This is a version of a paper published in the journal *Philosophy of Science* 68 (Sept. 2001): 377-93. Previously I gave some arguments against the general "new wave" model of reduction in "Collapse of the New Wave" (*Journal of Philosophy* 95: 53-72.), but interesting problems surface in Bickle's own version of the story. Indeed, there has been much talk (but too little in print) about Hooker's token reduction, which Bickle co-opts for his purposes. So, for philosophers of science, the final section of this critical notice is (I hope) worth the read.

Post-Structuralist Angst -- Critical Notice: John Bickle,

Psychoneural Reduction: The New Wave

Ronald Endicott §

Department of Philosophy & Religion, North Carolina State University

John Bickle, **Psychoneural Reduction: The New Wave**. Cambridge, MA: M.I.T. Press (1998), xi + 235 pp.

ABSTRACT

In *Psychoneural Reduction: The New Wave,* John Bickle presents his most recent ideas from the "new wave" school of reductive materialism. After presenting Bickle's account of scientific theory reduction, which is a modified structuralist gloss on Paul Churchland and

Clifford Hooker's general view, I press three main points. First, Bickle's modification seems to lose what was distinctive about the Churchland-Hooker account, so that it becomes a modified structuralist gloss on Kenneth Schaffner's older nonwavish approximate reduction. Second, a familiar problem for classical reductionism resurfaces within this newest wave of thinking, a problem that is exacerbated by Bickle's conciliatory treatment of property plasticity and the subsequent intertheoretic cross classification of terms. Third, Bickle's interesting response to cross classification via Hooker's function-to-structure token reduction has virtually nothing to do with token reduction and everything to do with eliminative materialism.

1. Introduction.

John Bickle has written an impressive book -- profound in its ideas, provocative in its claims, and polished with an array of logical techniques turned to the most current trends in the philosophy of science. Bickle's treatment of intertheoretic reduction (chaps. 2 and 3) and his formalization of psychological theories (chap. 5, secs. 1 and 3) deserve special mention. Their utility stands quite apart from any philosophical aims they are enlisted to serve, chiefly, the doctrine of reductive physicalism (chaps. 1 and 4) and/or revisionary physicalism (chap. 6). For one should distinguish between *an account of scientific reduction* versus *a defense of reductive physicalism*, which, more briefly, is the difference between "reduction" and "reductionism." The latter may entail the former, since one must know what it means for a thing to reduce if one is to understand the claim that all things reduce to the physical. But the former does not entail the latter, seeing that an account of scientific reduction might shed light on those cases where the world shows itself in a simple and uniform way even if, contrary to reductive physicalism, the world does not always show itself in a simple and uniform

physical way. Thus, I applaud Bickle's work on reduction. But I take issue with his reductionism

As for the first, Bickle offers a synthesis of opposing views that would astonish even Hegel. Note the theses and antitheses. Some say reduction involves two theories, the reduced and reducing, while others speak of three theories, giving place to an approximating progeny. Some say reduction contrasts with elimination, which preserves a theory's ontology, while others speak of eliminative reduction, which replaces that ontology. Some say reduction is a purely formal relation, a match between isomorphic structures, while others speak of robust metaphysical implications, a matter of substantive identities. And, among the latter group, some say reduction must involve type identities, meaning the general properties which factor into scientific laws, while others claim that the reduction of specific tokens will suffice, meaning the particular objects which fall under those scientific laws. Bickle, brilliantly, brings all these elements together (see below, the end of section 2).

As for the second, Bickle wants to defend materialism and keep the "identity theory alive and well" (Paul Churchland's advertisement on the back flap). He aims for something "stronger than one-way dependency" between psychological and physical kinds (3, 6). He claims to be a "full-blooded physicalist as opposed to a property dualist" (14). On the other hand, Bickle makes surprising concessions and compromises -- accepting the one-many mappings between theoretical domains (115), and the mere token reduction of psychology (155-163) -- positions that not only invite property dualism but have defined *anti-*reductionism for a full four decades. No wonder Bickle is "willing to give up the label 'reductionism' if that causes too much cognitive dissonance" (5). This juxtaposition of reductive and nonreductive themes might appear like a mythical chimera, with the head of a lion, the body of a goat, the open arms of a functionalist, the hardened heart of a materialist.

Indeed, Bickle's philosophical creature appears self-destructive, since lions typically devour goats and functionalists typically reject materialism. Is it viable? Probably not (see below, the end of sections 4 and 5).

2. Reduction: The Newest Wave

Bickle says "the new-wave account of intertheoretic reduction begins with some key insights from Clifford Hooker" (23). But Hooker's model is a modification of Kenneth Schaffner's (1967) account of approximate reduction, which can be defined by the following two conditions:

S DEDUCTION: a corrected T_R*, not the original reduced T_R, is deduced from the basic reducing T_B.

