Hylomorphism and the Metaphysics of Structure

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Abstract: Hylomorphism claims that structure is a basic ontological and explanatory principle; it accounts for what things are and what they can do. My goal is to articulate a metaphysic of hylomorphic structure different from those currently on offer. It is based on a substance-attribute ontology that takes properties to be powers and tropes. Hylomorphic structures emerge, on this account, as powers to configure the materials that compose individuals.

1 The Hylomorphic Notion of Structure

Hylomorphism claims that structure (or organization, form, arrangement, order, or configuration) is a basic ontological and explanatory principle. Some individuals, paradigmatically living things, consist of materials that are structured or organized in various ways. You and I are not mere quantities of physical materials; we are quantities of physical materials with a certain organization or structure. That structure is responsible for us being and persisting as humans, and it is responsible for us having the particular developmental, metabolic, reproductive, perceptive, and cognitive capacities we have.

The hylomorphic notion of structure is not the same as others that have appeared in the literature. It is not the same, for instance, as Ted Sider's (2012) notion. Sider uses the term 'structure' to refer to what grounds the distinction between things that are fundamental or perfectly natural in Lewis's (1983) sense, and things that are not. Hylomorphism provides one account of what structure in Sider's sense includes, but the specifically hylomorphic notion of structure is not the same as Sider's. Nor is it the same as David Chalmers's (2002, 258). For Chalmers, structural descriptions are abstract microphysical descriptions of a system's state at a time that are contrasted with microphysical dynamic descriptions of how a system's states change over time. For hylomorphists, by contrast, structure

1 Other accounts of hylomorphic structure that have appeared in the literature include Kit Fine's (1999), Mark Johnston's (2006), David Oderberg's (2007), Kathrin Koslicki's (2008), and Michael Rea's (2011). The account of hylomorphic structure that I will be developing here differs from theirs in ways that will become evident.
is not an abstract postulate, nor are descriptions of structures confined to microphysics.

One way of illustrating the hylomorphic notion of structure involves the many appeals to structure that we find in the sciences, especially biology and biological subdisciplines such as neuroscience. Here is an example taken from a popular college-level biology textbook—note the references to organization, order, arrangement, and related things:

Life is highly organized into a hierarchy of structural levels, with each level building on the levels below it. . . . Biological order exists at all levels. . . . [A]toms . . . are ordered into complex biological molecules. . . . [T]he molecules of life are arranged into minute structures called organelles, which are in turn the components of cells. Cells are [in turn] subunits of organisms. . . . The organism we recognize as an animal or plant is not a random collection of individual cells, but a multicellular cooperative. . . . Identifying biological organization at its many levels is fundamental to the study of life. . . . With each step upward in the hierarchy of biological order, novel properties emerge that were not present at the simpler levels of organization. . . . A molecule such as a protein has attributes not exhibited by any of its component atoms, and a cell is certainly much more than a bag of molecules. If the intricate organization of the human brain is disrupted by a head injury, that organ will cease to function properly. . . . And an organism is a living whole greater than the sum of its parts. . . . [W]e cannot fully explain a higher level of order by breaking it down into its parts. (Campbell 1996, 2–4)

This passage suggests that the way things are structured, organized, or arranged plays an important role in them being the kinds of things they are, and in explaining the kinds of things they can do. Consider likewise William Bechtel, a philosopher of neuroscience:

[T]he organization of . . . components typically integrates them into an entity that has an identity of its own. . . . Organization itself is not something inherent in the parts. . . . In virtue of being organized systems, mechanisms do things beyond what their components do. . . . As a result, organized mechanisms become the focus of relatively autonomous disciplines. . . . (2007, 174, 185–186)

According to Bechtel, a complex whole—what he calls a ‘mechanism’—consists of parts plus an organization that confers on it capacities not had by its parts taken in isolation. In addition, descriptions of structured wholes and explanations of their behavior are irreducible to descriptions.
and explanations of their unstructured parts. Bechtel goes on to argue that higher-level and lower-level empirical disciplines have different subject-matters on account of the ways things are organized or structured. As a result, those disciplines have different vocabularies and provide different kinds of explanations, and this makes higher-level disciplines autonomous—irreducible to lower-level disciplines in the traditional philosophical sense.

