The Shape of a Total Theory's Base: Categorial Foreclosures and What They Force

Jeff Wozniak
Independent Researcher ORCID: 0009-0002-3436-6863

August 3, 2026

Abstract

What must a theory's fundamental categories be like if it is to account for everything, its own theorists included? A recent paper derives the domains such a theory must address (Wozniak, 2026). This paper asks what base could address them all, and answers by elimination. It first sharpens what accounting for a domain requires: the phenomenon must follow from primitives the base already needs elsewhere, and an axiom asserting the link does not count, however it is labeled. Against that standard three familiar arguments turn eliminative. Newman's theorem and Putnam's permutation argument rule out bases of pure structure, whose content collapses into a claim about cardinality. The explanatory gap rules out bases of third-person facts. The gap run in reverse rules out bases of experience alone, though weakly, since experience already carries rich structure. Each result closes a route without refuting a view; denial and category change stay open. A narrow specification survives: a base whose general primitives carry an intrinsic aspect alongside a relational one, whose reference is fixed from inside, whose dynamics apply to the theorist who states them, and which has a well-defined formal object beneath it. The specification converges on Russellian monism from an unfamiliar direction, the demands of totality rather than the mind–body problem, and hands that position burdens rather than support, chief among them the individuation of whatever carries the intrinsic aspect. Whitehead and Spinoza sit in the surviving region; neither built the formal object. The paper certifies no candidate and proposes none.

Keywords: total theory; categorial ontology; explanatory gap; structural realism; Russellian monism; process philosophy

1 The question a target specification leaves open

A total theory quantifies over everything and places no explanandum outside its own scope, including the theorists who hold it. A recent specification—the necessary-conditions net—makes that demand precise and derives its consequences (Wozniak, 2026). A theory answers to coherence, that it hangs together as a system, and to completeness, that it addresses every domain its own scope entails; seating the theorist inside the described world forces most of those domains, and an independent-variation test sorts them into structural slots required of any total theory and world-contingent fillers required only of a theory of our world. The structural slots are eight: arena, modality, matter as a habitability-constrained slot, dynamics, records and temporal asymmetry, definiteness, interiority, and agency. A theory silent on any of them has abandoned the claim to totality.

The net is a target specification. It says what would count as a coherent, complete total account without asserting that anything has hit the mark, and that restraint keeps it compatible with monism, pluralism, and the possibility that reality is not neatly totalizable. Read against the current

field, the net is diagnostic rather than decisive. The literature offers physics-first programs that illuminate matter and spacetime and go dark on the interior, and mind-first programs that target the interior and say little about matter or the arrow; no worked account seats its theorist, speaks to the inside, anchors its content, and covers the span under one uniform rule. That combination, with a well-defined formal base beneath it, is a definite position the net specifies; the field leaves it empty.

This paper asks the next question. The net certifies no survivor, but it constrains the kind of thing a survivor would have to be, and the constraint can be extracted from the net's own discharge taxonomy. Every structural slot forces a position, and a position is weaker than a substantive posit; the net admits three ways of discharging a slot. A theory may discharge a slot *by account*, placing the phenomenon in its ontology and deriving it from the base. It may discharge a slot *by specifying arising conditions*, giving the conditions under which the domain's phenomena appear. Or it may discharge a slot *by principled denial or dissolution*, arguing that the domain's apparent demand is ill-posed. Modality falls to a Humean denial of irreducible modality as readily as to a realist modal structure; interiority yields to an eliminative argument no less than to an account of the inside. The three routes are equally legitimate at the net's bar.

The first two routes form one family: both place the phenomenon in the world and derive or condition it instead of arguing it away. Call a base that takes this positive route on every structural slot a *by-account satisfier*. Denial is a real option the net honors, and a theory that denies its way through several slots is not thereby defective. The by-account satisfier is one kind of total theory among the kinds the net permits, singled out here because it is the demanding one: it owes a derivation everywhere it might instead have owed an argument for silence. The question of this paper is what a by-account satisfier would have to look like. The answer divides into a negative half, which categories of base foreclose the by-account route for some slot, and a positive half, what features a base that forecloses none must have. The shape the positive half derives converges with a position the mind–body literature reached from its own direction—Russellian monism—and Section 4 records the convergence and what falls outside it. Both halves stay on the near side of the gap Stroud identified for transcendental arguments: the claims concern what an *account* must be, never what reality instantiates (Stroud, 1968).

2 Discharge by account, sharpened

The by-account route needs a sharper definition than the net supplies, and supplying one is the first contribution of this paper. The net is permissive about how a slot gets discharged. Its primitive-honesty condition asks only that whatever the theory uses but cannot derive be declared a primitive, and its penalties fall on the smuggled posit rather than the declared one: a declared primitive can be counted, compared across theories, and challenged, and the net prefers it to a hidden one on exactly those grounds (Wozniak, 2026). A bridge or identity that is declared and fully specified therefore passes as the net is written. So on the net's own text a specified psychophysical identity, a fully declared bridging law, and a duly declared low-entropy boundary condition each count as legitimate discharges. Under that reading no category forecloses anything beyond the anchoring failure of pure structure, because any slot can be closed by declaring a primitive tailored to it.

A sharper criterion is needed:

> A slot is discharged *by account* when the phenomenon arises from the base's *general* primitives plus its dynamics. A primitive is general when it belongs to the specification of the base's own units and their law, stated in the base's vocabulary over the base's state space; a primitive that bridges that vocabulary to an independently specified domain of

> facts is tailored to what it delivers, and a discharge that runs through such a bridge—even a declared one—is not by account.

This criterion strengthens the net; it is not read off the net's text. The net penalizes the smuggled posit; the criterion extends the penalty to the declared bridge, and the extension preserves the net's rationale. A declared identity between a physical state and a phenomenal one adds to the theory a primitive axiom in a vocabulary the base does not define, and the phenomenon it delivers enters the theory through that axiom rather than from the base; its failure is one of derivational opacity rather than absence of definition. An ordinary scientific identity is untouched: that water is H_2O connects two descriptions inside one vocabulary, and its derivation runs through general chemistry and ordinary reference-fixing, so no bridging primitive appears. The phrase *independently specified* carries no separate weight. A domain is independent of a base when the base's vocabulary cannot state its facts (Sider, 2011). Discharging such a domain therefore takes a new predicate, and the axiom that introduces the predicate is the bridge. Extending the net's unearned-stipulation intent from the undefined case to the bridging case is defensible, and it is a sharpening rather than a theorem. The criterion also collapses the net's two positive routes—account and arising-conditions—into a single standard, which is what licenses the single name *by-account satisfier* for a base that takes either positive route on every slot.