S RELATION: there is an analogical relation between the reduced T_R and the corrected T_R*.

In other words, reduction is the deduction of an analogue T_R* from a more basic reducing T_B (to reduce a theory T_R is to deduce its often corrected image T_R*). Moreover, Schaffner (1977, 150-151) extends his account to cover a range of cases within a general reduction-replacement model, which can be summarized thus:

S CONTINUUM: there is a continuum of strong to weak analogies between the reduced T_R and the corrected T_R*, with the strong relations justifying retention and the weak relations justifying replacement of the ontology of T_R.

Now the general new wave model, which might appear as a slight ripple, is a constraint on the nature of the corrected image T_R*. Specifically, Paul Churchland (1979) and Clifford Hooker (1981) add the following:

CH CONSTRUCTION: the language of the basic reducing T_B, not the original reduced T_R, must supply the resources for constructing the corrected image T_R*.

Bickle places great weight upon this feature, calling it "Hooker's first important insight about intertheoretic reduction" (27). [1] And, undeniably, the condition has an interesting effect: it guarantees that S DEDUCTION will be *intra*theoretic and that S RELATION will be *inter*theoretic. As a consequence, new wavers tout its many alleged virtues -- it allows one to always and in principle displace the original theory targeted for reduction (Churchland, 1979, 82, 1985, 11); it removes the burden of explaining intertheoretic bridge laws (Bickle, 1992, 223-224, 1996, 58); and it is the key to reducing a false theory by a true one (Churchland, 1979, 84, 1985, 9-11). I have already criticized these claims when discussing the general new wave model (Endicott, 1998a, 58-64), and will not repeat the criticism here, save a brief return to the matter of reducing the false by the true, since Bickle makes it his solitary segue into new wave reduction (24-28).

But this is the general new wave account Bickle describes (27-30), and it provides the foundation for his own view, which amounts to a post-structuralist gloss on the above four conditions (this "post-structuralism" is not to be confused with any program known by the literati). That is, inspired by the semantic or model-theoretic view of theories employed by

structuralists in the philosophy of science, and drawing from the work of Moulines (1984), and Balzer, Moulines, and Sneed (1987), Bickle proposes:

BMS STRUCTURES: theories are sets of models, with reduction and replacement defined in terms of membership, inclusion, and other set-theoretic relations supplemented with ontological links between their members.

To provide a modicum of detail, models, on the structuralist view, are the ontological items depicted by linguistic-style theories. They are the *things* represented (62), or more precisely, *sets* of things. To capture them one must first axiomatize each theory by specifying the appropriate set-theoretic predicates, for example, those employed in the open sentence "$\underline{x}$ is a model of T" iff ___, where the blank is filled in by clauses describing the theory's various objects and fundamental relations in set-theoretic terms (62-3). *Reduction*, then, relates the models of the reducing T_B (or its subset T_R*) to the models of the reduced T_R under certain restricting conditions (66).

The structuralist literature recommends various and often conflicting conditions dressed in divergent modes of presentation (see Rott, 1987). Bickle employs two from Balzer, Moulines, and Sneed (1987), and a third from Mayr (1976), altering them to fit the trio of reduced, reducing, and approximating theories. The first is roughly: (1), for all x of T_R and x′ of T_R*, if x′ is an actual model of T_B, and x and x′ stand in the reduction relation p (row), then x is an actual model of T_R (68). That is, (1) describes a set-theoretic correspondence such that if a model is in the reducing T_B, and under the reduction relation p, then a model is in the reduced T_R. The restriction thus mimics Nagel's (1961) condition of

derivability whereby, given sentences of T_B (plus the appropriate bridge laws), the sentences of T_R follow (68-69).

The second is roughly: (2), for all x that are confirmed models of T_R, there must be some x´ in the intersection of T_R* and the confirmed models of T_B, where, again, x and x´ stand in the reduction relation p (69-70). That is, (2) describes a set-theoretic correspondence in the opposite direction, taking confirmed models of T_R onto those of T_B. Though Bickle does not say, the restriction thus mimics Nagel's (1961) condition of connectability whereby whatever is good and true about the reduced theory is reflected in the more basic reducing theory.

The third, inspired by the nonNagelian tradition of theory succession represented by Feyerabend and Kuhn (71), is roughly: (3) there is an anomalous potential model x of T_R that is not a member of T_R's confirmed models but is nevertheless linked to some x´ in the intersection of T_R* and the confirmed models of T_B, again, under the reduction relation p (72). [2] That is, (3) establishes an explanatory advantage for the basic T_B (with its subset T_R*) such that T_B will have a counter to the anomaly for the old and original T_R. The net result is that (1) and (2) are faithful to the "retention" end of the S CONTINUUM, while (3) is faithful to the "replacement" end of the S CONTINUUM.