Often when people think of structure, they think of something static such as the relatively unchanging spatial relations among atoms in a crystal. But many structures, including those that distinguish living things from nonliving ones, are not static spatial relations, but dynamic patterns of environmental interaction. The neurophysiologist Jonathan Miller makes this point explicit:

> [T]he physical universe tends towards a state of uniform disorder. . . . In such a world the survival of form depends on . . . [either] the intrinsic stability of the materials from which the object is made, or the energetic replenishment and reorganisation of the material which is constantly flowing through it. . . . The configuration of a fountain . . . is intrinsically unstable, and it can retain its shape only by endlessly renewing the material which constitutes it; that is, by organising and imposing structure on the unremitting flow of its own substance. . . . The persistence of a living organism is an achievement of the same order as that of a fountain. . . . [I]t can maintain its configuration only by flowing through a system which is capable of reorganising and renewing the configuration from one moment to the next. But the engine which keeps a fountain aloft exists independently of the watery form for which it is responsible, whereas the engine which supports and maintains the form of a living organism is an inherent part of its characteristic structure. (Miller 1978, 140–141)

Miller brings out an additional point. The dynamic structure that qualifies something as a living thing is also what enables that thing to persist through time. It is one and the same organism that persists through the constant influx and efflux of matter and energy because of its structure and its dynamic ability to impose that structure on incoming matter and energy.

A final idea about structure is introduced by John Dewey (1958, 253–258). He suggests that mental phenomena can be understood as species of structural phenomena in general. If structure is uncontroversially part of the natural world, and mental phenomena are just species of structural phenomena, then they must be uncontroversially part of the natural world as well. The resulting view thus appears to be naturalistic. Moreover, because structural descriptions and explanations are irreducible to descriptions and explanations that appeal to unstructured physical materials, the account
also appears to be antireductive. And if structure is a basic ingredient of
the natural world, then it is unmysterious on this account how mental
phenomena could be both natural and irreducible.

The foregoing authors gesture toward a view of structure in the natural
world. According to it, structure serves as a principle of unity, persistence,
and power. It is responsible for setting something apart as a discrete
individual distinct from the rest of the physical universe, and it explains
why such an individual can exist one and the same over time. It also
explains why that individual can do many of the things it does: why it
has many of the powers it has, including the powers that classify it as a
living being or a mental one. Finally, an individual’s structure explains the
autonomy of various empirical disciplines that would look to describe and
explain its behavior. We can express the foregoing theoretical roles that
structure plays on this view with some slogans:

Structure matters: it operates as an irreducible ontological
principle, one that accounts at least in part for what things
essentially are.

Structure counts: it explains the unity of composite individu-
als, including the persistence of one and the same living
individual through the dynamic influx and efflux of matter
and energy that characterize many of its interactions with
the wider world.

Structure makes a difference: it operates as an irreducible
explanatory principle, one that accounts at least in part for
what individuals can do, the powers they have.

Structure minds: it provides us with resources for under-
standing the place of mental phenomena within the natural
world.

Elsewhere, I have argued in favor of taking hylomorphic structure as
a basic ontological and explanatory principle, and I have argued that an
account of mental phenomena based on hylomorphic structure implies
attractive solutions to mind-body problems, including the problem of
emergence and the problem of downward causation (Jaworski 2011, 2012).
In what follows, I plan to say more about the metaphysics of hylomorphic
structure. I will articulate an account of hylomorphic structure based on a
substance-attribute ontology that takes properties to be powers and tropes.

2 Sparse Properties, Tropes, and Powers

A substance-attribute ontology claims that substances or individuals, as I
will call them, and attributes or properties, are fundamental entities. There
are in addition states of affairs or events (some philosophers call them
‘facts’): individuals having properties or standing in relations at times. An
event exists exactly if an individual has a property at a time or several individuals stand in a relation at a time (Kim 1976). Event $e$ is identical to event $e^*$ exactly if $e$ and $e^*$ have the same individuals, properties, and times. If, for instance, event $e$ is identical to $a$'s having property $P$ at time $t$, and event $e^*$ is identical to $b$'s having property $Q$ at time $t^*$, then $e = e^*$ exactly if $a = b$, $P = Q$, and $t = t^*$.

The principal agents in this ontology are individuals. They can both act on other individuals and be acted on by them; they have, in other words, both active and passive powers—both powers to affect things and powers to be affected by them. Individuals enter into causal relations by exercising their powers, and they are empowered in the ways they are by their properties.

The properties I have in mind are natural properties, not mathematical or logical ones. For our purposes, we can put properties of the latter sorts to one side. Natural properties play several theoretical roles in this ontology. First, they are causal enablers; they confer the powers that make causal interactions among individuals possible. Second, because they confer powers, properties are also causal explainers; they explain why individuals act or are acted on in the ways they are. Third, properties ground the objective similarities and differences among individuals. Individuals are always similar or dissimilar in certain respects. These respects are properties (Martin 1996a, 71–73; 1997; 2007, 42–43). Moreover, since properties are possessed by individuals independent of any descriptive or explanatory interests we happen to have, the similarities and differences they ground are objective.