The criterion does not bar a legitimate general base, and the arena slot shows why. A theory discharges the arena slot by declaring what kind of thing its base is, and a declared base looks, on a careless reading, like a primitive the criterion would forbid. It is not. The base is the specification the criterion protects: the units, their law, and their vocabulary come before any slot, and they are indifferent to which slot is in view. A tailored primitive bridges out of that specification to reach a slot the base could not reach on its own—an identity added only for interiority, a condition added only for the arrow. Declaring the general base therefore discharges the arena slot and violates nothing, because base-declaring is specification rather than bridging. A base whose units bear an intrinsic aspect discharges interiority the same way: the aspect belongs to the declared specification of the units, so nothing bridges out of the base's vocabulary to reach the interior. Section 4 returns to this case and to the further work the aspect does.

A declared boundary condition is the harder case, and the vocabulary test sorts it. The net files an arrow mechanism—a Past-Hypothesis low-entropy boundary condition—as a legitimate world-contingent filler of the records-and-asymmetry slot, and treats such a condition as a matter of coherence rather than a completeness failure (Wozniak, 2026; Albert, 2000). On its face the condition looks slot-tailored, since it is adopted with the arrow in view, and its standing as a posit is itself contested (Earman, 2006). Under the criterion it is nonetheless general in form. It selects a macrostate in a state space the base's dynamics already define, in the vocabulary the base already speaks, and it adds no predicate the base lacks. Its full statement brings a coarse-graining and a probability measure with it, and both live on the base's own state space: the macrostates partition that space, and the measure is the one its geometry supplies. The dynamics yield thermodynamics whatever initial macrostate obtains, the condition picks among values already admitted, and the arrow is one downstream consequence of that selection. The contrast with a bridging axiom is exact: the boundary condition constrains the base's own variables, while a psychophysical identity writes the phenomenal into the theory, a vocabulary no third-person base defines. On this test a declared low-entropy boundary condition discharges the arrow slot by an account the net already accepts, whatever the further debate about its physical motivation.

Everything downstream is conditional on this criterion. An opponent may hold that a declared bridging axiom is a genuine account—that a specified psychophysical identity or a fully declared bridging law discharges its slot. Against that opponent, every foreclosure in Section 3 and every

design constraint in Section 4 that leans on the criterion drops from its stated strength to defeasible. The criterion is the single most load-bearing move in the paper. The results below are stated at the strength the criterion earns them, with the dependency marked where it bears weight.

3 Where a category forecloses the by-account route

A base's fundamental category can foreclose the by-account route for at least one structural slot. The claim narrows rather than silences: where the route is foreclosed, denial or a category exit remains, so the theory must discharge the slot some other way or become a theory of a different kind. "Category K cannot discharge slot S" is false for every K and S, because denial is almost always available; the defensible claim is that K's identity conditions close the by-account route for S, leaving the other routes open. The strengths run from theorem-grade down to a defeasible tendency, and each result is labeled at the strength it earns and no higher.

3.1 Pure structure cannot self-anchor

A base of pure structure—relations up to isomorphism, with no privileged natural relations and no intrinsically natured relata—cannot fix its own content, and the core of the result is a theorem. Newman's theorem states that for any domain of the required cardinality and any purely structural specification W, a system of relations instantiating W exists (Newman, 1928). So "reality has structure W," with W specified purely structurally, is satisfied by any set of the right size, and the theory's content collapses to a claim about how many things there are. The term-level analogue is Putnam's permutation argument: a predicate fixed only by structural role has a permutable extension with every theorem's truth-value preserved, so nothing in the theory fixes what the predicate picks out (Putnam, 1980, 1981). For a base whose predicates are defined by structural role, the permutation bites by construction. The one premise is that content is exhausted by structural content, which is exactly what pure structuralism asserts—the commitment descends from epistemic structural realism's restriction of theoretical knowledge to structure (Worrall, 1989)—and what ontic structural realists deny when they treat relations as concrete, physically instantiated primitives (Ladyman, 1998). The foreclosure targets pure structure, and the theorem forces a choice: exit the category, accept the collapse of content into cardinality, or restrict the structure quantified over. The reply literature that followed Newman's revival takes the exit in one form or another (Demopoulos and Friedman, 1985; Melia and Saatsi, 2006; Ainsworth, 2009; Ladyman and Ross, 2007), and working structural realism has mostly already made it by adding natural or concrete relations; the exit is a category change, and it is legitimate here because a theorem forces it.

3.2 A third-person base forecloses interiority by account

A base composed entirely of third-person facts—facts statable without reference to any subject's point of view, extrinsic and relational and quantitative—can discharge the interiority slot by denial or by a category exit, and not by account. The operative property is the absence of intrinsic phenomenal character; the extrinsic, relational, and quantitative marks are sufficient signs of that absence and fall short of defining it. A base of intrinsic-but-character-free quiddities is third-person in this operative sense, and Section 4 recovers the same foreclosure for it through the forward gap—the gap running from third-person facts to the phenomenal, as distinct from the reverse direction tested later in this section. The property is separate from the pure structure of the preceding foreclosure, which fails at anchoring, and from the extrinsic pole a world-side base possesses. The argument is a transfer of the explanatory gap. Suppose the base discharges interiority by account,

so the phenomenal facts arise from its general primitives plus dynamics with no interiority-tailored posit. The gap literature holds that no such derivation is available: a physical description conjoined with the denial of the phenomenal facts is coherently conceivable (Chalmers, 1996), a standing explanatory gap separates the two (Levine, 1983), and third-person facts leave a phenomenal fact knowably open (Nagel, 1974; Jackson, 1982). The general third-person base underdetermines the phenomenal facts, so the supposition fails, and the by-account route closes.

The standing objection is a-posteriori physicalism, which holds that the physical base entails the phenomenal facts through a specified psychophysical identity with no transparent derivation. That identity is declared, so the net as written admits it; the criterion excludes it, because it is a bridging axiom. It writes the phenomenal vocabulary into the theory by fiat, and the entire mental domain enters through the axiom rather than from the base—which is also why the boundary-condition case of Section 2 offers no rescue by parity, since a boundary condition fixes a value in the base's own state space while the identity conjoins that vocabulary with one the base does not define. The phenomenal-concepts strategy replies that the opacity lies in our concepts rather than in the world, so that the identity is no worse off than the identity of water with H_2O (Loar, 1990; Block and Stalnaker, 1999). The criterion prices this reply rather than refuting it: the chemical identity is derivable from general chemistry inside one vocabulary, the psychophysical identity is underivable in principle on the gap premise, and an opponent who rejects the gap premise or the criterion's extension exits the antecedent rather than defeating the conditional.