Yet Bickle knows restrictions (1) through (3) are "too weak to be adequate" (74), and, for an historical lesson, he mentions Schaffner's (1967) incontrovertible point that set-theoretic isomorphisms do not suffice for reduction (74-76). For example, thermodynamics, hydrodynamics, and exchange economics might have the same formal structure, but they do not reduce to one another. Indeed, for a more recent lesson, one might add that formal isomorphisms are insufficient for weaker relations like *realization*. [3] The molecular interactions in a distant star might be isomorphic to the computer program Wordstar, but the

former does not realize the latter (Searle 1992, 206-208). And ditto for Blockheads and Lilliputianary Isomorphs (Block 1978; Lycan 1979). So formal isomorphisms are cheap, and purely structuralist reduction is dead.

Consequently, following Moulines (1984), Bickle postulates additional post-structuralist *ontological reductive links* between reduced and reducing theories, links which comes in three varieties: *homogeneous ORLs*: where there is partial or total identity between elements in the potential models of T_R and T_B (77-8); *heterogeneous ORLs*: where there is no identity even though the intended empirical applications of T_R and T_B significantly overlap (78-9); and *mixed ORLs*: where there is both homogeneous and heterogeneous links between elements in the models of T_R and T_B (80). With an eye to the S CONTINUUM, homogeneous ORLs indicates smooth reduction, like the case of Kepler's laws and Newtonian mechanics; heterogeneous ORLs indicates bumpy replacement, like the case of phlogiston and oxygen chemistry; and mixed ORLs indicates a middle-ground of rough and revisionary metaphysics, like Newtonian mechanics and special relativity.

This is Bickle's core account of *type* reduction/elimination, which he later supplements with Hooker's programmatic remarks about function-to-structure *token* reduction (150-164). [4] More on the token new wave later. But even now an amazing synthesis appears. The overall picture involves two theories in ideal cases of perfect retention where $T_R = T_R^*$ (see Hooker, 1981, 203), and three theories otherwise (T_R, T_R^*, and T_B). [5] The picture has both ontological preservation and elimination, as shown by the S CONTINUUM and depending upon the degree of set inclusion between T_R and T_B determined by their ORLs (78-81). And the picture contains both formal and metaphysical aspects, as shown by the pure set-theoretic correspondences of (1) through (3) and the post-

structuralist ORLs of the BMS STRUCTURES (81). This is Bickle's new wave thinking, and it is a grand scheme that captures a wide range of scientific practice.

3. Is This The New Wave Or Old The Revolutionary Sixties?

I begin with a tension between new wave condition CH CONSTRUCTION and Bickle's BMS STRUCTURES. Specifically, once Bickle has applied the post-structuralist gloss, he seems to have removed all traces of the new wave. Simply put: (a) The basic new wave model is distinguished from Schaffner's account only by CH CONSTRUCTION; (b) Bickle's model-theoretic approach does not retain CH CONSTRUCTION; therefore, (c) Bickle's account is a model-theoretic version of Schaffner, not the new wave. The first premise is established by a cursory examination of Schaffner. The second needs defense.

Observe that CH CONSTRUCTION is essentially *linguistic* in nature, concerning different descriptive resources for T_R and T_B and excluding T_R's vocabulary from the construction of T_R^* from T_B. As I put it, "the language of the basic reducing T_B, not the original reduced T_R, must supply the resources for constructing the corrected image T_R^*." Or, as Churchland says, T_R^* must be wholly constituted by "general sentences of T_B that are theorems of T_B" (1979, 81). Or, as Bickle describes it, "neither T_R itself or any structure constructed from its vocabulary and explanatory resources get deduced in a reduction," rather, T_R^* is "a structure already within the vocabulary of the reducing theory T_B" (27, 28). However, if one moves to a *non*sentential account of theories, in the present case, a model-theoretic account in terms of "things depicted" (62), then any linguistic constraint is lost.

Explained more fully, the move from *theories qua sentences standing in logico-syntactic relations* to *theories qua things standing in set-theoretic relations* requires that Bickle translate or replace the old-style reduction via deduction (etc.) with the new-style

reduction via set-inclusion (etc.). For Bickle wants to "embed" the Churchland-Hooker account within his post-structuralist view (58). Hence, to be successful, the strategy must yield model-theoretic versions of all three Schaffner conditions and the one Churchland-Hooker condition.

