

Nomic-Role Nonreductionism: Identifying Properties by Total Nomic Roles

Ronald P. Endicott

(final draft, published in *Phil. Topics* 35, 2007)

North Carolina State University

I introduce “nomic-role nonreductionism” as an alternative to causal-role functionalism in the philosophy of mind. It is inspired by recent trends in cognitive science that emphasize embodied cognition and multi-level methods of explanation in the special sciences. While causal-role functionalists identify mental properties by an intra-level transition theory that describes relations between inputs, internal mental states, and outputs, I suggest that one identify mental properties by a more comprehensive theory that includes inter-level facts about realization from the appropriate implementation sciences. Thus mental properties are understood by a broad network that includes a horizontal dimension of intra-level causal relations as well as a vertical dimension of inter-level realization relations. To set the stage, in section 1 I describe the popular second-order version of causal-role functionalism. In section 2 I present the alternative nomic-role nonreductionism. In section 3 I support this view by an argument that generalizes upon an imputed rationale for scientific versions of causal-role functionalism. In section 4 I consider some possible problems. Then in section 5 I describe a general account of property identity that utilizes the same picture of causal and realization relations.

I. CAUSAL PROFILING BY AN INTRA-LEVEL TRANSITION THEORY

Consider the familiar second-order version of causal-role functionalism in the philosophy of mind. Very briefly, mental properties are understood by their position within a psychological theory that describes mentally-relevant causal transactions. Formulated as a Ramsey postulate, the theory is a conjunctive sentence that expresses all laws that govern causal relationships between types of inputs, mental states, and outputs within a cognitive system, here abbreviated as ‘ $T(I_1 \dots I_n, M_1 \dots M_n, O_1 \dots O_n)$.’ Mental properties are then understood to be the second-order properties of having first-order physical properties that occupy the corresponding causal roles described by \underline{I} (by saying that the latter are *physical* properties, I mean to confine the discussion to physically-acceptable versions of second-order causal-role functionalism). Put in the simplest way, where the term ‘ M_i ’ represents some mental property, and where ‘playing role R_i ’ means occupying that i th position in theory T (being the value of ‘ M_i ’ in the Ramsey postulate or ‘ F_i ’ in

any Ramsey formula generated from the postulate by replacing mental terms by property variables), second-order causal-role functionalists claim that having that mental property is the property of having some physical property that occupies causal role R_i . More generally, the second-order functionalist schema is this:

(F) M_i = the (second-order) property of having some (first-order physical) property that occupies causal role R_i .¹

Although causal-role functionalism provides the clearest contrast to the view I want to develop, various kinds of functionalists have been united in the view that the pertinent roles involve relations between input properties, mental properties, output properties, and nothing more. This is true about machine functionalists who understand mental properties in terms of the operations described by the appropriate computer program, as well as causal-role functionalists who understand mental properties in terms of the roles described by the appropriate psychological theory. This is true about commonsense-based analytic functionalists who utilize *a priori* methods to discover the common meanings of mental terms, as well as scientific-based psychofunctionalists who utilize *a posteriori* methods to discover the empirical truths about the mind. And this is true about first-order functionalists who are reductive physicalists, as well as second-order functionalists who are nonreductive physicalists. So Hilary Putnam says that the machine states of a mind are “related to one another and to the motor outputs and the sensory inputs,” David Lewis refers to “causal relations among mental states, sensory stimuli, and motor responses,” Ned Block frames the theory by which one identifies mental state types in terms of “a mental state, input, and output,” and Sydney Shoemaker appeals to “causal facts about mental states -- about their relations to inputs, outputs, and one another.”²

The practice of identifying mental properties solely in terms of causally-linked input properties, output properties, and other mental properties is so widespread that it deserves a name. I call it “causal profiling.” It targets *intra-level* relations inasmuch as the causal processes from sensory inputs to mental states to behavioral outputs occur at roughly the same level of reality. This interpretation is quite natural given two major motivations for causal-role functionalism. One is a traditional picture of cognitive science pitched at a relatively high-level

of abstraction that ignores facts about realization and physical mechanisms from the appropriate implementation sciences, the other is a theory of metaphysics that employs a causally flat scheme of roles and their physical occupants.

Regarding the traditional picture of cognitive science, consider two historically important developments that led to the rise of cognitivism. Edward Tolman postulated mental maps in rats because of their behavior of traveling the shortest distance to a food source contrary to their conditioned training and apart from speculation about how those maps are implemented in the brain, and Noam Chomsky postulated a language acquisition device in humans with rules governing syntactic transformations because of their behavior of producing sentences that outrun stimulus training quite apart from speculation about how language modules are implemented in the brain.³ These cases illustrate a pure behaviorally based postulation of inner representations without consideration of neural mechanisms. This kind of “top-only” theorizing became integrated with classical computational models of the stated calculations and rules, which Ned Block describes with the example of logic gates (patterns of circuitry that implement logical operations):

How such gates work is no more part of the domain of cognitive science than is the nature of the buildings that hold computer factories. This reveals a sense in which the computer model of the mind is profoundly *un-biological*. We are beings who *have* a useful and interesting biological level of description, but the computer model of the mind aims for a level of description of the mind that abstracts away from the biological realizations of cognitive structures.”⁴

A theory of intra-level causal roles thus fits this abstract, implementation-ignoring picture of cognitive science very well. Yet another way to highlight the intra-level nature of causal profiling is to note the kind of metaphysics it implies, namely, a flat theory of mental roles and physical occupants that ignores important inter-level dimensions of realization. Carl Gillett describes this flat view in terms of a theory of realization whereby (I) the realized and realizing properties are possessed by the same individual (a token identity condition), and (II) the causal powers that individuate the realized property are a subset of or otherwise contributed by the causal powers bestowed upon an individual by the realizing property (a matching of causal

powers condition).⁵ Causal-role functionalism is flat because even second-order functionalists typically state that the same object instantiates both causal-role and occupant properties, as expressed by condition (I), and the idea that one property occupies the role of another implies a matching of causal powers, as expressed by condition (II), at least assuming a general background metaphysics of properties and powers. As Gillett explains: “Under the flat view one property instance contributes all the powers individuating the realized property -- the realizer property instance thus literally plays the very causal role that individuates the realized property.”⁶

One might wonder how a theory of realization based upon the second-order functionalist’s role-occupant distinction could be metaphysically “flat,” given that philosophers have understood second-order functionalism to be a paradigm nonreductive view that implies a hierarchy of distinct sets of properties in nature. But one must distinguish “property orders” from the “causal levels” implied by talk about properties bestowing causal powers upon individuals. Kim makes this distinction by pointing out that while first-order and second-order properties are possessed by the same individual, the causal powers that create a difference in levels are bestowed upon different individuals as reflected in the “macro-object/micro-constituent” hierarchy, specifically, the properties and powers of wholes versus the different properties and powers of their proper parts.⁷ Hence different property orders are instantiated at the same (flat) mereological level where the causal roles are played.

In sum, I interpret causal-role functionalism as an intra-level transition theory because of the stated ties to abstract cognitive theory and a flat metaphysics of causal roles and physical occupation. If one wishes to recast the theory more broadly to include inter-level causation and multi-level methods of explanation, very well, it will become the kind of theory I develop as an alternative to the traditional interpretation of causal-role functionalism.

II. COMPREHENSIVE PROFILING BY A TOTAL THEORY

Like second-order causal role functionalism, the view I develop is a nonreductive position according to which mental properties are not identical to physical properties. Going beyond the folk dichotomy of ‘mental’ versus ‘physical,’ the nonreductive picture I accept presents nature as a hierarchy of distinct sets of objects and properties, reflected in the existence of general to

special sciences, where the properties in the domains of special sciences are typically not identical to but determined by or dependent upon the properties in the domains of the general sciences. For example, generally speaking, properties in course-grained, behaviorally-based functional psychology are not identical to the properties described by finer-grained theories of neuro-computation, and they in turn are not identical to the properties described in neuro-chemistry and still more general chemical theories, and they in turn are not identical to the properties described in basic physics. This is not the place to argue for this kind of nonreductive position. It is here assumed, save some expository comments that serve to indicate the kind and level of property in question.⁸ For the many reductive physicalists I beg their indulgence. A nonreductive alternative to second-order causal-role functionalism is worth exploring, at least until the tide of future science turns wholly against nonreductive theories of mind. I believe the waters are still favorable.

