to all bodies upon which experiments can be carried out, are to be taken as qualities of bodies universally.

Rule 4 In experimental philosophy, propositions gathered from the phenomena by induction are to be taken as true, wether exactly or approximately, contrary hypotheses notwithstanding, until other phenomena appear through which they are either rendered more accurate or liable to exceptions.

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19 Harper, William L., 2002. 'Howard Stein on Isaac Newton: Beyond Hypotheses?'. In: D. Malament, ed., *Reading Natural Philosophy: Essays in the History and Philosophy of Science and Mathematics* (LaSalle, Ill., Open Court), 71–112.

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