Now the Schaffner conditions have straightforward set-theoretic corollaries. S DEDUCTION becomes a form of set-inclusion, with T_R^* being a subset of the models of T_B; S RELATION has its analogy cashed out by the structural restrictions (1) through (3) and the degree of set inclusion between T_R and T_R^* determined by their ORLs; and the ontological ramifications of S CONTINUUM are transformed into homogeneous and heterogeneous ORLs between the respective sets of models. But what could CH CONSTRUCTION possibly become? To be faithful it must somehow *restrict T_R^* to T_B and exclude T_R*, just as the vocabulary of T_R^* was restricted to T_B and excluded from T_R. So, employing the model-theoretic apparatus and aping CH CONSTRUCTION, the result is:

> B CONSTRUCTION: the elements of the basic reducing T_B, not the original reduced T_R, must supply the resources for the elements in models of the corrected image T_R^*.

Yet this is contradicted by homogeneous and mixed ORLs that express partial or total identity -- not exclusion -- between elements in the models of T_R and T_B. The problem runs deep. *Turn old-style theories at the level of linguistic representation into new-wave models at the level of things represented and T_R can no longer be excluded*. For reduction is ontologically retentive, at least by half the new wave scheme, meaning that any T_R posed at the retentive end of the S CONTINUUM will have its ontology preserved (29, 50, 81-82, 97;

also Hooker, 1981, 45, 203). So one can *exclude* T_R only at the level of words and concepts, not things, a fortiori, not collections of things.

Three more points about CH CONSTRUCTION. First, granted, there are still languages on Bickle's account, specifically, the different vocabularies at the meta-theoretical level that are used to define set-theoretic predicates for reduced and reducing theories (62-3). But it would not be in the spirit of Bickle's proposal to apply the exclusionary CH CONSTRUCTION at this level, or at this level alone. For the goal is to find a version of new wave conditions for the theories, *understood via sets of models,* rather than any meta-level language which depicts those models.

Second, other nonsententialist views do not suffer the same problem. Thus, Churchland's (1989) own modification of the general new wave account according to which theories are nonsentential vectors through connectionist phase space may (in principle) respect CH CONSTRUCTION. For, depending upon the mesh with psychology, vectors through connectionist phase space might count as representational items and hence act as surrogates for the older linguistic theories. In other words, they are *concepts* of things and *not the things themselves*. As a result, the concept/phase space of T_R might be excluded from the concept/phase space of T_R* even when, for cases of smooth reduction, the things denoted by T_R and T_R* are the same. [6]

Third, and a point of consolation, the loss of CH CONSTRUCTION is no great loss. I have argued elsewhere that the condition should be rejected because it ignores the coevolutionary development of theories and unduly restricts reductionist methodology (Endicott, 1998a, 64-67). But it actually does no work in Bickle's text. Consider how he sets the stage. The classical derivational model is problematic because false theories are often reduced: "Modus tollens alone requires that if T_R is false, then T_B must be false as well, in

contradiction to its assumed truth" (24). So Bickle proposes the new wave CH CONSTRUCTION as a solution: "The problematic cases arise from their treating reduction not just as deduction but as deduction of a *structure specified within the vocabulary and framework of the reduced theory* -- either T_R itself or some corrected version T_R^*" (27). [7]

But this focus on CH CONSTRUCTION is a mistake. For assume that Bickle is still working within the sententialist paradigm so that the deduction of a truth evaluable item will be an ongoing concern. Even then, the trouble is not that T_R and T_B (or its subset T_R^*) have different descriptive resources. One theory can be true and another false while sharing the same language and conceptual resources, for example, when one theory is formed by simple permutations on the other (cf. Ptolemaic versus Copernican astronomy, or, in the simplest case, where one theory denies a proposition that the other affirms, all else remaining constant). No, the trouble is that T_R is supposedly *false* and T_B supposedly *true* -- precisely where modus tollens becomes problematic and precisely where condition S DEDUCTION comes into play, allowing that a corrected T_R^* and not some incorrect (aka *false*) T_R be *derived* from T_B.

So Bickle should bid farewell to the new wave. That one novel condition is lost by his model-theoretic gloss, and he does not need it anyway. Bickle is no longer a Churchlander or a Hookerite. He is a model-theoretic Schaffnerite.

4. Old Plasticity Problems Resurface

New wave or no, surely the most important question is whether Bickle's post-structuralist account of reduction can be used to support his philosophical aspirations, namely, reductive physicalism. Consider the following abbreviated but very influential argument from the nonreductivist side:

(I) Reductive physicalism presupposes, in its account of reduction, that there are intertheoretic biconditional bridge laws linking psychological properties to physical properties (the goal of type or property identity requires lawful coextension).

(II) But, because of property variability and the subsequent cross-classification of terms, there are no intertheoretic biconditional bridge laws linking psychological properties to the physical properties.