Beginning at the low end of the mind's place within this world-hierarchy of property levels, mental properties of the kind described by functional psychology are typically determined by but not identical to lower-level neuro-computational, neuro-chemical, or other physical properties because mental properties are typically multiply realized by those properties.⁹ Let the term "underputs" name these lower-level physical properties that serve to realize mental properties. Given the determinative nature of realization, there are inter-level laws of the form: 'necessarily, if P then M ,' where ' P ' names a physical underput property and ' M ' names a mental property. Such laws constitute part of M 's realization role, and they will be included in the theory T by which M is understood.

Concerning the intersection at the high end of the mind's place within the world-hierarchy, various still higher-level psychological, moral, and social properties are determined by but not identical with mental properties because those properties are likewise multiply realized by mental properties. For example, utilizing a broadly Lockean theory of personal identity, the property of being a person is multiply realized by different psychological profiles, which is to say, different mixtures of rationality, consciousness, and similar cognitive capacities. More central to the scientific literature, according to trait theories in psychology, a human personality is itself built from various mixtures and dimensions of component psychological factors and so multiply realized by them.¹⁰ Let the term "overouts" name those higher-level properties that more basic mental properties serve to realize. Since overouts are thus determined by mental

properties, there are inter-level laws of the form: ‘necessarily, if M then V ,’ where ‘ V ’ names an overout property. Such laws also constitute part of M ’s realization role, and they will be included in the same theory T by which M is understood.

Parenthetically, one can accept an expanded set of laws governing underputs and overouts while disagreeing about exactly how one should interpret such realization laws. The standard view is that, because of multiple realizability, a given physical underput property P is a lawfully sufficient but not necessary condition for M . But elsewhere I have argued that in order to account for the converse of multiple realizability, one should view the physical realizing property P as an INUS condition for M .¹¹ And there are more familiar debates over *local* versus *regional* versus *global* determination, pace the literature on supervenience. Accordingly, philosophers have also begun to speak about broader forms of realization by determinative conditions outside the individual.¹² Even so, the view I want to develop that utilizes a scheme of inter-level realization laws can be maintained by those who hold different views about the form and nature of those realization laws, just as a version of causal-role functionalism that utilizes a scheme of intra-level causal laws can be maintained by those who hold different views about the form and nature of those causal laws.

In any case, the set of laws connecting a specific mental property M to its input properties, other mental properties, and output properties, constitutes a horizontal cross-section of M ’s nomic relations. This is the property’s *intra-level causal role*. The set of laws connecting M to its underput properties, other mental properties, and overout properties, constitutes a vertical cross-section of M ’s nomic relations. This is the property’s *inter-level realization role*. And the set of all such laws constitutes M ’s *total nomic role*. As a consequence, there are two Ramsey postulates to consider. There is the Ramsey postulate composed by the conjunction of all intra-level causal roles involving mental properties, which I call a “Causal Theory of Mind.” There is also the Ramsey postulate composed by the conjunction of all total nomic roles involving mental properties, which I call a “Total Theory of Mind,” here abbreviated as: ‘ $T(P_1 \dots P_n, I_1 \dots I_n, M_1 \dots M_n, O_1 \dots O_n, V_1 \dots V_n)$,’ with the additional P and V terms representing types of underputs and overouts, respectively.

Utilizing a Ramsey postulate with a larger set of laws than Causal T is not unprecedented. David Mellor says that the actual properties of the world are those quantified over by a Ramsey

postulate that contains “all laws.”¹³ Total T is more modest in extension, containing only the subset of laws that involve mental properties. To borrow some terminology from Robert Cummins, Total T is a combination of a causal transition theory and the underlying property instantiation theories that target mental properties as well as their higher-level overout properties, yielding a full picture of horizontal and vertical nomic relations that center upon the life of the mind.¹⁴ I will have much more to say about the interpretation of Total T shortly. But I am now in a position to present an alternative to causal-role functionalism that identifies mental properties by Total T . I call this practice “comprehensive profiling” and the resulting philosophy “nomic-role nonreductionism.” Where ‘playing role R_i ’ now means occupying that i th position in Total T (being the value of ‘ M_i ’ in the Ramsey postulate or ‘ F_i ’ in any Ramsey formula generated from the postulate by replacing mental terms by property variables), the schema for nomic-role nonreductionism is:

(N) M_i = the (first-order mental) property that occupies total nomic role R_i .¹⁵

Several points of clarification are in order. First, definition (N) says that mental property M_i is identical to the property that occupies total nomic role R_i . Consequently this is a first-order schema, because mental property M_i is the property that occupies the pertinent i th position in Total T , not some second-order property of having some first-order physical property that occupies that position (recall the difference between “orders” and “levels” discussed in the previous section). Why is a first-order scheme now acceptable for a nonreductive philosophy of mind? Because there is no longer any need to use the logico-metaphysical machinery of second-order properties, since the difference between mental and physical properties is now manifest within the theory T itself by virtue of the inter-level realization laws connecting them. Mental properties are assigned to the mental terms ‘ $M_1 \dots M_n$,’ as well as any property variables that replace them, while physical properties are assigned to the physical input terms ‘ $P_1 \dots P_n$,’ as well as any property variables that replace them. To turn a phrase from Bishop Butler, everything is what it is, and not in the place of another.

Since the nomic-role nonreductivist does not assign first-order physical properties as the value of the variables that replace mental terms, the functionalist doctrine of physical occupation

is rejected. Indeed, to accept it within a scheme that utilizes Total T would lead to contradiction. George Bealer makes roughly this point in a footnote of a paper devoted to a different issue with functionalism. Where ‘ T ’ is the Ramsey postulate, and ‘ \mathbf{T} ’ is the set of Ramsey predicates formed from T , and ‘ \mathbf{R} ’ is the set of first-order physical properties that satisfy \mathbf{T} , Bealer says:

But there are limitations on how comprehensive T may be. If T includes too much information about the standard mental properties, functionalism is subject to immediate refutation. For example, suppose T includes a clause stating that, say, the property of being in pain is not a first-order *physical* property (having firing C-fibers, etc.), as is required by the denial of the identity thesis. And so on for the other standard mental properties dealt with by T . In that case, there could be *no* first-order physical properties \mathbf{R} that satisfy \mathbf{T} , contradicting the materialistic version of functionalism.¹⁶

Simply put, if T says that mental properties differ from physical properties in a certain respect, then physical properties cannot play *that* mental role of differing from physical properties since no property can differ from itself. Yet Total T is precisely the kind of “comprehensive T ” Bealer describes, because it displays the difference between mental and physical properties in its inter-level realization laws. To make the point in a more precise way, assume that the physical properties are the underput properties within Total T . Given multiple realizability, for any physical underput P and mental property M , there is a set of laws which show that P is not a necessary condition for M (e.g., Total T might introduce P and other alternate realizations that are equally sufficient for M as distinct neural properties by means of different developmental laws that govern brain plasticity). So for specific properties M_i and P_i in the network of laws described by Total T , start with the Ramsey postulate ‘ $T(\dots P_i \Rightarrow M_i, M_i \not\Rightarrow P_i, \dots)$,’ which highlights the part of Total T that represents P_i as lawfully sufficient but not necessary for M_i . Then generate the Ramsey sentence ‘ $\dots \exists F_i \dots [T(\dots P_i \Rightarrow F_i, F_i \not\Rightarrow P_i, \dots)]$,’ which is the same part of Total T with ‘ M_i ’ replaced by the property variable ‘ F_i ’ and prefixed by an existential quantifier. The semantics for Total T requires that physical underput properties $P_1 \dots P_n$ are the value of its P -terms, which is why P_i is assigned to the term ‘ P_i .’ But by the

functionalist doctrine of physical occupation, that same P_i would be assigned to the property variable ' F_i ' that replaced ' M_i ,' since it is the physical property that realizes M_i by virtue of occupying its role in the pertinent contextually-relevant situation. Hence ' $P_i \Rightarrow P_i$ ' and ' $P_i \not\Rightarrow P_i$.' The use of Total \underline{T} thus calls for a radical departure from functionalist doctrines.