The view I have described takes properties to be sparse not abundant (Lewis 1983). A sparse account of properties has several noteworthy features. First, a sparse account sharply distinguishes properties from predicates. Predicates can be identified with sentence-frames (Strawson 1974, 37–38; Armstrong 1978a, 2–3), linguistic expressions such as ‘___ is red’ and ‘___ is taller than ___’ that form sentences when the blanks are filled in by terms. (For convenience I will omit the blanks when discussing predicates in the future.) Properties are supposed to be the non-linguistic correlates of at least some predicates. Some accounts that take properties to be abundant claim that every predicate expresses a property, and that different predicates express different properties. A sparse account of properties denies these things.

According to a sparse account, it is possible for different predicates to express the same property (‘weighs 453.59 grams,’ ‘weighs 1 pound’), and for different properties to be expressed by the same predicate in different contexts (‘The team is good,’ ‘The wine is good’) (Armstrong 1978b, 9–14; Campbell 1990, 25; Molnar 2003, 26). Likewise, not every predicate expresses a property. For one thing, there might be unknown properties to which no actual predicates correspond (Armstrong 1978b, 12–14; Molnar 2003, 25). In addition, some predicates are self-referentially incoherent.
such as the predicate ‘is a property to which no predicate corresponds,’
which generates a version of Russell’s paradox. These predicates do not
(and indeed cannot) correspond to any property (Molnar 2003, 26). It
is also possible to invent predicates, but it is not possible to invent prop-
erties. When we invent predicates, moreover, we can do so by iterating
formal operations ad infinitum, yet it is implausible to suppose that the
number of properties could be infinite (Ellis and Lierse 1994, 9; Molnar
2003, 26). Similarly, we can invent a nonenumerably infinite number of
predicates to describe physical entities such as subatomic particles, pro-
vided we take seriously the use of real numbers in physics. It is, however,
extremely implausible to suppose that those physical entities should have
nonenumerably infinite properties (Bradley 1979, 12–13; Molnar 2003,
26).

For the foregoing reasons, sparse properties are distinct from predicates.
What, then, determines which predicates express properties, and whether
two or more predicates express the same property or different ones? The
answer, on a sparse account, is that this is largely an empirical matter. We
take our best empirical descriptions, explanations, methods, and techniques,
and countenance all the properties needed to make the descriptions and
explanations true and the methods and techniques effective (Ellis 2002,
44–45; Molnar 2003, 27; Armstrong 2010, 19).

There are many debates about properties in the literature. An old
one concerns whether properties are universals or particulars. Realists
that they are universals—“repeatable” entities (Loux 2006). Numerically
one and the same universal can be instantiated by and thereby be wholly
present in diverse individuals. Nominalists, by contrast, claim there are
only particulars. Extreme nominalists posit only individuals, but moderate
nominalists posit other particulars besides. These latter are called ‘abstract
particulars’ to distinguish them from individuals, which are the concrete
particulars. Abstract particulars include classes and tropes.

Tropes are particularized properties, also called ‘unit properties,’ ‘prop-
erty instances,’ ‘individual accidents,’ and ‘modes,’ among other things
(Stout 1923; Williams 1953, 1986; Campbell 1981, 1990; Martin 1996a,b,
1997, 2007; Molnar 2003; Heil 2003, 2005). To understand the concept
of a trope, it is helpful to contrast it with the concept of a universal. Con-
sider two apples, a and b, which are qualitatively indistinguishable. The
redness of a is completely indistinguishable from the redness of b. Realists
explain this similarity by claiming that there is a universal, redness, that
is instantiated by both a and b. Trope theorists deny this. There is not
a single entity, the universal redness, which is instantiated by both a and
b; rather, a’s redness is a property that is numerically different from b’s
redness. a’s redness and b’s redness nevertheless exactly resemble each other.
Because of this exact resemblance, it can seem as though there is an entity, a
universal, which the two literally have in common. But according to trope

Author’s Proof
theorists, this is not the case. Saying that $a$ and $b$ have the same color is analogous to saying that a boy and his father have the same nose, or that two embarrassed celebrities arrived wearing the same dress. Statements like this do not posit a single nose or a single dress, but two exactly resembling ones. Realists insist that all similarities must be grounded in numerically identical universals, but trope theorists deny this. They take similarities as ground-level facts that stand in need of no further explanation.