(III) Therefore reductive physicalism is false.

This legendary argument originates with Hilary Putnam (1960, 1967), and it receives a clear and explicit presentation in Jerry Fodor (1974). Bickle, however, is unpersuaded. In particular, he rejects premise (I), claiming that it is plausible only given the classical account of reduction whereby T_R is deduced from T_B via *inter*theoretic bridge laws. But, thanks to CH CONSTRUCTION, or rather, the joint work of S DEDUCTION, S RELATION, and CH CONSTRUCTION, the new wave derivation/inclusion of T_R* from/in T_B is *intra*theoretic, and the only *inter*theoretic relation with T_R is one of *analogy*, not bridge law.

Indeed, Bickle *defines* "new wave" reduction as a position according to which, in effect, premise (II) is true but (I) is false. So, being conciliatory about premise (II), he says early on that "*multiple realizability and mental anomaly nix the required principles*" of classical reduction (4, italics his), and that his defense of reductionism "will deny neither these features of the psychological nor their toll on classical reduction" (4). The key, however, is to embrace a competing "new wave" account of reduction that "*remains viable in light of these objections to classical reduction*" (5, italics his), which is to say, contra premise (I), that the new wave position remains viable in spite of the absence of classical

intertheoretic bridge laws. And Bickle repeats this theme throughout, most clearly when he responds to Davidson's argument against psychophysical laws:

> One consequence of this difference ... is that connecting principles, lawlike or otherwise, are not required to effect the derivation. There are no disparate vocabularies to connect the premises (T_B and C_R) and the conclusion (T_R*) ... Davidson's challenge, based upon the impossibility of *psychophysical* (bridge) laws, is entirely without force. If the deductive part of the reduction has no gap to bridge between the language or the ontology of premise and conclusion, then the nonexistence of lawlike connections between reduced and reducing concepts or kinds is of no consequence. Since it incorporates Hooker's insight, new-wave reductionism nowhere requires connecting principles of the sort that Davidson nixes (108; see also Bickle's 1992, 224; 1996, 58-59).

But this new wave gambit cannot succeed. For Bickle's reduction actually *requires* classical connecting principles -- not in the derivation/inclusion of T_R* from/in T_B, of course, but in another fashion. [8] To begin, Bickle's new wave machinery still justifies intertheoretic identities when the analogy between T_R and T_R* is sufficiently smooth (29), as explicitly stated by the S-CONTINUUM (29-30), and when cashed out by homogeneous and mixed ORLs (78, 80).

Consider the ORLs. Ontological reductive links are constituted by ordered triples $<D_1, ..., D_n, A_1, ..., A_m, r_1, ... r_p>$ of base sets, auxiliary sets, and fundamental relations, illustrated by classical collision mechanics with sets of particles and times for the first, mathematical objects for the second, and velocity and mass for the third (77). Consequently,

as shown by the third, ORLs target *properties*, as well they should. Moreover, homogeneous and mixed ORLs require total or partial *identity* between such elements. For example, where $\underline{X}$ and $\underline{Y}$ are sets of elements from the potential models of T_R and T_B, respectively, homogeneous ORLs with total identity require that $\underline{X}$ be a subset of $\underline{Y}$ and $\underline{Y}$ a subset of $\underline{X}$ (78), entailing that, for all members $\underline{u}$ of $\underline{X}$ and $\underline{Y}$, $\underline{u}$ is a member of $\underline{X}$ iff $\underline{u}$ is a member of $\underline{Y}$. In other words, the models must share *numerically the same members*, including, then, *the selfsame properties and relations*.[9]

Finally, the *language* for expressing such property identities is employed in the very axioms of the model-theoretic approach, namely, in the meta-level language used to specify the appropriate set-theoretic predicates for reduced and reducing theories (62). So: (A) Bickle is committed to intertheoretic property identities for cases of reduction with homogeneous and mixed ORLs; (B) Bickle is committed to terms in the meta-level language which express those properties; therefore (C) Bickle is committed to intertheoretic connecting principles that can be formed by these terms and which will express the stated property identities. Any problems for classical bridge laws will therefore accrue to this newest new wave. The Putnam-Fodor argument strikes at the heart of the ORLs.