Second, let me clarify the interpretation of Total T as a combination of intra-level causal transition theories and inter-level property instantiation theories. As discussed previous, I view Causal T as an intra-level transition theory motivated by abstract cognitive theory and a flat metaphysics of causal roles and physical occupants. In contrast, I view Total T as an inter-level expansion on Causal T motivated by theories of embodied cognition and a dimensioned metaphysics of property instantiation or realization. Beginning with the former, many contemporary cognitive theories are no longer exclusively pitched at a relatively high-level of abstraction that ignores the facts about physical mechanisms described in lower-level realization sciences. Rather, the theories in question integrate traditional high-level data from functional psychology with lower-level data relevant to issues of physical implementation and embodiment from the various fields of cognitive neuroscience, animal cognition, and robotic engineering.

To mention just a few sample cases, consider neuropsychologists David Milner and Melvyn Goodale's "two systems" theory of vision in which postulates a *perceptual system* located in the ventral stream that passes from the primary visual cortex to the temporal lobe, providing visual categorization and learning such as recognizing shapes, and an *action system* located in the dorsal stream that passes from the primary visual cortex to the parietal lobe, providing visual control of action such as grasping and manipulating objects.¹⁷ One of the many sources of evidence comes from individuals with visual agnosia who have damage to the temporal but not parietal lobes. As a result they cannot recognize objects by categorizing them in terms of shapes even though their sensory-motor skills for grasping the appropriate shapes is unaffected. For present purposes, the important point is that the theory involves a specific neurophysical hypothesis about two separate processing channels in the human and primate brain which explains the separate functioning of visual perception and visually-guided action. It is a theory of visual functions by divided mechanisms.

Or consider a current theory of visual consciousness. Several neuroscientists maintain that visual consciousness in humans and other like-embodied mammals is realized by activity

that extends beyond the primary visual cortex V1-V2 into the intermediate-level processing areas V2-V5, and Jesse Prinz adds that representations from that processing must be made available to working memory through an attention mechanism.¹⁸ The combined picture contains relatively low-level data about cellular activity at specific regions of the brain and relatively high-level psychological processes of memory and attention. Specifically, and with an eye to filling out the different parts of Total *T*, the hypothesis about intermediate-level processing in areas V2-V5 is committed to the specific types of physical structures in V2-V5 (as opposed to the structures in other areas of the brain or in other types of brains or even in other forms of engineering). So where ‘*P*’ represents a structural property in areas V2-V5, and ‘*M*’ represents a state type for intermediate-level visual processing, there is an inter-level realization law of the form ‘necessarily, $P \Rightarrow M$.’ The additional hypothesis about the processes of attention that deposit representations in working memory is then an intra-level causal story committed to causal laws of the form, ‘necessarily, $M \Rightarrow O$,’ yielding another cross-section of laws represented by Total *T*.

This form of cognition is especially relevant for the expanded picture of mind that Total *T* represents, since it directly implicates cognitive capacities that arise by virtue of the naturally selected mechanisms that serve to realize them, like the distinct kinds of visual processing capacities described by Milner and Goodale that arose because of an evolved division between their realizing mechanisms in humans and other closely related animals. Theories of vision must be tailored to specific systems with the appropriate eye-to-brain connections, and similarly for other cognitive capacities.¹⁹

Granted, Total *T* is a “rational reconstruction” of scientific theories of embodied cognition. But I assume it is permissible to perform logical operations upon extant theories, and Total *T* is a logical construction of the kind laws one can find in the broader fields of contemporary cognitive science. Yet, in addition to scientific theories that emphasize the role of physical mechanisms, one can also understand the inter-level nature of Total *T* by a dimensioned metaphysical theory of realization. Again following Gillett, and in contrast to the flat metaphysics of causal roles with physical occupation, a dimensioned theory maintains that (I*) the realized and realizing properties are possessed by an individual versus its distinct constituent parts (a mereological condition), and (II*) the realized and realizing properties have distinct causal powers suited to the different albeit compositionally-related individuals that possess them (a compositional powers condition).²⁰ As I view them, dimensioned theories are a species of

what Cummins called a “property instantiation” theory inasmuch as they explain the instantiation of a property in a kind of system S by “the properties of S ’s components and their mode of organization.”²¹ Indeed, this mereology is central to the more publicized species of a property instantiation theory introduced to the philosophical community by Jerry Fodor and developed by Cummins, namely, a functional analysis wherein higher-level (realized) functional properties or associated capacities decompose into lower-level sub-capacities that ultimately decompose into simple mechanistic-level processes (the basic realizing parts).²² Functional decomposition is just composition in reverse. As long as the properties in question are associated with causal capacities, thus involving the causal powers in Gillett’s metaphysical theory, the resulting functional analysis counts as a dimensioned theory of realization.

Of course, in order to accommodate the mereological dimensions of realization, the domain of Total T must include not only objects but also their proper parts. This means that, within the set of physical underput properties described by Total T , some will belong to an object while others will belong to its proper parts. To make this idea more precise, one can utilize Kim’s notion of a micro-based physical property.²³ Let N be a micro-based physical property possessed by an object or system y when (a) y ’s proper parts x_1, \dots, x_n possess their microphysical properties P_1, \dots, P_n , (b) the possession of P_1, \dots, P_n by x_1, \dots, x_n determines the possession of N by y , and (c) N is a physical property. The set of physical underput properties will include both micro properties and micro-based properties, thus understood. Consequently, when its variables are made explicit, Total T represents an expansion of Causal T not only because of the added dimension of properties but also because of the added mereological dimension of particulars. So much for my brief sketch of nomic-role nonreductionism and its Total theory of an embodied mind. More needs to be said by way of clarifying and developing the position. And several problems need to be addressed and resolved. But first I want to provide some positive support.

III. SUPPORTING ARGUMENT

Accepting Total T is one thing, using it to understand the nature of mental properties is quite another. One could continue in the spirit of causal-role functionalism and abstract cognitive science by ignoring all reference to embodied processes and realization relations as mere matters

of implementation. Yet I think this general viewpoint is no longer compelling. Specifically, by including facts about inter-level realization, I believe Total *T* represents a *more complete and comprehensive theory of mind* than Causal *T*. Thus I find the following argument worthy of serious consideration:

- (1) Between two theories, one should understand the nature of mental properties by the better scientific theory of mind.
- (2) Total *T* is a better scientific theory of mind than Causal *T* because it is a more complete and comprehensive theory of mind.
- (3) Therefore, between Total *T* and Causal *T*, one should understand the nature of mental properties by Total *T*.

Beginning with (1), functionalists do not dispute the use of theories in understanding the nature of mental properties. They are part of the procedure that generates schemas like (F) and (N) for Ramsey-style terms tied to their containing theories. However, commonsense functionalists will reject (1) if they believe that the only worthwhile project is to analyze folk concepts of the mind. For folk concepts contain little if any data from scientific theories of mind, which is why J.J.C. Smart could claim that his causal analysis of mind does justice to the views of an “ancient Greek peasant,” and why David Lewis could construct his theory of mind from “commonsense folk platitudes.”²⁴ This is not to deny that folk concepts might have a structure similar to scientific theories, with connections to explanatory principles and beliefs about scientific essences.²⁵ But their content is dramatically different, like the difference between folk physics and real physics. In any case, since my goal is to describe a mental property’s scientific essence rather than its nominal folk essence, I believe premise (1) is secure. In this I follow scientific functionalists who likewise believe that the nature of mental properties can only be understood by our best scientific theories. Their Causal *T*, as well as my Total *T*, makes generous use of large portions of scientific psychology to reveal the broadly relational nature of mental properties.²⁶

However, in spite of agreement on (1), traditional scientific functionalists will reject premise (2) on grounds that the additional information contained in Total *T* about realization roles is irrelevant to the true nature of mind. Why? Because they believe in the high-level nature

of an abstract mind as revealed by abstract cognitive science and a flat metaphysical theory of realization by functional roles and physical occupation. Accordingly, they follow a conservative methodology whereby abstract minds are best understood by information gathered from a relatively narrow range of scientific disciplines committed to the same implementation-ignoring “top-only” methods employed within branches of classical artificial intelligence and high-level computational psychology. In contrast, I seek to develop a philosophical account of the inter-level nature of an embodied mind based upon theories of embodied cognition and a dimensioned metaphysics of realization. Accordingly, those who accept this perspective follow a more liberal methodology whereby embodied minds are best understood by information gathered from many scientific disciplines committed to “top-down,” “bottom-up,” “mutually interactive,” and “co-evolutionary” methods employed across the broad fields of cognitive science.²⁷ Who is correct?