Two exits remain. An eliminativist about the interior discharges the slot by denial at the net's bar, and owes the eliminative argument instead of a derivation. Russellian physicalism holds that the physical base already includes unknown intrinsic natures (Stoljar, 2001), and the operative property sorts the view by what those natures are. Natures that bear phenomenal character mean the base was never third-person in the operative sense; the foreclosure's target category is vacated, and the base owes the both-poles obligations of Section 4 instead. Character-free quiddities leave the base inside the category. So scoped, and under the gap premise and the criterion together, the foreclosure holds: a base free of intrinsic phenomenal character cannot generally derive the phenomenal once bridging identities are barred. The conceivability citations corroborate the gap premise; the load rests on the premise itself. A worked, non-opaque derivation of phenomenal structure from third-person structure would lift the foreclosure.

A tempting rescue fails. The net's reflexive-closure condition requires the theorist to be seated inside the world as a physical subsystem, and one might think a base that seats the theorist has thereby placed its interior. It has not. Placing the theorist as an object—the "you are here" locus that refers to a location partly by occupying it (Ismael, 2007)—is orthogonal to placing it as a subject with an inside, because self-locating facts are themselves third-person representable. Seating the theorist and accounting for the interior come apart, so a base can do the first cleanly and still foreclose the by-account route to the second.

3.3 A third-person process inherits the same foreclosure

A base of third-person states plus transition rules forecloses interiority by account exactly as a static third-person base does. A transition rule maps third-person states to third-person states, and specifying it needs only third-person vocabulary, so a dynamical third-person base adds temporal ordering without adding an intrinsic aspect. The premises of the previous foreclosure carry over. A process without an inside is as conceivable as a subject without one. The new resource—temporal ordering—is orthogonal to the intrinsic-versus-extrinsic distinction, so it cannot bridge that gap. Process buys the world-side slots that motion and settling require, and it buys nothing for the interior. One system in the current literature tests this boundary. Integrated information the-

ory identifies each experience with a maximally irreducible cause-effect structure over a substrate (Oizumi et al., 2014; Tononi et al., 2016), and it is no casual occupant of the third-person cell: the theory presents itself as running from phenomenological axioms to physical postulates, an intrinsic ontology rather than an extrinsic one, and it has built exactly the formal apparatus—a state space, a measure—that Section 4 will demand and the historical both-poles systems lack. The criterion prices the identity at its center: the theory fixes which cause-effect structure is identical to which experience and leaves open why any such structure is experienced at all, so the discharge runs through a bridging axiom, and it stands or falls with the criterion exactly as the physicalist identity does. Read as third-person process, integrated information theory inherits this section's foreclosure; read as an intrinsic ontology, it exits the category and owes instead the both-poles requirements of Section 4.

3.4 An experience-first base forecloses the determinate world, more weakly

A base of purely intrinsic or phenomenal facts forecloses the by-account route for the world-side slots, most sharply definiteness, and the result is the mirror of the third-person case at a lower strength. The argument runs the conceivability transfer in reverse: suppose a phenomenal base discharges definiteness by account, so the determinate structured world of alternatives arises from phenomenal primitives; a base with the same phenomenal character but no determinate public world of alternatives is offered as conceivable, prising the intrinsic and the structural apart in the reverse direction. The premise is contested, and more heavily than its mirror. Experience already instantiates rich structure—phenomenal similarity spaces, temporal succession, the specious present—so the reverse conceivability is far less secure than the forward one, and an idealist can offer the determinate public world as a constitution from the categorial and apperceptive structure any experiencing subject must impose, which is an account rather than a denial (Kant, 1998). The foreclosure therefore holds only as a defeasible tendency, and definiteness is the sub-case that retains the most strength: the constitution reply supplies a world of structured appearance, but the selection of one determinate outcome among admissible alternatives is exactly what categorial form does not fix. The measurement problem generalized beyond quantum mechanics is the sharp form of the slot at issue (Maudlin, 1995; Bell, 1990), and the standing escape is an experience-first base that reads enough structure off experiential form to discharge it. This weaker strength propagates: any downstream requirement that leans on the world-side foreclosure inherits its defeasibility.

3.5 An agent-first base tends toward a thin world

A base of information states, credences, or tasks tends to leave the world thin (Fuchs, 2016; Friston, 2010), and the tendency is the weakest result here—closer to a standing habit of the genre than a categorial necessity, and reported as such. The target is the monistic version, on which agent states are the whole base. Such states are individuated functionally, by inferential and decision role, and functional individuation does not fix physical realization: a credence does not entail what its bearer is made of, so a sole-agent base cannot derive its own material constitution and the habitability constraint the matter slot imposes. The world-side then stays functionally thin or turns overtly anti-realist. The residue is narrow because the restriction is a choice. "Agent states are fundamental" does not forbid declaring rich world-furniture as co-primitive, and a two-base agent-plus-world ontology escapes the thinness at the cost of no longer being agent-first. QBism in particular is better read as a principled denial of observer-independent furniture, a dissolution rather than a foreclosure at all (Fuchs, 2010); on the same ground it claims to dissolve the definiteness slot, and that claim is a denial-route discharge at the net's bar, owed its argument like any other. The result is graded as a

Base category	Route foreclosed	Form of the argument	Strength
Pure structure	self-anchoring (content)	Newman/Putnam theorem in a stated setting	theorem-in-setting (strongest)
Third-person substance/field	interiority by account	conceivability/gap transfer + the criterion	strong, conditional on the gap premise and the criterion
Third-person process	interiority by account	the above + dynamics-preserves-third-person	strong, inherits the row above
Experience-first	determinate world by account	inverse conceivability (contested)	defeasible; definiteness least-weak
Agent-first	rich world-content	functional underdetermination, sole-base restriction	defeasible tendency (weakest)

Table 1: Categorial foreclosures at their validated strengths. Each entry is a claim about a discharge *route* rather than about undischargeability: where the by-account route is foreclosed, denial or a category exit remains. Every row below the first is conditional on the by-account criterion of Section 2; against an opponent who admits declared bridging axioms as accounts, the strong rows drop to defeasible.

tendency, and no more is claimed for it.