In light of this, perhaps Bickle might be willing to relinquish the ontological import of his theory.[10] Indeed, he already emphasizes the maxim: "theory reduction first, ontological consequences second and dependent upon it" (29, also 195). It might be a small step, then, to divorce the two entirely, separating out the identities which bring in train the troublesome classical bridge laws. But, unfortunately, this small step would have disastrous effects, for it would require a radical revision of the S CONTINUUM and the BMS STRUCTURES. No more retention. No more ORLs. What remains is a mere formal calculus which, at best, would mirror the logic and epistemics of science but which, at bottom, would deliver no

metaphysical goods. Worse, without the substantive metaphysics links, Bickle's account would become purely formal in nature and would thus fall prey to Schaffner's criticism of structuralist reduction (75-7). For ORLs are precisely what Bickle adds to the structuralist restrictions which enable him to "bypass the Schaffner-inspired 'too weak to be adequate challenge'" (82). Remove the ontological connections and Bickle runs headlong into Schaffner. I sense a dilemma. Keep the ontology and Bickle's account collapses into the classical model. Lose the ontology and Bickle's account collapses into a purely structuralist model.

5. The Token New Wave

I noted Bickle's conciliatory stance toward the anti-reductionist premise (II) presented in the last section. Specifically, Bickle grants that multiple realizability and mental anomaly "nix" intertheoretic biconditional bridge laws (4). More than that, he gives place to "one-many" and "many-one mappings" (68, 115, 161), which frustrate biconditionals and establish the nonidentity of psychological and physical properties. [11] And, at the end of chapter 4, a chapter which cites almost every weapon that has ever been forged in the type-physicalist arsenal, Bickle says "nothing I've introduced so far in this chapter will completely remove this final worry" (150), a worry about radical cross-classification between psychological and neurophysical kinds (151-155). Traditional reductive physicalists may feel that Bickle is far too generous. [12] Nevertheless, as a consequence, Bickle turns to Hooker's function-to-structure token reduction (155-63), meaning that, from all appearances, *he abandons type-identities in favor of mere token reduction*. This is curious, given Bickle's earlier diatribe against token physicalism (6-14). There must be a deeper subtext.

What is this "function-to-structure token reduction"? Hooker suggests the strategy for a wide range of recalcitrant functional types. Using the familiar tripartite taxonomy

employed within cognitive science -- roughly the semantic (L_1), syntactic (L_2), and the physical mechanistic (L_3) -- he constructs theory T out of higher-level L_1 and L_2 predicates, and theory T* out of mechanistic L_3 predicates, claiming that: "Systems of a type S of class T are contingently token/token identical with systems of type S' in class T* = $_{df}$ every instance (token) of a type S system externally classified as in class T is contingently identical with some instance (token) of a type S' system externally classified as in class T*" (Hooker 1981, 504). [13]

This talk of "contingent identity," which Bickle adopts (157-59, 163), should be explained. Perhaps it means that intertheoretic identity statements are empirically significant and known *a posteriori*. Regardless, Bickle accepts Hooker's account (155-63) and so adds this final splash to his new wave model:

HB TOKEN REDUCTION: in some cases, only tokens the original T_R

are identifiable with tokens of the basic reducing T_B or its subset T_R*.

Might the anti-reductionist applaud, not object? After all, the *anti*-reductionist has carried the standard of token identity, accepting only that tokens of a type-irreducible T can be identified with tokens of a basic T_B or its subset T_R^*. So, as if suffering from the Stockholm syndrome, Hooker and Bickle appear to counter their detractors by identifying with their cause.

But not exactly. Given new wave ideology, this is "token identity" in name only. For, when standardly construed, *token identity in the absence of type identity involves the same object exemplifying two distinct properties*. In the inter-level case, this would mean *property dualism*, the same object having both an irreducible higher-level property and its lower-level

realizer property. But Bickle will have none of this (6-14). Indeed, in spite of the apparent advertisement, *there is no place for standard token identities on the new wave scheme*.

Let T_R and T_R* be the functional-level and base-level theories, respectively, which describe the "systems of type S of a class T" and "systems of type S' in class T*"; and suppose, further, that T_R and T_R* are located at the *retentive* end of the S CONTINUUM. This seems right, given that the kind of token reduction in question involves such a large class of successful and paradigmatically retained theories, according to Hooker (1981, 505), theories like "electrical engineering" (being an amplifier versus a particular kind of circuit) and "physics" (being a high energy electron source versus their quantum specifications). Such cases elicit the "strong intuition" that "strongly retentive reduction" is involved (1981, 498).

However, by the S CONTINUUM, if T_R and T_R* are located at the retentive end, they must be related by *strong analogy*, having a "comparative smoothness" of mapping between their (old-style) terms or their (new style) models. Yet functional-level theories radically cross-classify basic mechanistic-level theories -- a fact which not only violates the strong analogy but motivated the retreat to token reduction. Functional and physical theories are not "equipotent isomorphic images," to use a new wave phase. Radical cross-classification is not smooth but bumpy in the extreme.