Perhaps both. One should be open to the possibility that humans and other cognitive systems may have developed more than one or even several mental systems over the long course of evolution. Perhaps there is an embodied mind that involves various activities like perception, special problem solving in specific environments, and the fast and efficient on-line motor control of behavior. And perhaps there is an abstract mind that involves various activities like reflection, general problem solving across multiple environments, and various off-line calculations for more leisurely behavior. If such is the case, one may take the supporting argument (1) through (3) in a less contentious way as a claim about the nature of properties in an embodied mind, while giving place for an abstract mind in the traditional functionalist theory.

Even so, to support my claim that the properties of an embodied mind have a broader mental essence, and to move the debate beyond the war between abstract and embodied perspectives, I offer a metaphysical argument that generalizes upon the basic rationale for scientific versions of causal-role functionalism. My claim is that the reasons which actually justify including causal inputs and outputs into a theory of mental essence are also reasons that justify including realization underputs and overouts into a theory of mental essence. Rhetorically put, what is so special about causal roles versus realization roles? It is not because people are aware of the pertinent causal inputs and outputs but *unaware* of the others. That is false, and even if it were true, it would only be relevant to the project of defining the meaning of mentalistic discourse, pace commonsense functionalism. So, to state my question more precisely, why do scientific causal-role functionalists understand the relational nature of mental properties

in terms of causal input properties and behavioral output properties rather than a myriad of other things, for example, things that do not cause mental phenomena (properties of a nearby but causally isolated object), or things that are only remote causes (properties of events that only cause the mind's causal inputs)?

The first set of things do not produce *mental phenomena*, while the second do not produce mental phenomena *directly*. So I submit that, in contrast to other things that are not deemed relevant to a theory of mental essence, the causal inputs and behavioral outputs are the items of *direct mental production*. Sensory inputs directly produce mental phenomena, which in turn directly produce other types of mental states, which in turn directly produce behavioral outputs. Things that lie outside this neighborhood are excluded because they are not items of direct mental production.²⁸ But the point generalizes. *Lower-level underputs also directly produce higher-level mental phenomena, which in turn directly produce still higher-level overouts*. There is perfect parity. Hence they should be included in a theory about the nature of mind.

Of course I have used a vague and generic idea of “direct mental production” to describe the similarity between causal and realization roles. But the notion of mental production can be cashed out in various ways that preserve the generalization from causes to realizations. For example, the notion of *directness* can be understood in terms of the idea that the items of production are not too spatio-temporally distant from the resulting token states or events, or the idea that the items of production lack a significant number of similarly-scaled intermediaries between them and the resulting token states or events, and these ideas apply to the pertinent cases of causation and realization alike. Moreover, the generic notion of *production* can be understood in terms of a cluster of scientifically useful and familiar ideas such as determination with covering laws that support counterfactuals. And, consonant with my generalization, many philosophers associate both causation and realization with the same stock of metaphysical ideas about determination or dependency as well as laws and counterfactuals.²⁹

Granted, causation and realization might differ in some respects. For example, realization is typically described exclusively as an inter-level relation, causation is typically not. Realization is typically described as a relation between properties of the same individual or compositionally-related individuals, causation is typically not. But it is absolutely striking that the pertinent cases of causation and realization converge on such things as the close proximity between their tokens

in space and time, the determination or dependency between causal pairs and realizing pairs, the existence of covering laws and true counterfactuals involving their distinct properties. So I believe the hypothesis that best explains why scientifically-minded functionalists framed their theories in terms of causal inputs and outputs is that they were motivated by such matters of direct mental production -- matters that carry over to the case of realizing underputs and overouts. Hence I find the following argument persuasive:

- (1*) Between two theories, one should understand the nature of mental properties by the better theory of mental production.
- (2*) Total *T* is a better theory of mental production than Causal *T* because it is a more complete and comprehensive theory of mental production.
- (3*) Therefore, between Total *T* and Causal *T*, one should understand the nature of mental properties by Total *T*.

Let me also say that it is perfectly understandable why a reductive first-order functionalists would resist the move to Total *T*. On their view, physical realizations do not produce mental phenomena, they *are* mental phenomena. Consequently, only the causes play a substantive role as independent variables for their theory of mind. But a nonreductively-minded philosopher does not have that luxury. On their view, the mechanisms for lower-level underputs also play a substantive role as independent variables for a theory of mind. Hence I believe nomic-role nonreductionism and its practice of comprehensive profiling by Total *T* is a more natural development of the nonreductive perspective than its second-order functionalist competitor.

Even so, I should emphasize that while nomic-role nonreductionism goes beyond causal-role functionalism in certain important respects, it is not altogether foreign. First, like causal-role functionalism, nomic-role nonreductionism accepts the *relational* nature of mentality. It simply understands the nature of mental properties by a broader set of properties and relations. Second, like second-order causal-role functionalism, nomic-role nonreductionism expresses the physical *irreducibility* of mental properties. It simply expresses the desired irreducibility by using Total *T* under a first-order interpretation of its mental and physical terms rather than Causal *T* under a second-order interpretation of its mental terms. Third, like scientific versions of causal-role

functionalism, nomic-role nonreductionism respects the *nomic* status of at least large portions of psychological theory. Total *T* is a collection of laws, not folk platitudes, or assumptions for agent interpretation, and so on.

IV. PROBLEMS AND ISSUES

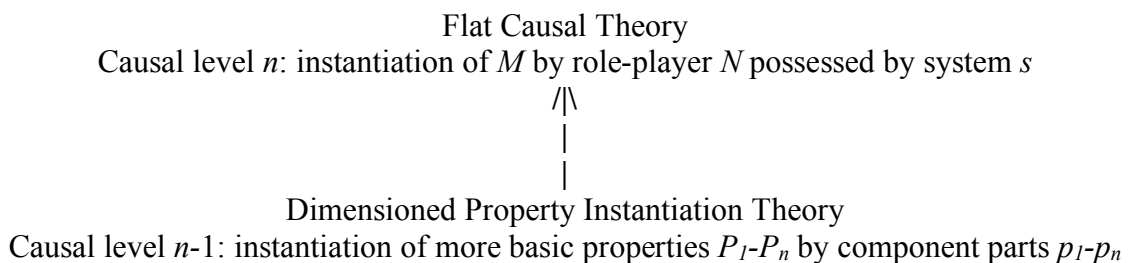
I admit there are various areas of concern, especially given the nascent status of my view. So I will discuss three concerns that I hope will further clarify nomic-role nonreductionism.

First Concern: Supplementary Metaphysics. I have explicitly rejected the functionalist idea that physical properties realize mental properties by occupying their causal roles. So how do I define realization?³⁰ Fortunately, there are several alternate theories that do not presuppose the functionalist doctrine of physical occupation, and a nomic-role nonreductivist is free to choose among them. I have already mentioned Gillett's dimensioned theory of realization that explicitly rejects the flat view of causal roles and physical occupation. And there are other functionally-independent notions of realization, such as the idea of realizing properties as determinables and realizing properties as their determinates, or a more generic notion of determination over the same individual or compositionally-related individuals.³¹

Second Concern: Theoretical Differentiation. Yet one might argue that I have not provided a significant alternative to causal-role functionalism because I have overstated the difference between Total *T* and the second-order interpretation of Causal *T*. In point of fact, some information about inter-level realization roles is *recoverable* from Causal *T* under its second-order interpretation. Specifically, one might argue that the physical underput properties $P_1 \dots P_n$ enter the meta-theory of Causal *T* where they are assigned as the semantic value of the property variables that replace mental terms, and from this one can deduce psychophysical laws of the kind 'necessarily, if *P* then *M*,' at least given certain auxiliary assumptions that utilize a method of functional explanation.³² But, regardless, this piece of semantics plus the inferred property connection is hardly equivalent to theories of implementation science conjoined with the appropriate metaphysics supplied by a dimensioned property instantiation theory.