Table 1 collects the five results at their strengths. Third-person bases foreclose the interior by account; a purely phenomenal base forecloses the determinate world by account, more weakly; pure structure cannot self-anchor. The strengths track how much of each argument is a theorem, how much a contested premise, and how much a genre habit.

4 The shape of a satisfier

The foreclosures constrain a base that discharges every slot by account. The register is fixed and held throughout this section: each claim is a conditional necessity about what an *account* must be, of the form *if a base discharges every structural slot by account and passes the coherence and anchoring conditions, then it has feature F*. None of it claims that reality instantiates F. A second discipline governs which conditional necessities get promoted: the promotion must be forced by the net rather than shaped toward a preferred answer. Features the net does not force are held to Section 5.

4.1 Both poles in the general primitives

A by-account satisfier's general base includes both an intrinsic and an extrinsic aspect. The derivation runs through the foreclosures together with three conditions of the net: honesty, self-inclusion, and anchoring. The anchoring condition says that a theory's terms must pick out definite referents, and that structural role alone cannot do the picking; Section 3 showed that any structure of the right size satisfies a purely structural description. Reference must therefore be fixed by something stronger, a natural relation in Lewis's joint-carving sense (Wozniak, 2026; Lewis, 1983). The interiority slot forces the intrinsic aspect: discharging interiority by account requires the base to contain or generally derive intrinsic facts, and a purely third-person base forecloses that route. The intrinsic aspect is not a bridge. The physicalist starts from a third-person vocabulary and adds an axiom to connect it to a phenomenal one; the both-poles base starts from a vocabulary in which

phenomenal character already figures. Nothing is added along the way, and declaring the base is the one move the criterion protects. The aspect also does further work: it supplies the categorical grounds that dispositional structure presupposes, and it supplies the relata for the anchoring relation derived below (Russell, 1927; Goff, 2017). That work corroborates the license without supplying it, since character-free quiddities could do both jobs and leave the interior unsettled. The world-side slots force the extrinsic aspect along two paths of unequal strength. The reverse gap makes the rich world-side structure a tendency only: the experience-first foreclosure is defeasible, an experience-first base that reads structure off experiential form remains the standing escape, and this path yields no necessity. The anchoring condition, by contrast, forces the existence of at least one genuine extrinsic relation outright. The reference requirement derived below fixes the theory's terms by a natural relation internal to the base; that relation reaches from the theorist's side to the world's side, so at least one extrinsic relation is present without waiting on the reverse gap. The extrinsic aspect is thus present on either path—its rich structure a defeasible tendency, its minimal presence a consequence of anchoring.

Granting both aspects present, the honesty condition bears on how the base holds them. A base with two correlated but separate populations, intrinsic items and extrinsic items, owes the correlation between them; a correlation entrusted to a primitive bridge between the two populations is not by account under the criterion, so a fully derived correlation requires a common base beneath both. The base therefore carries both poles in its general primitives. This requirement is the complement of the two strong foreclosures: a third-person base is foreclosed for lack of an intrinsic pole, a purely phenomenal base for lack of an extrinsic one, and a base that forecloses neither supplies what each of them lacks.

The shape thus far converges with a known position. A base whose intrinsic natures carry the world's extrinsic structure is Russellian monism (Russell, 1927; Alter and Nagasawa, 2015; Goff, 2017); the granularity fork of Section 5 is the choice its panpsychist and cosmopsychist readings dispute, and the individuation debts are their combination and decombination problems. The convergence is not mutual confirmation, because the routes are not independent: the foreclosures above run on the same gap arguments and the same structuralism of physics that motivate Russellian monism, and agreement between arguments that share their premises carries no added weight. The convergence marks a division of labor instead. The gap literature supplies the foreclosure. The totality frame supplies the demand, since a total theory must take a position on interiority, where the mind–body literature may treat it as one puzzle among others. The constraints past the shared middle come from the totality route alone: the extrinsic pole carried by genuine relations rather than coordinated parallelism, reference fixed by a natural relation internal to the base, dynamics that cover the theorist's own theorizing, and a well-defined formal object underneath. The traffic also runs toward the position rather than from it. The convergence hands Russellian monism burdens its defenders have not taken up—an internal reference-fixing relation and a formal object among them—and a position that meets them meets demands the mind–body problem never raised. Nothing here targeted the position, and nothing borrows support from it.

4.2 The extrinsic pole is carried by genuine relations

The anchoring condition constrains the form of the extrinsic pole and not only its presence: the pole must be carried by genuine, relatum-connecting relations, and coordinated parallelism does not qualify. A base whose extrinsic structure is bare parallelism—independently unfolding series with matching contents and no relation running between them—supplies nothing for reference or representation to consist in. Reference-fixing connects a term on the theorist's side to a referent on the world's side, and a matching of two independent series is a fact about the pair of series rather

than a relation from either to the other. On the structural-content reading the point inherits the Newman–Putnam collapse of Section 3: a coordination specified purely as a structural pattern is permutable, so it fixes no determinate referent (Newman, 1928; Putnam, 1980). On the intrinsic-content reading, where aboutness is carried by a brute quale, the exclusion rests instead on the anchoring condition's demand for a relation, and it holds at strong-conditional strength, short of a theorem. A windowless per-unit base falls on either reading: Leibniz's monadology coordinates windowless monads by a pre-established harmony that runs no relation between them, and so supplies nothing for reference to consist in (Leibniz, 1714). A base whose extrinsic pole is carried by real relations survives—Whitehead's prehension, in which a new event takes up prior events into its own constitution, and Spinoza's causal nexus of finite modes within an attribute (Whitehead, 1978; Spinoza, 1677).

This exclusion rests on the naturalness premise the anchoring condition already builds in: that reference is fixed by a natural, joint-carving relation—the Lewisian doctrine sometimes called reference magnetism—rather than by bare covariation. An opponent who takes reference to be pure covariation, a reliabilist about reference (Dretske, 1981), declines that premise, and for the parallelist the exclusion then inverts. Pre-established harmony delivers perfect, exceptionless covariation between a monad's states and the world, so on a covariational standard the windowless monad is an exemplary reference-fixer rather than a failed one. The genuine-relations requirement is therefore conditional: it holds on the naturalness premise and reverses under covariational reliabilism, and every result below that leans on it inherits that conditionality.