Hence suppose, on the other hand, the function-to-structure token reduction between T_R and T_R* is located at the *nonretentive or replacement* end of the S CONTINUUM, as is appropriate for weakly analogous theories. But then the trouble is obvious -- if the functional theory T_R is not retained, then there are no tokens of its types, and hence no token identities between T_R and T_R*. If there is no phlogiston, then nothing is token identical with phlogiston!

Nor, finally, but less obviously, does it help to locate matters somewhere in the *middle* of the S CONTINUUM. Functional theories are still too disanalogous, displaying radical cross-classification with many-many mappings. Moreover, even if all higher-level functional theories were middle-of-the-road, roughly analogous to mechanistic-level theories, this entails a divisionist ontology with parts of T_R retained and parts of T_R replaced, which is to say, mixed ORLs whose elements are either linked by identity or not. So for any recalcitrant functional property element in a mixed ORL one can press the problem -- *if it is real it is type-irreducible, if it is replaced it can yield no tokens for the token reduction*. Thus, after the wind dies down and the waters recede, familiar options reemerge: it's *property dualism/token physicalism or eliminative materialism*. Reductionism, as a broad philosophical position, drifts silently away.

Unsurprisingly, the new wave chooses eliminativism. Though Hooker countenances the possibility that each functional property is either (i) directly identifiable with a mechanistic property or (ii) its instance is identifiable with an instance of a mechanistic property (1981, 506), he nonetheless says that "there are no properties corresponding to predicates falling under case (ii) above if by this one means a single property common to all instances" (1981, 507). Similarly, Bickle says: "I should note a potentially discomforting final wrinkle in Hooker's account. Sometimes reductions of function to structure plus dynamics require 'resisting putative $L_1 + L_2$ semantics' ... In such cases we conclude that the functional-level predicates fail to denote" (162, the inner quote is from Hooker 1981, 507). And again, speaking of the alleged token reductions, Bickle says: "They don't even guarantee that the categories of the functional theory have genuine ontological extension" (163). So new wave "token reduction" is just eliminativism with the water muddied. [14]

Of course, the functional terms "fail to denote" or lack "genuine extension" only by failing to have a genuine *functional* extension. Hooker, at least, believes some functional-level predicates can have mechanistic-level denotations when semantically "reconstructed" (1981, 507-12). But, either way, there is no irreducible, higher-level functional property. Where there was once thought to be token identity, as standardly conceived (one object with two distinct properties), there is here one object with a base-level physical property but no higher-level functional property. The label "token reduction" is justified, apparently, by the lingering use of a reconstructed or, in the absence of a plausible analysis, instrumentally interpreted higher-level functional predicate.

To which I counter that one now has a reasonable *reductio* of the position, since eliminativism with respect to other functional domains that enjoy "the same cross-classifications," for example, those within "electrical engineering" and even "physics" vis-a-vis the underlying quantum specifications (Hooker 1981, 505), is entirely unacceptable. Put differently, the $L_1 + L_2$ semantics is not a fixed feature of a small and restricted psychological area. As Lycan points out, the functional role/occupant distinction may be reiterated all the way down (Lycan 1987, 37-8, 45). But surely eliminativism is not *that* widespread.

But however the eliminativist proposal may fare, in the end Bickle's chimera seems unstable. The creature must either lose its functionalist arms or reject its materialist heart.

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FOOTNOTES

[1] I am puzzled by Bickle's emphasis on Hooker, given Churchland's early and explicit remarks (Churchland, 1979, 83), and given Bickle's earlier credit to both new-wave founders (e.g., Bickle, 1992, 223).

[2] Given this restriction, and the full S CONTINUUM, I would call p a "reduction/elimination" relation, since it encompasses both retention and replacement; i.e., like Hooker (1981, 45), I reserve the term "reduction" for cases of ontological preservation.

[3] Realization, sadly, is a notion more frequently used than analyzed. I hope to correct that soon (Endicott, forthcoming).

[4] This is Bickle's "core" account, since he adds more set-theoretic machinery to shed light on "significantly corrective reductions" (82). In particular, Bickle modifies Balzer, Moulines, and Sneed's (1987) notion of a *blur*, which imposes a topology on otherwise unstructured sets (82-101). Intuitively, blurs "fictionalize" T_R^* in order to bring it in line with the original T_R, adding members to an otherwise correct T_R^* (89-90).

[5] Whether $T_R = T_R^*$ in cases of perfect retention depends upon how theories are individuated. Hooker's judgment is vindicated if ontological import is decisive, since, ex hypothesi, T_R and T_R^* will have the same ontology.