First, the role-player property is not the same as the physical properties described within a dimensioned theory of property instantiation. Although it is differently *ordered*, the role-player property is possessed by the same individual and thus exists at the same mereological *level* as *M*,

sharing its powers and thus occupying its role (recall the discussion of orders versus levels in section 1.). In contrast, the lower-level properties in a dimensioned theory are possessed by the *component parts or subsystems* of the object that instantiates M , having different powers appropriate to the parts versus wholes. To reflect this difference, let the role-player property be designated as ‘ N ,’ and the lower-level properties of the component parts be designated as ‘ P .’ Second, the functionalist view says only that a second-order property M is associated with a causal role and that a first-order physical property N plays that role. *But this does not indicate how a token of the first-order role-player property N is able to occupy the causal role associated with the second-order functional property M .* To understand that, one would need a deeper story about how the role-player N is itself determined *via* a dimensioned property instantiation theory, as illustrated below:



The causal level n describes a pattern of relations of the kind causal-role functionalists use to define their target property M of a system s , in the philosophy of mind, the intra-level causal transitions between types of inputs, internal computations, and behavioral outputs. This causal-level also includes occupier properties like N since they play the causal role of functional properties like M . Causal level $n-1$ then describes a pattern of relations of the kind that exist between the mereological parts of the system s and determine its powers by the contributions of the several powers of the properties P_1-P_n .

To add some flesh to these bones, on this larger picture there is a particular computational system s of engineering components that is token identical with a mind and which displays an engineering role-player property N , say, having a structure of logic gates, that subserves the mind’s computational property M , say, performing addition. The computer system is the object within the domain computer engineering that possesses the complex structural property of logic gates, not the individual component circuits, but it does so by virtue of the capacities of the

several component circuits that combine to form the system of logic gates. So the computer system's role-playing structure of logic gates N is explained by the accumulative powers of the more basic properties P_1-P_n of the engineering components p_1-p_n in a mereologically dimensioned way.

Now my point is that any causally flat metaphysics which says only that M has a role-player logic-gate property N is absolutely silent about how that kind of property is able to occupy this role, because it is silent about how the more basic parts p_1-p_n and their properties P_1-P_n compose the system s and thus determine its properties (in their orders) N and M . For that one needs a dimensioned property instantiation theory -- the mereology and the laws connecting the parts to the wholes -- along with the empirical nuts and bolts supplied by the appropriate implementation sciences.³³ In short, all this dimensioned information is contained in Total T , not Causal T , even on its second-order interpretation. So, regarding the vertical slice of realization roles, Total T is informationally rich while Causal T is impoverished.

Third Concern: Domains of Discourse. Finally, some believe that Causal T is a general theory of mind that ranges over human and nonhuman cognitive systems, while others believe it is a species-specific theory that explains just one of several kinds of minds. Likewise, I believe one can develop Total T either as a general or a species-specific theory. Various cognitive theories extend beyond the human species, like Milner and Goodale's two systems theory of vision, or Feigenson, Dehaene, and Spelke's theory of exact and approximate core systems for counting.³⁴ Exactly how far Total T extends beyond the human species is an empirical question that must be answered by scientific investigation. But there are problems that follow species-specific and general interpretations of Total T , and they are worth addressing.

On the one hand, one might think that a species-specific interpretation spells trouble because it results in a reductive theory, contrary to my exposition of Total T . For example, Lewis and Kim have both argued that species-specific properties yield species-specific psycho-physical identities.³⁵ Yet I reject the idea that a species-specific theory is *ipso facto* a reductive theory. Mental properties can be multiple realized by physical underpinnings within various species, even within the same individuals at different times. The case of neural plasticity within the mammalian brain is well-documented, and the development of artificial neural implants provides compelling evidence that the same macrofunctional information values can be carried out by processes that exhibit quite different micro-causal profiles.³⁶

On the other hand, one might think that a more general interpretation of Total *T* also spells trouble because it will contain wildly disparate and heterogeneous physical realizations represented under its physical underpinnings. Yet the appeal to heterogeneous physical realizations is only thought to be a problem when it is conjoined with objectionable reductive claims, for example, that a mental property is identical to a disjunction of otherwise heterogeneous physical properties.³⁷ But Total *T* is an explicit nonreductive theory in the sense that it exhibits the distinct nomic roles of mental and physical properties, and the nomic-role nonreductionist need not accept any further identities based upon constructivist ideas about physical properties picked out by disjunctions of physical terms. So, in summary, I think Total *T* represents a coherent theory, and the corresponding philosophy of nomic-role nonreductionism represents a viable position in the philosophy of mind.

V. EXTENDING THE SCOPE OF COMPREHENSIVE PROFILING

Thus far I have framed the discussion in terms of a contrast between two theories of mind, causal-role functionalism and nomic-role nonreductionism. But each view arguably presupposes a general theory of property identity. Causal profiling presents the relational nature of mental properties by intra-level causal roles. So it is plausible to assume that there is a causal theory of properties in the background. Comprehensive profiling presents the relational nature of mental properties by total nomic roles. So it is plausible to assume that there is a broader nomic theory of properties in the background. I want to finish by making some suggestions about such general matters.

Part of the metaphysical duty of a property is to contribute to an object's *causal powers*. This has led many philosophers to embrace a causal theory of properties. On such a view, (C) properties are the same if and only if they contribute the same causal powers to their instances.³⁸ Sydney Shoemaker, who has developed this idea with considerable care, explains that they are conditional powers in the sense that are based upon the condition that the system has other properties with other powers, and in his more recent formulations the conditional causal powers include both forward-looking and backward-looking dimensions.³⁹ The causal theory of properties is thus closely linked to the causal-role functionalist's method of causal profiling by an intra-level transition theory framed in terms of backward-looking causes and forward-looking

effects, and it implies that method with the aid of auxiliary assumptions about the connection between causal powers and causal laws. Properties are identified by the network of causal laws into which they enter.

But causal powers are not the only important features that properties possess. Being mindful of realization roles, properties also have upward-looking and downward-looking dimensions as well. Accordingly, I submit that another duty of a property is to contribute *realization capacities* to its instances. Intuitively, while the forward-looking dimension concerns how a property's instantiation can cause things, and the backward-looking dimension concerns how a property's instantiation can be caused by things, the upward-looking dimension concerns how a property's instantiation can realize things, and the downward-looking dimension concerns how a property's instantiation can be realized by things. I have explained realization roles in terms of a Cummins-style property instantiation theory under a Gillett-style interpretation of causal powers for the objects and their component parts. So my observation is that a property not only bestows causal powers on its instances to bring about certain effects (and to be the effect of certain causes), it also bestows realization capacities on its instances to be composed of parts with a specific organization (and to be itself a part of some still higher-level composite).⁴⁰

The expanded principle is thus (T): properties are the same if and only if they contribute the same causal powers and realization capacities to their instances. This theory of properties is closely linked to the nomic-role nonreductionist's method of comprehensive profiling by a theory of total nomic roles, and it implies that method with the aid of auxiliary assumptions about the connection between the powers/capacities and laws. Properties are identified by the larger network of nomic connections into which they enter. Accordingly, this theory of property identity is also supported by considerations about what is the more complete and comprehensive theory of mind as well the similarity between causation and realization with respect to matters of metaphysical production, as discussed in section 3. I like to think this proposal represents the kind of holism about properties that Quine would have accepted, had he accepted properties.

But do I think Shoemaker's causal theory of properties is false?⁴¹ Shoemaker in effect proposes that no two properties can endow their instances with exactly the same causal powers. I am in effect proposing that no two properties can endow their instances with exactly the same causal powers and realization capacities. If I do not think Shoemaker's principle is false, why offer the stated expansion on causal powers? My answer is that, if the properties are understood

aright, Shoemaker's principle is true but not the whole truth. Stated purely in terms of intra-level causal relations, it represents an incomplete description of the true facts about causal powers.

The complete story represented by (T) is already implicit in some of Shoemaker's remarks. For example, when illustrating the conditional power of a knife to cut wood, Shoemaker spoke about its being "made of steel." He said:

A knife-shaped object has the power of cutting wood conditionally upon being knife-sized and made of steel; for it is true of knife-shaped things, but not of things in general, that if they are knife-sized and made of steel they will have the power to cut wood. ⁴²

But being made of steel is a *compositional* matter, which is to say, the downward-looking dimension of a realization role. So the knife's causal powers are also conditional upon the right kind of engineering (play knives made out of paper or soft plastic cannot cut wood). They are *multi-level conditional powers*. This view also makes perfect sense when one remembers how, as Cummins put it: "property theories and transition theories fit together in an important way when target properties are dispositional." ⁴³ With a causal disposition, there is a precipitating event causing a manifestation, which is a causal-state transition. But that causal disposition also decomposes into the level of physical mechanisms. The mechanisms thus *ground* the causal capacity, which is why a real cutting knife's causal powers are conditional upon the appropriate range of physical compositions and their mode of organization. Moreover, the causal powers and realization capacities work in tandem. A real cutting knife cannot cut wood without the application of an outside force, such as the movement of a hand. Causal dispositions need a precipitating event. Put in nomic terms, multi-level conditional powers means multi-level laws: if an object possesses a suitable physical or engineering type of underput, and it receives a suitable type of causal input, then it must possess the realized property and all that follows.