4.3 An individuation debt at some granularity

The base holds both poles, and the net further demands that it derive its own theorists. Reflexive closure seats the theorist who holds a total theory inside the world it describes, as a bounded, error-capable locus of representation that can be right or wrong about part of the world (Wozniak, 2026). The net forces one such locus; that the world as we find it contains *many* is an additional premise, adopted here as an observation rather than derived from the net, and everything downstream that trades on plurality inherits that status. The loci are individuated as representers, and a representer that is bounded is one that can misrepresent; whether each locus also has an interior of its own is left open here. A by-account satisfier of our plural world derives these plural bounded loci from its general primitives, with no bridging primitive introduced to hand the account its theorists. The obligation holds at strong strength on the by-account criterion, and drops to defeasible against an opponent who admits a declared individuation primitive.

The obligation falls due differently at different granularities, and no granularity escapes it. A base of a single neutral kind, neither mental nor physical, would hold both poles by deriving them, without being a base of units that each bear two (James, 1904; Russell, 1927). Its fate turns on what its elements are. Elements with no intrinsic character face the forward gap again, and the base inherits the interiority foreclosure. Elements bearing proto-phenomenal character make the base a both-poles base at some granularity (Goff, 2017); whether the step from proto-phenomenal to phenomenal is transparent is a question the combination literature presses, and it falls due inside the combination debt below. Panqualityist elements, with genuine qualitative character but no subjecthood, also make a both-poles base, and their debt takes the awareness form: experiencing subjects must be derived from unexperienced qualities (Coleman, 2014). A base of subject-sized units, both poles carried at the theorist's own scale with nothing beneath, escapes these debts and incurs its own, since the world's inanimate furniture must then be derived from subject-scale units. The sharp cases are the polar ones. A per-unit base of many bounded interiors owes the macro-unity of each theorist-locus, the combination debt; a cosmic base of one unbounded interior

owes the plurality and boundedness of the loci, the decombination debt. The debts differ from the foreclosures in the criterion's own terms: a psychophysical identity bridges between two vocabularies, while combination and decombination ask for derivations inside one, since unity and boundedness are structural predicates already available over a phenomenal base. An unproven derivation inside one vocabulary is a debt; a derivation that would need a bridge is foreclosed. The forced result is both poles in the general primitives; the granularity of the intrinsic pole, and the debt it incurs, are left open.

4.4 Self-applicable dynamics

A by-account satisfier's dynamics govern the theorist's own operation, and the derivation is near-definitional given two net conditions. Reflexive closure seats the theorist as a process in the world, and rule uniformity forbids exempting any case within a rule's scope. The theorist's own operation—representing, measuring, forming records—therefore falls under the same generative dynamics as everything else, with no exempt mental dynamics (Wozniak, 2026). The net's fixed-point specification of reflexive closure sharpens this: coherent self-inclusion requires the self-representing operation to close on a fixed point under the dynamics, which presupposes that the dynamics apply to it, and where the fixed point is absent the self-reference falls to a liar-like construction that either contradicts or fails to denote. The core requirement—no exempt mental dynamics—follows from the two conditions directly. The fixed-point reinforcement holds only at the strength the net assigns it. In formal settings where the self-representing operation is exhibited as an explicit mathematical construction, the closure claim is a theorem; for a theory that has not supplied such a construction, it is a structural analogy, and it remains one until the construction is supplied.

4.5 Reference fixed by an internal natural relation

A by-account satisfier fixes its reference by a natural relation internal to its base, and the derivation runs from anchoring and self-inclusion together. A total theory's reference cannot be fixed by relation to anything outside its ontology, because nothing is outside it; the causal chains of ordinary baptism (Kripke, 1980) are themselves internal to the described world, so what is unavailable is any reference-fixer beyond the theory's own furniture. The anchoring condition's escape from the Newman and Putnam collapses is a natural, joint-carving relation that resists permutation (Lewis, 1983, 1984), the standing reply to the inscrutability of reference (Quine, 1960). So the reference-fixing relation must live in the base and must close without vicious circularity: the theory's account of representation and its account of reference must both be grounded in that one relation, neither presupposing the other. The two conditions force exactly this much—a non-external, internal, natural, non-circular reference-fixing relation. They do not force that the relation be an asymmetry; Section 5 gives the reasons for withholding that stronger claim.

4.6 A well-defined formal object beneath it

A by-account satisfier rests on a well-defined formal object, a requirement the net already imposes, inherited here without fresh derivation. The net's well-definedness condition is necessary for any coherent total theory: a state space, a dynamical law, a measure, or a limit invoked in a derivation must exist as a well-defined object and not merely be describable in non-contradictory sentences (Wozniak, 2026). A by-account satisfier passes that condition by assumption, so it has one. The requirement appears here because it is exactly the bill the both-poles occupants have historically left unpaid, and Section 6 takes that up. A both-poles base with that object in place is the difference between the satisfier-shaped category and the systems that have so far occupied it.

Requirement on the account	Forced by (net conditions)	Strength
Both poles; extrinsic pole carried by genuine relations	interiority-by-account + world-side-by-account + honesty + self-inclusion + anchoring	intrinsic pole strong; extrinsic presence forced, rich structure defeasible; genuine-relations form magnetism-conditional; granularity open
Self-applicable dynamics	self-inclusion + rule uniformity	strong core; fixed-point gloss capped at analogy
Reference by an internal natural relation	anchoring + self-inclusion	strong on the naturalness premise; asymmetry not part of it
Well-defined formal object	well-definedness	inherited from the coherence conditions

Table 2: The requirements a by-account satisfier must meet, each traced to the net conditions that jointly force it. The requirements bind any *account* that discharges the domains, and none of them describes how reality is. The both-poles requirement's world-side leg has two supports: the defeasible experience-first tendency for the rich structure, and the anchoring condition, which forces the existence of at least one genuine extrinsic relation. The extrinsic pole is carried by genuine relations, conditional on the naturalness premise about reference; per-unit versus cosmic granularity is left open as a residue the net does not adjudicate.

Table 2 collects the four requirements with the net conditions that force each. Section 7 discounts the list: the four supports differ in strength, and one requirement is inherited from the coherence conditions rather than derived here. At full strength the satisfier holds both poles in its general primitives, applies its dynamics to the theorist's own theorizing, fixes reference from inside by a natural relation, and rests on a well-defined formal object underneath.