[6] Of course, this is not to say that the connectionist corollary is *plausible*. Whether two concepts/phase spaces have no intersection will depend entirely upon how the respective theories become calibrated within the individual psyche (Endicott, 1998a, 71). It is interesting, though, to see what becomes of the advertised new wave virtues. E.g., where a linguistic separation between T_R and T_R^* allows one to *stop talking* in terms of the reduced theory (Churchland, 1979, 82, 1985, 11), a conceptual separation between T_R and T_R^* allows one to *stop thinking* in terms of the reduced theory.

[7] Actually, at this point in the text Bickle has switched imperceptively from the issue of reducing the false by the true (24-5) to the problem of explaining inter-theoretic connections in cases of radical falsity (25-8). No matter, my argument still holds: S DEDUCTION, not CH CONSTRUCTION, allows the model to avoid deducing T_R, be it minimally or radically false.

[8] In "Collapse of the New Wave" (Endicott, 1998a, 67-72) I offered a similar argument against the general new wave model based upon the ontological consequences of (iii) S-CONTINUUM conjoined with an unavoidable commitment to public language which can express property identities at the retentive end of the continuum. Bluntly put, if you have the *identities* and you have the *language*, then you have classical intertheoretic bridge laws in full sententialist dress.

[9] Similarly, partial identity requires that $\underline{X}$ be a proper subset of some set in $\underline{Y}$ (78), entailing that all members $\underline{u}$ of $\underline{X}$ are members of $\underline{Y}$ (but not vice versa), preserving the selfsame properties and relations of T_R into T_B. Note, as a difference in exposition, that I have used the variables "X" and "Y" rather than those already defined for for the base sets "D_i" and "D_j" (78), making it clear that ORLs include the auxiliary sets and fundamental relations, as Bickle says immediately before (77) and after (78). Note, too, that Bickle's talk of base sets is ambiguous on this point. In some places they *contrast* with the fundamental relations, the "Ds" versus the "rs" (77), while in other places they *include* the fundamental relations, e.g., when he speaks of "relational base sets of the theory (pressure, volume, temperature)" (161).

[10] Bickle has suggested this in discussion.

[11] The reference to "one-many" and "many-one" mappings may need clarification. To wit, it is not just that some functional and intentional properties are realized by various physical state types in top-down, one-many fashion via compositional plasticity, but that,

conversely, some physical state types serve to realize various functional and intentional properties in bottom-up, one-many fashion via context sensitivity (see Richardson 1979, 540-55; Kincaid 1990, 577-83; Endicott 1994). Thus, there appears to be a dramatic type-identity refuting, many-many intertheoretic mapping (Hull 1974, 39; Kincaid 1988, 274; Endicott 1998b). Parenthetically, about this Bickle says something bizarre, viz., that context dependency is a "philosopher's fantasy" which depends solely upon "'Twin Earth'-style intuitions" (161). Graciously, however, he accommodates the fantasy in his overall account. Perhaps what Bickle means is that context sensitivity is objectionable on *some* construals, e.g., it does not appear to hold true for 'total' realizations when defined by suitably wide, perhaps world-wide conditions (Endicott 1994, 68-71; 1998b, 278 fn.21).

[12] Perhaps Bickle should simply dig in his type-reductive heels, especially given his efforts to answer the problem of multiple realization within the same individual over time (126-38; cf. Hornsby 1984; Horgan 1993; Endicott 1993). And there are other nonconciliatory strategies, e.g., Bechtel and Mundale (1999). The dialectical exchange is not over.

[13] There is a complication concerning Hooker's use of "instance" that Bickle does not mention. Specifically, Hooker's presentation of token reduction is preceded by a discussion about a hierarchy of determinate and determinable properties (1981, 497-500). Hence it is possible that "instances" might also mean *properties*, on some occasions, which would explain Hooker's otherwise metaphysically incoherent remarks about particular instances that *recur* (ibid., 506). Still, Hooker *does* use "instances" for particulars, in the usual nonrepeatable sense that contrasts with properties, which is why token function-to-structure reduction can yield two distinct cases: (i) the identification of a "property" *or* (ii) the identification of an "instance" (loc. cit.). Indeed, this standard use of "instance" is shown by Hooker's example of predicates designating "this machine" and by predicates like "is

comprised of transistorised flip flops, diodes and wires," etc., whose designata form the extension of T* (504). Bickle, in any case, always means token instances in the usual sense: "Unlike Kim's local reductions, the contingent identities obtain directly between functional-state and physical-state *tokens*, not types" (158), and they may include "chimps, T-2700 androids, silicon-based aliens, and whatever else nature or inventive cognizers can build" (159).

[14] It is worth noting that Hooker may no longer take the eliminativist route. For Hooker's later work is free of the reduction or elimination spirit that possesses Bickle, inasmuch as Hooker now proposes a "naturalism" that does not require reduction, being in principle consistent with "dualisms of many sorts" (1987, 261).