So I think a theory based upon causal powers and realization capacities gives the complete picture of property identity. The world is a fabric of intra-level and inter-level relations, and I believe this fact should be reflected in the philosopher's theories of the world.

ACKNOWLEDGEMENTS

I have received a number of helpful comments on an earlier draft of this paper. I especially want to thank David Austin, John Bickle, John Carroll, Randy Carter, Robert Cummins, Eric Funkhouser, Jaegwon Kim, Brian McLaughlin, Michael Pendlebury, and John Post. I also want to thank those at the 2008 Central Division Meeting of the APA who heard and commented on a shorter version of this paper, especially Carl Gillett, Andrew Melnyk, Gualtiero Piccinini, and Robert Wilson. Any faults that remain are entirely my own.

NOTES

¹ Regarding presentation, some use first-order logic with mixed quantification where variables range over both individuals and their properties (Block, 1980, pp.174-176), while others use second-order logic with individual variables for objects and predicate variables for properties (Shoemaker, 1982). I choose the latter. For those unfamiliar with the method, one generates the existentially quantified Ramsey sentence ' $\exists F_1 \dots \exists F_n [T(I_1 \dots I_n, F_1 \dots F_n, O_1 \dots O_n)]$ ' from the stated Ramsey postulate by replacing all mental terms with existential quantifiers and property variables. One then constructs a set of predicates for each property variable in the Ramsey sentence, such as ' $\exists F_1 \dots \exists F_n [T(I_1 \dots I_n, F_1 \dots F_n, O_1 \dots O_n) \text{ and } x \text{ has } F_i]$.' Each predicate expresses the possession of a specific property, here the property associated with the i th term in the theory T (' M_i ' in the Ramsey postulate and ' F_i ' in the Ramsey sentence). One then defines mental properties accordingly. Second-order functionalists typically use property abstraction. Following Block, where ' $\lambda x Fx$ ' means 'the property of being an x such that x is F ,' the resulting definition would be: ' $x \text{ has } M_i = \lambda x \exists F_1 \dots \exists F_n [T(I_1 \dots I_n, F_1 \dots F_n, O_1 \dots O_n) \text{ and } x \text{ has } F_i]$.' See Block (1980, pp.174-179) and Horgan (1984). So second-order mental properties are certain properties of individuals defined by property abstraction over the physical properties that meet the condition of occupying the roles described in T . For discussion of various technical problems associated with the Ramsey method, see Field (1978, p.91 and fn. 23), Horgan (1984, pp.326-327), and David (1997, pp.144-146).

² Putnam (1967, p.434); Lewis (1972, p.212); Block (1978, p.272), and Shoemaker (1982, 93). Parenthetically, in saying that second-order functionalists are nonreductive physicalists, I exclude certain nonstandard interpretations of the second-order language. For example, Kim

employs the language of second-order functionalism coupled with a deflationary interpretation whereby “the property of having property *P*” picks out the same property as “the property *P*” (1998, p.99). Thus he is a nominal second-order functionalist but a metaphysical first-order functionalist.

³ Edward Tolman (1948) and Noam Chomsky (1965). Chomsky is now interested in a larger picture of language that incorporates data collected from the relevant areas of neuroscience and animal cognition. See Mark Hauser, Noam Chomsky, and Tecumsch Fitch (2002).

⁴ Block (1995, pp.385-386).

⁵ Gillett (2002, pp. 317-318). I present the theories of flat and dimensioned realization in terms of properties, which fits nicely with the idea of multiple realization. Gillett presents the flat and dimensioned theories in terms of property *instances*, which others find problematic. See Polger and Shapiro (2008).

⁶ Gillett (2003, p. 593).

⁷ See Kim (1998, pp. 82-86).

⁸ This is a substantive assumption, and I thank John Bickle for reminding me to acknowledge it. Nonreductionist positions that are based upon standard Putnam-Fodor style considerations about multiple realizability have been the focus of lively criticism. See Bechtel and Mundale (1999), Bickle (2003), Shapiro (2004), and Polger (2004). For considerations that multiple realizability can be sustained, though shorn of the traditional assumptions about abstract cognitive theory and top-only methodology, see Keeley (2000), Gillett (2003), Van Eck, Looren de Jong, and Schouten (2006), and Aizawa (2007, and forthcoming).

⁹ For some basic ideas about multiple realization, see Endicott (2005).

¹⁰ A classic example is Raymond Cattell’s multivariate theory of sixteen primary traits, which other researchers then grouped under five higher-level traits. See Cattell (1957), Cattell, et. al. (1970), and Norman (1963). So there are three explicit levels of ontology in this approach to personality theory -- a “personality” that decomposes into “five global traits” that themselves decompose into “sixteen primary traits.” Of course these in turn must be realized by still lower-level mechanisms.

¹¹ For the standard sufficient conditions view, see Lepore and Loewer (1989, p.179); Kim (1996, p.133). For the INUS conditions view, see Endicott (1994, pp.68-69). Specifically, my

suggestion is that realizing properties that occur within laws like ' $P_1 \Rightarrow M_1$ ' must include an additional realization-base condition P_2 such that a difference in P_2 allows P_1 to determine some other property M_2 but not M_1 (the converse of multiple realizability). Let this be represented by the realization law " $(P_1 \ \& \ P_2) \Rightarrow M_1$." If M_1 is multiply realized by properties other than the joint pair P_1 and P_2 , then the pair is not necessary, meaning that P_1 is an INUS condition -- an insufficient but necessary part of an unnecessary but sufficient condition.

¹² See Horgan (1993) and Wilson (2001).

¹³ Mellor (1991, p.112).

¹⁴ Cummins (1983).

¹⁵ Applying the Ramsified functionalist scheme, the corresponding Ramsey predicate for Total T is: (N) ' x has M_i , = the F_i such that $\exists F_1 \dots \exists F_n [T(P_1 \dots P_n, I_1 \dots I_n, F_1 \dots F_n, O_1 \dots O_n, V_1 \dots V_n)$ and x has $F_i]$.' As I go on to explain in the text, this is not a second-order position about the mental property. The right-hand side does *not* mean the (second-order) property of having the condition that is specified by the entire Ramsey formula. Accordingly, a "first-order" property in this context does not mean a *physical* property, only a property that is not defined over other properties by the method of property abstraction (see fn. 1). As well, "order" does not mean "level," as discussed previously (section 1). On the view sketched here, a mental property remains higher-level *vis-à-vis* the properties of the physical sciences but first-order in the sense that it is not defined over other properties by the method of property abstraction.

¹⁶ Bealer (1997, pp.75-7, fn.8), with a slight change in the terms. Bealer continues by saying that "the way around these problems is, presumably, to confine T to a description of the *characteristic interaction* of the standard mental properties with one another and macroscopic physical properties (loc. cit), meaning, in present terminology, that functionalists who assign first-order physical properties to the property variables that replace mental terms can avoid contradiction by employing the more restricted Causal T , since it omits the distinct inter-level realization roles whose inclusion would conflict with physical occupation.

¹⁷ Milner and Goodale (2006). In the Epilogue to this second edition, Milner and Goodale discuss various developments in neuroscience that have occurred in the intervening years, most notably the use of fMRI on human subjects, which further confirm their hypothesis about ventral and dorsal streams underlying the perception and action systems. See also Jacob (2005).