5 The conjecture tier

The net leaves several features underdetermined, and it underdetermines them in two different ways. The granularity at which the intrinsic pole is carried is a genuine open residue, one the net does not lean on either way. A directional reference relation and a derived rather than posited arrow are parsimony conjectures: a satisfier could realize either more economically than the net requires, but promoting them past what the net forces would import a shape the net does not license. Separating the one residue from the two conjectures is why all three are held out of the requirement tier.

5.1 Per-unit versus cosmic granularity

A base of units each bearing both poles and a base of one cosmic individual bearing both poles both satisfy the both-poles requirement, and the net discriminates between them nowhere. The choice is a residue the net does not adjudicate. Each polar granularity owes its direction-fixed individuation debt, combination for the per-unit base and decombination for the cosmic one; both debts are payable in place with the base's general resources, both stand historically unpaid, and neither is a proven category exit. The combination debt faces the subject-summing objection (Goff, 2017; Coleman, 2014; Chalmers, 2016), and the decombination debt faces the boundary problem pressed against the cosmic option—though Goff, that option's best-known defender, holds the cosmic route the less burdened of the two (Goff, 2017). A cosmic base with derivative but real plural loci is the priority-monist reading of the decombination direction (Schaffer, 2010), on which the debt is a

grounding claim rather than an unbuilt derivation; the accounting here prices it at the same bar, since the by-account route asks for the derivation. The net forces neither granularity, and that is the firm result. Whether the two debts match in severity the literature does not settle (Chalmers, 2016); the open residue reported here records the net's silence rather than a verdict on that debate. Keeping the cosmic horn open leans on one further point: Spinoza's system, examined in Section 6, shows that the cosmic cell admits an occupant whose extrinsic pole is carried by genuine relations. The showing is defeasible, and the cell's viability is a question about the category rather than about its seventeenth-century occupant.

5.2 Reference as an asymmetry

The internal natural relation that fixes reference might be a directional asymmetry, a settled-against-open polarity, rather than a symmetric relation. The anchoring condition does not force this. Lewisian naturalness is not inherently asymmetric: a symmetric natural relation, a natural metric or a "same charge as" relation, can resist permutation and break the Putnam collapse just as well (Lewis, 1983, 1984). The leap from natural to asymmetric is exactly where a directional architecture would enter a headline requirement if promoted, and that is the reason to withhold it. The asymmetry is a conjecture about the reference relation, and it belongs here.

5.3 A derived rather than posited arrow

A satisfier might derive its temporal arrow from uniform dynamics instead of fixing it by a declared boundary condition. The net does not require this either: a declared low-entropy boundary condition discharges the arrow slot by an account the net accepts, as Section 2 shows, so deriving the arrow is a preference rather than a requirement.

The reference asymmetry and the derived arrow share a shape. Each refines a requirement the net forces only in a weaker form, and each would sharpen the satisfier's profile toward a single realization if it held. Their place is here, outside Section 4, because only net-forced features enter the requirement tier. A satisfier could have a symmetric natural relation and several distinct asymmetries, could be per-unit or cosmic in its granularity, and could declare a general boundary condition for the arrow, and it would still be a by-account satisfier.

6 The historical occupants and their unpaid bill

The region that forecloses no slot by account is occupied at both granularities; its occupants' strengths and debts locate the open problem. Whitehead's event ontology takes the base to be fundamental events, each bearing an intrinsic pole, a for-itself aspect, and an extrinsic pole, an objective aspect available to later events, formed by a directional process in which a new event takes up the settled past into a determinate outcome (Whitehead, 1978).[1] The base bears both poles per unit, so it forecloses neither the interior nor the determinate world by account, and it is the paradigm of the both-poles category, as distinct from a general two-aspect base or a neutral monism. Read against the requirements of Section 4, the system supplies the intrinsic aspect the third-person bases lack and the extrinsic aspect the experience-first bases hold only weakly, and it makes the dynamics self-applicable by treating the theorist's own experience as events among events—a society of occasions in personal order, which is where its combination debt falls due.

[1] The intrinsic/extrinsic gloss compresses Whitehead's own mental-pole/physical-pole distinction, on which the mental pole is conceptual prehension of eternal objects rather than experience simpliciter. The reading here is schematic and commits only to the two-aspect structure the argument uses.

The system leaves the last requirement unpaid, and the bill must be stated precisely, because parts of it have been paid. Formal work on the scheme exists—the region-based mereotopology descending from Whitehead's method of extensive abstraction, categorical reconstructions of the process scheme, and process algebras built expressly on it (Clarke, 1981; Epperson and Zafiris, 2013; Sulis, 2024)—and each formalizes the extensive relations or supplies a framework while leaving concrescence without a generative dynamics and a measure. The sharpest case is the Whiteheadian reading of quantum theory that identifies actual occasions with state reductions (Stapp, 1979): it inherits quantum theory's state space, law, and measure whole, and it borrows them through exactly the kind of bridging identity the criterion prices, so the debt reappears inside it. Integrated information theory, read as the intrinsic ontology it declares, sits under the same verdict: its measure is evaluated over a transition structure the theory imports rather than generates, so the apparatus is real and the becoming is still described from outside (Albantakis et al., 2023). The unbuilt object is a generative dynamics over a state space of occasions, with a measure, under which concrescence is constructed rather than described (Whitehead, 1978). The bill is not imposed from outside. Discharging dynamics by account takes a law, and a law needs a space to act on; discharging definiteness by account means selecting one outcome among admissible alternatives, and selection needs a weighting, which is a measure. The well-definedness condition adds only that these objects must exist as mathematics rather than as descriptions. The debt differs in kind from the foreclosures. A foreclosure is entailed, liftable only by a category exit, because a third-person base cannot generally derive the intrinsic, and pure structure cannot anchor itself, whatever else is added; the debt is contingent and fixable in place, since nothing in the both-poles category forbids formalization and nothing shows the missing object to be impossible. The grading is deliberate on the other side as well: the conceivability argument against combination runs from micro-phenomenal premises that no theorist fully conceives, so it earns less than the forward gap earns (Goff, 2017; Chalmers, 2016), and the combination debt is filed as an obligation rather than a foreclosure.