¹⁸ See Zecki (1993) and Prinz (2005). Two points of clarification are in order. First, Prinz follows Jackendorff (1987) and many others in viewing the perceptual system in terms of an organized hierarchy, where different subsystems represent perceptual features at different levels of abstraction. This begins with very fine-grained and specific visual features (like points in a primal sketch) and ends with very course-grained abstract representations that are invariant across perceptual vantage points (like the 3D outline of a body), with the intermediate-level subsystems located in the middle with representations of the kind one is consciously aware with details that are vantage point specific rather than invariant (2005, p.382). So in this context “levels” refers to a perceptual level of abstraction in visual processing, not a metaphysical level of properties. Second, although Prinz presents his theory of consciousness as a functional theory (*ibid.*, p. 390), he grounds intermediate-level processing in areas V2-V5 (*ibid.*, p. 384), and working memory in the frontal and temporal cortexes (*ibid.*, p. 388). His theory is thus inter-level by addressing both ‘what’ and ‘where’ questions about consciousness.

¹⁹ The role of realizing mechanisms is also indirectly implied by niche-dependent cognition, as described in Clark (1997, pp. 23-25). See also Varela, Thompson, and Rosche (1991).

²⁰ Gillett (2002, p. 322; 2003, pp. 598-599).

²¹ Cummins (1983, p.15).

²² Fodor (1968) and Cummins (1975).

²³ See Kim (1998, 84-86).

²⁴ Smart (1959, p.160) and Lewis (1972, p.212).

²⁵ See Gopnik and Metzloff (1997) and the discussion by Margolis and Lawrence (1999).

²⁶ I thank Eric Funkhouser for requesting clarification about the use of theories in this context. My argument in the text that generalizes from causal roles to realization roles is also meant to address why a theory that expresses a mental property’s total nomic role should be taken to reveal the nature of the properties in question.

²⁷ Among philosophers, Andy Clark (1997, 2001) provides a clear expression of the more liberal, ecumenical spirit I have in mind. Owen Flanagan (1992) also defends a form of liberalism with his “natural method” wherein the deliverances of phenomenology, cognitive psychology, and neuroscience are brought into reflective equilibrium. Patricia Churchland gives a nice summary

of the broader methodologies: “top-down strategies (as characteristic of philosophy, cognitive psychology, and artificial intelligence research) and bottom-up strategies (as characteristic of the neurosciences) for solving the mysteries of mind-brain function should not be pursued in icy isolation from one another. What is envisaged instead is a rich interanimation between the two, which can be expected to provoke a fruitful co-evolution of theories, models, and methods, where each informs, corrects, and inspires the other” (1986, p.3). But Churchland’s view illustrates that not all methodological liberals accept nonreductionism. She believes that if a higher-level theory is not eliminated, it will eventually co-evolve with a lower-level theory until the two reach “reductive consummation” (ibid., p.264). Yet compare Robert McCauley (1996), who argues that the co-evolution of inter-level theories may result in a stable equilibrium. See also Endicott (2007, p.165), who adds that the process of theoretical co-evolution may only converge to the point of token identities, which allows for partial reduction and mechanistic explanation.

²⁸ My remarks are compatible with the extended mind hypothesis (Clark and Chalmers, 1998). For example, a calculator may count as an item of direct mental production by virtue of its feedback and control activities that allow it to be coupled with the brain as part of the larger brain+calculator system.

²⁹ I do not think my generalization argument is affected if one rejects the idea that causation implies determination and covering laws. For example, those who favor statistical versions of causation reject the aspect of determination. But the move to statistical laws can be made for a theory of realization as well. So I can still argue that insofar as coverage by statistical laws makes ‘causes’ a significant item for inclusion in a theory of mind-defining essence, the same point can be made about ‘realizations.’ In any case, for views that realization implies determination *via* covering laws, see Kim (1981/1993, p. 180; 1996, p.133), Lepore and Loewer (1989, p.179), and Tye (1995, p.41). Parenthetically, this metaphysical tradition contrasts with logical and mathematical traditions of realization, where the idea of lawful determination is absent. See Endicott (2005).

³⁰ I thank Brian McLaughlin for raising this issue in correspondence.

³¹ See Endicott (2005).

³² See Levine (1993) and Chalmers (1996).

³³ Elsewhere I plan to describe in much more detail how a dimensioned theory of realization complements a flat functionalist theory of roles and occupants.

³⁴ Feigenson, Dehaene, and Spelke (2004).

³⁵ See Lewis (1969) and Kim (1972, 1992). Others replied by arguing that a species-specific reduction will miss important psychological generalizations, and I argued that postulating more narrow individual-time-relative mental properties makes the reductive proposal indistinguishable from a token identity thesis. See Endicott (1993, p.315).

³⁶ For the much cited case of compensatory plasticity from neural damage or experimental intervention, see Rauschecker (1995), Von Melchner, Pallas, and Sur (2000) and Sur (2001). For experience-dependent plasticity where the brain acquires different neural wiring through learning and environment, see King (1999). For the development of artificial neural implants, see Berger and Glanzman (2005). For an interesting counter to multiple realizability arguments based upon these considerations, see Shapiro (2004). Thus, concerning Sur's cross-modal experiments that result in auditory areas acquiring visual functions, Shapiro argues that the before and after cases count as the same kind of physical realization because there is no difference concerning the causal mechanisms by which those neural processing areas perform the visual function, and similarly for cases of neuron-to-chip replacement (2004, 56-65). But Shapiro has stated in conversation that he no longer finds the argument convincing, since it turns on metaphysical disagreements over how fine-grained or course-grained the appropriate description of the causal mechanisms should be. For the continued debate over multiple realizability, see the references in footnote 8.

³⁷ Fodor (1974/1981) and Block (1997).

³⁸ Shoemaker (1980).

³⁹ Shoemaker (1998).

⁴⁰ In correspondence, Robert Cummins suggested a nice way to put the point about parity, which I relay near verbatim. If we ask what intellectual role property identity plays, the answer often involves considerations that one can get the same effect by substituting one mechanism for another, a whosis for a widget, where 'effect' means something like a robust regularity, as in the Stroop Effect, or the photoelectric effect. Effects are thus dispositional properties subject to a dimensioned property analysis. So it seems right to say that E cannot be the same effect as E^* if

there is a way of *realizing E* that is not a way of *realizing E**. But this seems as compelling as the idea that *P* and *P** must be different if there is a way of *causing x* to have *P* but not *P**.

⁴¹ I thank Brian McLaughlin for raising this question in correspondence.

⁴² Shoemaker (1980/1984, p. 213).

⁴³ Cummins (1983, p. 21).

BIBLIOGRAPHY

- Aizawa, K. 2007: "The Biochemistry of Memory Consolidation: Model Systems for the Philosophy of Mind," *Synthese* 155: 65-98.
- ____ forthcoming: "Neuroscience and Multiple Realization: A Reply to Bechtel and Mundale," *Synthese*.
- Bealer, G. (2007). "Self-Consciousness," *Philosophical Review* 106: 69-117.
- Bechtel W. and Mundale, J. 1999: "Multiple Realizability Revisited" *Philosophy of Science* 66: 175-207.
- Berger, T. and Glanzman, D. 2005: *Toward Replacement Parts for the Brain: Implantable Biomimetic Electronics as Neural Prostheses*. Cambridge MA: MIT Press.
- Bickle, J. 2003: *Philosophy and Neuroscience: A Ruthlessly Reductive Account*. Dordrecht, The Netherlands: Kluwer Academic Publishing.
- Block, N. 1978: "Troubles with Functionalism," rpt. in N. Block, ed., *Readings in Philosophy of Psychology* vol. 1. Cambridge MA: Harvard University Press, 1980, 268-305.
- ____ 1980: "What is Functionalism?," *Readings in Philosophy of Psychology*, 171-84.
- ____ 1995: "The Mind as the Software of the Brain," in Edward Smith and Daniel Osherson, eds., *An Invitation to Cognitive Science: Thinking*, vol. 3. Cambridge MA: MIT Press, 377-425.
- ____ 1997: "Anti-Reductionism Slaps Back," *Philosophical Perspectives* 11: 107-132.
- Cattell, R. 1957: *Personality and Motivation Structure and Measurement*. NY: World Book.
- Cattell, R., Eber, H., Tatsuoka, M. 1970: *Handbook for the Sixteen Personality Factor Questionnaire*. Champaign, IL: Institute for Personality and Ability Testing.
- Chalmers, D. 1996: *The Conscious Mind*. New York: Oxford University Press.
- Chomsky, N. 1965: *Aspects of a Theory of Syntax*. Cambridge MA: MIT Press.

- Churchland, P.S. 1986: *Neurophilosophy: Toward a Unified Science of the Mind/Brain*.
Cambridge MA: MIT Press.
- Clark, A. 1997: *Being There: Putting Brain, Body and World Together Again*.
Cambridge MA: MIT Press.
- ____ 2001: *Mindware: An Introduction to the Philosophy of Cognitive Science*. NY: Oxford
University Press.
- Clark, A. and Chalmers, D. 1998: "The Extended Mind," *Analysis* 58: 7-19.
- Cummins, R. 1975: "Functional Analysis," *Journal of Philosophy* 47: 741-65.
- ____ 1983: *The Nature of Psychological Explanation*. Cambridge MA: MIT Press.
- David, M. 1997: "Kim's Functionalism," in J. Tomberlin, ed., *Philosophical Perspectives* 11,
133-48.
- Endicott, R. 1993: "Species-Specific Properties and More Narrow Reductive Strategies,"
Erkenntnis 38: 303-21.
- ____ 1994: "Constructive Plasticity," *Philosophical Studies* 74: 51-75.
- ____ 2005: "Multiple Realizability," in D. Borchert, ed., *The Encyclopedia of Philosophy*,
vol.6, 2nd Edition. US: Thomson Gale, Macmillan Reference, 427-432.
- ____ 2007: "Reinforcing the Three 'R's: Reduction, Reception, and Replacement," in M.
Schouten and H. Looren de Jong, eds., *The Matter of the Mind: Philosophical Essays on
Psychology, Neuroscience, and Reduction*. UK: Blackwell, 146-171.
- Feigenson, L., Dehaene, S., and Spelke, E. 2004: "Core Systems of Number," *Trends in
Cognitive Sciences* 8: 307-314.
- Field, H., 1978: "Mental Representation," rpt in N. Block, ed., *Readings in Philosophy
of Psychology* vol. 2. Cambridge MA: Harvard University Press, 1981, 78-114.
- Flanagan, O. 1992: *Consciousness Reconsidered*. Cambridge MA: MIT Press.
- Fodor, J. 1968: "The Appeal to Tacit Knowledge in Psychological Explanation," *Journal of
Philosophy* 65: 627-40.
- ____ 1974: "Special Sciences," rpt. in *Representations: Philosophical Essays on the
Foundations of Cognitive Science*. Cambridge MA: MIT Press, 1981, 127-45.
- Gillett, C. 2002: "The Dimensions of Realization: A Critique of the Standard View," *Analysis*
62: 316-22.
- ____ 2003: "The Metaphysics of Realization, Multiple Realizability, and the Special Sciences,"

- Journal of Philosophy* 103: 591-603.
- Gopnik, A. and Meltzoff, A. 1997: *Words, Thoughts, and Theories*. Cambridge MA: MIT Press.
- Hauser, M. Chomsky, N., and Fitch, T. 2002: "The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?," *Science* 298: 1569-1579.
- Horgan, T. 1984: "Functionalism and Token Physicalism," *Synthese* 59: 321-38.
- ____ 1993: "From Supervenience to Superdupervenience: Meeting the Demands of a Material World," *Mind* 102: 555-86.
- Jackendorff, R. 1987: *Consciousness and the Computational Mind*. Cambridge MA: MIT Press.
- Jacob, P. 2005: "Grasping and Perceiving Objects," in A. Brook and K. Adkins, eds., *Cognition and the Brain: Philosophy and Neuroscience Movement*. Cambridge: Cambridge University Press, 241-283.
- Keeley, B. 2000: "Shocking Lessons from Electric Fish: The Theory and Practice of Multiple Realization," *Philosophy of Science* 67: 444-465.
- King, A. "Sensory Experience and the Formation of a Computational Map of Auditory Space in the Brain." *BioEssays* 21 (1999): 900-911.
- Kim, J. 1972: "Phenomenal Properties, Psychophysical Laws, and the Identity Theory," *Monist* 56: 177-192.
- ____ 1981: "Psychophysical Supervenience," rpt. in *Supervenience and Mind: Philosophical Essays*. London: Cambridge University Press, 1993, 175-93.
- ____ 1992: "Multiple Realization and the Metaphysics of Reduction," rpt. in *Supervenience and Mind*, 309-35.
- ____ 1996: *Philosophy of Mind*. Boulder, CO: Westview Press.
- ____ 1998: *Mind in a Physical World*. Cambridge MA: MIT Press.
- Lepore, E. and Loewer, B. 1989: "More on Making Mind Matter," *Philosophical Topics* 17: 175-91
- Levine, J. 1993: "On Leaving Out What It's Like," in Davies, M. and Humphreys, G., eds., *Consciousness: Psychological and Philosophical Essays*, Oxford: Blackwell, 121 - 136.
- Lewis, D. 1969: "Review of *Art, Mind, and Religion*," *Journal of Philosophy* 66: 23-35.
- ____ 1972: "Psychophysical and Theoretical Identifications," rpt. in *Readings in Philosophy of Psychology* 1, 207-15.
- Margolis, E. and Laurence, S. 1999: "Concepts and Cognitive Science," in E. Margolis and S.

- Laurence, eds., *Concepts: Core Readings*. Cambridge MA: MIT Press, 3-81.
- McCauley, R. 1996: "Explanatory Pluralism and the Co-Evolution of Theories in Science," in McCauley, ed., *The Churchlands and Their Critics*. London: Blackwell Publishers, 17-47.
- Mellor, D. 1991: "Properties and Predicates," rpt. in J. Bacon, K. Campbell, L. Reinhardt, eds., *Ontology, Causality and Mind: Essays in Honor of D. M. Armstrong*. NY: Cambridge University Press, 1993, 101-13.
- Milner, D. and Goodale, M. 2006: *The Visual Brain in Action*, 2nd edition. Oxford: Oxford University Press.
- Norman, W. 1963: "Toward an Adequate Taxonomy of Personality Attributes: Replicated Factor Structure in Peer Nomination Personality Ratings," *Journal of Abnormal and Social Psychology* 66: 574-583.
- Polger, T. and Shapiro, L. 2008: "Comments and Criticism: Understanding the Dimensions of Realization," *Journal of Philosophy* 105 (2008): 213-222.
- Prinz, J. 2005: "A Neurofunctional Theory of Consciousness," in *Cognition and the Brain: Philosophy and Neuroscience Movement*, 381-396.
- Putnam, H. 1967: "The Nature of Mental States," rpt. in *Mind, Language and Reality: Philosophical Papers*, vol. 2. London: Cambridge University Press, 1975, 429-40.
- Rauschecker, J. "Compensatory Plasticity and Sensory Substitution in the Cerebral Cortex." *Trends in Neurosciences* 18 (1995): 36-43.
- Shapiro, L. 2004: *The Mind Incarnate*. Cambridge MA: MIT Press.
- Shoemaker, S. 1980: "Causality and Properties," rpt. in *Identity, Cause, and Mind*, Cambridge: Cambridge University Press, 1984, 206-233.
- ____ 1982: "Some Varieties of Functionalism," rpt. in *Identity, Cause, and Mind*, 93-119.
- ____ 1998: "Causal and Metaphysical Necessity," *Pacific Philosophical Quarterly* 79: 59-77.
- Smart, J. 1959: "Sensations and Brain Processes," *Philosophical Review* 68: 141-156.
- Sur, M. 2001: "Cortical Development: Transplantation and Rewiring Studies," *International Encyclopedia of the Social and Behavioral Sciences* 4: 2837-2842.
- Tolman, E. 1948: "Cognitive Maps in Rats and Men," *Psychological Review* 55: 189-208.
- Tye, M. 1995: *Ten Problems of Consciousness: A Representational Theory of the Phenomenal Mind*. Cambridge MA: MIT Press.

- Van Eck, D., Looren de Jong, H., Schouten, M. 2006: "Evaluating New Wave Reductionism: the Case of Vision," *British Journal for the Philosophy of Science* 57: 167-196.
- Varela, F., Thompson, E., and Rosche, E. 1991: *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge MA: MIT Press.
- Von Melchner, L., Pallas, S. and Sur, M. 2000: "Visual Behavior Mediated by Retinal Projections Directed to the Auditory Pathway," *Nature* 404: 871-876.
- Wilson, R. 2001: "Two Views of Realization," *Philosophical Studies* 104: 1-31.
- Zecki, S. 1993: *A Vision of the Brain*. Oxford: Blackwell Publishing.