The cosmic granularity has its own developed occupant, and it leaves the same bill unpaid. Spinoza's one substance under the attributes of thought and extension is a both-poles base at cosmic scale: thought is a genuine attribute, so the intrinsic pole has genuine character, and the finite modes within extension stand in a real causal nexus, so the extrinsic pole is carried by genuine relations rather than by coordinated parallelism (Spinoza, 1677). Spinoza's doctrine matches the order of ideas to the order of things—the same cross-domain coordination Leibniz posits between monads—so the survival does not turn on avoiding parallelism. It turns on where the genuine relations sit: Spinoza's causal nexus runs between finite modes within an attribute, where Leibniz's windowless monads stand in no real inter-monadic relation—each mirrors all the others, but the mirroring is coordinated by a harmony external to every monad—which is the exclusion of Section 4. The intra-attribute nexus is the genuine-relations carrier the windowless base lacks. The survival has one contested joint. The anchoring relation of Section 4 reaches from the theorist's side to the world's side, and in Spinoza's system a relation between a mode of thought and a mode of extension cannot be causal, since causation runs within attributes. The survival therefore rests on the doctrine that idea and body are one mode under two attributes, so that the reach is secured by identity rather than by a further relation; the reading is textually grounded and contested, and the cosmic occupancy holds at the strength it earns. Spinoza's individuation debt runs opposite to Whitehead's, in the decombination direction, as the derivation of the plural finite modes from the one infinite substance; the per-unit combination problem is its mirror, an unbuilt derivation of macro-unity from micro-natures and no entailed foreclosure (Goff, 2017). The formal-object bill is unpaid in the same way: the substance, the attributes, and the modal derivation are not given as a state space, a law, and a measure under which the modes are constructed rather than merely described. Axiomatic reconstructions of the *Ethics* exist (Jarrett, 1978); they formalize the

deductive order of the text, and the construction of the modes from the substance remains undone.

The open problem this poses is a construction, and it is best stated as a target. A base that holds both poles in its general primitives, applies its dynamics to its own theorizing, fixes its reference by an internal natural relation, and—the outstanding piece—rests on a well-defined formal object would occupy the region the foreclosures leave open with the bill paid. The historical occupants show that the region is occupiable and which bill comes due; a formalized both-poles ontology remains the outstanding construction.

7 Scope and limits of the specification

The result is a target specification, in the same register as the net it builds on. It narrows the kind of base a by-account satisfier could have: a base with both an intrinsic and an extrinsic aspect in its general primitives, the extrinsic aspect borne by genuine relations rather than coordinated parallelism; dynamics that govern the theorist's own operation; reference fixed by an internal natural relation; and a well-defined formal object beneath it. The list is thinner than a bare count suggests. The formal-object requirement is inherited from the coherence conditions rather than derived from the account structure; the both-poles requirement's world-side leg is split, forced in the existence of an extrinsic relation and defeasible in its rich structure; and the reference requirement stops short of the directional asymmetry a reader might expect. The intrinsic pole is carried at a granularity, and that granularity owes a direction-fixed individuation debt whichever it is; whether the base is per-unit or cosmic is left open as a residue the net does not adjudicate, the combination and decombination debts each standing unpaid and neither granularity forced. A directional reference relation and a derived arrow remain the economical way to sharpen that shape rather than further necessities. The narrowing is conditional three times over. It is conditional on the by-account criterion of Section 2, a strengthening of the net that an opponent may decline, and on the antecedent that a base take the by-account route on every slot rather than deny its way through some of them. For the genuine-relations requirement it is conditional a third time, on the naturalness premise about reference that a covariational reliabilist can decline; under that premise's denial the exclusion of windowless parallelism inverts. All three conditions stand in plain view, and the results are held at the strength the conditions earn. Table 3 sets the whole derivation out as a ledger, stage by stage: what each stage demands, where the demand comes from, what it excludes, and the standing each result has earned.

The specification certifies no satisfier and proposes none. It shows that the pure forms of the field's main categories foreclose some slot by account and that their working versions survive by exit, that the region foreclosing none is real and has been occupied, and that its occupants leave a well-defined formal object as an unpaid bill. It does not show that a base meeting every requirement exists, is unique, or has been found, and a base could meet all of them and still be false or defective in a way not catalogued here. It reports which kinds of base cannot reach the target by account and what a base that reached it would have to have, and it leaves open, as a target specification must, whether anything reaches it.

TOTAL *stipulated target*	Quantify over everything; seat the theorists who hold the theory. *removes:* merely local theories, which exempt their own theorist.
ADMISSIBLE *necessary conditions (the net, Wozniak, 2026)*	Coherent, anchored, and positioned on all eight structural slots. *removes:* incoherent, unanchored, or slot-silent candidates.
BY ACCOUNT *declared sharpening, declinable (§2)*	Every slot discharged from the base's general primitives—no bridging primitive between the base's vocabulary and an independently specified domain. *removes:* nothing; it scopes the question. Denial and declared bridging posits remain legitimate discharges outside this paper's target.
UNFORECLOSED *graded per cut (§§3–4)*	A fundamental category that closes no by-account route. *removes:* pure structure (*theorem in a stated setting*) · third-person and character-free neutral bases (*strong, on the gap premise and the criterion*) · experience-first bases, weakly (*defeasible*) · sole-base agent-first programs (*defeasible tendency, weakest*) · windowless parallelism (*on the naturalness premise*).
THE SHAPE *conditional necessities (§4)*	Both poles in the general primitives, the extrinsic pole carried by genuine relations; self-applicable dynamics; reference by an internal natural relation; a well-defined formal object. *removes:* nothing further—the surviving description, each feature traced to the net conditions that force it.
THE RESIDUE *open (§§5–6)*	The granularity of the intrinsic pole, and the formal object itself. *remains:* the individuation debts, combination versus decombination, neither adjudicated · the outstanding construction, its bill unpaid by both worked occupants.

Table 3: The derivation as a ledger, stage by stage. Left, each stage and the standing its result has earned; right, the demand and what it removes from the search space. The strengths are those argued in the sections cited, and nothing here exceeds them; throughout, the claims are conditional necessities on an *account*, never claims about what reality instantiates.

References

Ainsworth, P. M. (2009). Newman's objection. *The British Journal for the Philosophy of Science*, 60(1):135–171.

Albantakis, L., Barbosa, L., Findlay, G., Grasso, M., Haun, A., Marshall, W., Mayner, W. G. P., Zaeemzadeh, A., Boly, M., Juel, B., Sasai, S., Fujii, K., David, I., Hendren, J., Lang, J., and Tononi, G. (2023). Integrated information theory (IIT) 4.0: Formulating the properties of phenomenal existence in physical terms. *PLOS Computational Biology*, 19(10):e1011465.

Albert, D. Z. (2000). *Time and Chance*. Harvard University Press, Cambridge, MA.

Alter, T. and Nagasawa, Y., editors (2015). *Consciousness in the Physical World: Perspectives on Russellian Monism*. Oxford University Press, New York.

Bell, J. S. (1990). Against 'measurement'. *Physics World*, 3(8):33–41.

Block, N. and Stalnaker, R. (1999). Conceptual analysis, dualism, and the explanatory gap. *The Philosophical Review*, 108(1):1–46.

Chalmers, D. J. (1996). *The Conscious Mind: In Search of a Fundamental Theory*. Oxford University Press.

Chalmers, D. J. (2016). The combination problem for panpsychism. In Brüntrup, G. and Jaskolla, L., editors, *Panpsychism: Contemporary Perspectives*, pages 179–214. Oxford University Press, New York.

Clarke, B. L. (1981). A calculus of individuals based on 'connection'. *Notre Dame Journal of Formal Logic*, 22(3):204–218.

Coleman, S. (2014). The real combination problem: Panpsychism, micro-subjects, and emergence. *Erkenntnis*, 79(1):19–44.

Demopoulos, W. and Friedman, M. (1985). Bertrand Russell's *The Analysis of Matter*: Its historical context and contemporary interest. *Philosophy of Science*, 52(4):621–639.

Dretske, F. I. (1981). *Knowledge and the Flow of Information*. MIT Press, Cambridge, MA.

Earman, J. (2006). The 'past hypothesis': Not even false. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics*, 37(3):399–430.

Epperson, M. and Zafiris, E. (2013). *Foundations of Relational Realism: A Topological Approach to Quantum Mechanics and the Philosophy of Nature*. Lexington Books, Lanham, MD.

Friston, K. (2010). The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience*, 11(2):127–138.

Fuchs, C. A. (2010). QBism, the perimeter of quantum Bayesianism. *arXiv preprint*. arXiv:1003.5209 [quant-ph].

Fuchs, C. A. (2016). On participatory realism. *arXiv preprint*. arXiv:1601.04360 [quant-ph].

Goff, P. (2017). *Consciousness and Fundamental Reality*. Oxford University Press, New York.

Ismael, J. T. (2007). *The Situated Self*. Oxford University Press.

Jackson, F. (1982). Epiphenomenal qualia. *The Philosophical Quarterly*, 32(127):127–136.

James, W. (1904). Does 'consciousness' exist? *Journal of Philosophy, Psychology and Scientific Methods*, 1(18):477–491.

Jarrett, C. (1978). The logical structure of spinoza's ethics, part i. *Synthese*, 37(1):15–65.

Kant, I. (1998). *Critique of Pure Reason*. Cambridge University Press, Cambridge. Translated and edited by Paul Guyer and Allen W. Wood; originally published 1781/1787.

Kripke, S. A. (1980). *Naming and Necessity*. Harvard University Press, Cambridge, MA.

Ladyman, J. (1998). What is structural realism? *Studies in History and Philosophy of Science Part A*, 29(3):409–424.

Ladyman, J. and Ross, D. (2007). *Every Thing Must Go: Metaphysics Naturalized*. Oxford University Press.

Leibniz, G. W. (1714). *Monadology*. Various (originally circulated in manuscript). Translated by G. R. Montgomery.

Levine, J. (1983). Materialism and qualia: The explanatory gap. *Pacific Philosophical Quarterly*, 64:354–361.

Lewis, D. (1983). New work for a theory of universals. *Australasian Journal of Philosophy*, 61(4):343–377.

Lewis, D. (1984). Putnam's paradox. *Australasian Journal of Philosophy*, 62(3):221–236.

Loar, B. (1990). Phenomenal states. *Philosophical Perspectives*, 4:81–108.

Maudlin, T. (1995). Three measurement problems. *Topoi*, 14(1):7–15.

Melia, J. and Saatsi, J. (2006). Ramseyfication and theoretical content. *The British Journal for the Philosophy of Science*, 57(3):561–585.

Nagel, T. (1974). What is it like to be a bat? *The Philosophical Review*, 83(4):435–450.

Newman, M. H. A. (1928). Mr. Russell's "causal theory of perception". *Mind*, 37(146):137–148.

Oizumi, M., Albantakis, L., and Tononi, G. (2014). From the phenomenology to the mechanisms of consciousness: Integrated Information Theory 3.0. *PLoS Computational Biology*, 10(5):e1003588.

Putnam, H. (1980). Models and reality. *The Journal of Symbolic Logic*, 45(3):464–482.

Putnam, H. (1981). *Reason, Truth and History*. Cambridge University Press.

Quine, W. V. O. (1960). *Word and Object*. MIT Press, Cambridge, MA.

Russell, B. (1927). *The Analysis of Matter*. Kegan Paul, Trench, Trubner & Co., London.

Schaffer, J. (2010). Monism: The priority of the whole. *The Philosophical Review*, 119(1):31–76.

Sider, T. (2011). *Writing the Book of the World*. Oxford University Press.

Spinoza, B. (1677). *Ethica, Ordine Geometrico Demonstrata*. Jan Rieuwertsz, Amsterdam. In *Opera Posthuma*.

Stapp, H. P. (1979). Whiteheadian approach to quantum theory and the generalized bell's theorem. *Foundations of Physics*, 9(1–2):1–25.

Stoljar, D. (2001). Two conceptions of the physical. *Philosophy and Phenomenological Research*, 62(2):253–281.

Stroud, B. (1968). Transcendental arguments. *The Journal of Philosophy*, 65(9):241–256.

Sulis, W. (2024). Mathematics of a process algebra inspired by whitehead's process and reality: A review. *Mathematics*, 12(13):1988.

Tononi, G., Boly, M., Massimini, M., and Koch, C. (2016). Integrated information theory: from consciousness to its physical substrate. *Nature Reviews Neuroscience*, 17(7):450–461.

Whitehead, A. N. (1978). *Process and Reality: An Essay in Cosmology*. The Free Press, New York, corrected edition. Originally published 1929.

Worrall, J. (1989). Structural realism: The best of both worlds? *Dialectica*, 43(1–2):99–124.

Wozniak, J. (2026). The shape of a total theory: A necessary-conditions net. Zenodo, doi:10.5281/zenodo.21498462.