Many trope theorists have been attracted to bundle theories of substance (Stout 1923; Williams 1953; Campbell 1981, 1990), but I follow those trope theorists who remain committed to a substance-attribute ontology. They include Martin (1996a; 1996b; 1997; 2007), Molnar (2003), Heil (2003; 2005), and trope theorists of the past such as Aquinas, Ockham, and perhaps even Aristotle.

One advantage of trope theory is that it enables us to avoid positing states of affairs or events as a separate ontological category (Campbell 1981, 354–355; Williams 1986, 4; Armstrong 1989, 117–119). The reason is that the relation between a trope and its individual bearer is not contingent but necessary, something that trope theorists have termed ‘nontransferability’ (Heil 2003, 141–142; Molnar 2003, 43–46). Martin explains:

Properties are nontransferable. The redness or sphericity of this tomato cannot migrate to another tomato. This is a consequence of the idea that properties are particular ways things are. The identity of a property—its being the property it is—is bound up with the identity of its possessor.

(Martin 2007, 44)

Apple $a$‘s redness cannot belong to something other than $a$, any more than Eleanor’s smile can belong to someone other than Eleanor. Consequently, there is no need to posit something in addition to individuals and properties, namely states of affairs or events, that tie individuals and properties to one another. For a property to exist on this account is for it to be the property of some individual.

Another debate about properties concerns what it means to say that properties confer powers. The view I favor is a version of the one defended by C. B. Martin (1996a; 1996b; 1997; 2007), John Heil (2003; 2005), and Martin and Heil (1998; 1999). Heil calls it the ‘identity theory.’ I will adopt his terminology, and call it the identity theory of powers. It claims that each property is essentially dispositional. In this sense it is similar to pure dispositionalist views (Shoemaker 1980; Mumford 2004; Bird 2007). Each property essentially empowers its individual possessor to interact with other individuals in various kinds of ways. A diamond’s hardness empowers the diamond to do a variety of things—to scratch glass, for instance. It is essential to the hardness that it empowers the diamond to do these things; it plays this power-conferring role in every possible world in which it exists. We describe this role in a variety of

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ways. We say that the diamond is able (or has the power or potential
or capacity) to scratch glass, or that the diamond would scratch that
mirror if raked across its surface. But the diamond’s hardness plays other
roles which we describe in different terms. We say, for instance, that the
diamond has a tetrahedral arrangement of carbon atoms. According to
the identity theory of powers, these descriptions are of numerically one
and the same property. The diamond’s hardness = the diamond’s power to
scratch glass = the diamond’s having a tetrahedral arrangement of carbon
atoms. These descriptions simply bring out different theoretical roles that
the one property plays. Dispositional descriptions such as ‘The diamond
would scratch that mirror if raked across its surface’ bring out the roles it
plays as a power. Nondispositional descriptions such as ‘The diamond has
a tetrahedral arrangement of carbon atoms’ bring out its role as a stable
manifestation—an actualization, we might call it—of a power possessed by
the carbon atoms, namely the power to be arranged tetrahedrally. The one
property is thus simultaneously both a stable manifestation of a power and
a power itself, both an actuality and a potentiality.

Martin and Heil mention the identity theory’s Lockean pedigree, but
to my mind the more obvious historical antecedent is Aristotle. Almost
everything on Aristotle’s view is both an actuality of some potentiality
and a potentiality for some further actuality. The only exceptions are
prime matter and God. The former is pure potentiality, on Aristotle’s view,
and the latter pure actuality, but both are limit cases on a continuum in
which otherwise every actuality is a potentiality and every potentiality an
actuality.  Numerically one and the same property thus plays different
theoretical roles.

It is worth noting one difference between the way Martin and Heil
develop the identity theory of powers and the way I do. The discussion of
powers in metaphysics has typically been framed as a debate about whether
properties are fundamentally categorical or fundamentally dispositional.
Martin (1996a) eschews talk of categorical properties on the grounds that
calling properties ‘categorical’ covertly begs the question against the identity
theory. His preferred term is ‘qualitative,’ and Heil (2003; 2005) follows his
lead. I agree with Martin and Heil that the term ‘categorical’ is prejudicial,
but I think the term ‘qualitative’ is overcommitted as well. The notion of a
quality has a narrower scope than the notion of a property. Qualities are
linked to our experiences of things.  Molnar (2003, 178) argues, however,
that some properties, such as those postulated by quantum theory, are not
qualitative. If he is right, then the notion of a property outstrips the notion

Martin calls his view the ‘Limit View’ for analogous reasons. If there is a difference between
him and Aristotle on this point, it is that Aristotle takes the limit cases to be real, whereas
Martin (1996a, 74–75; 1997, 215) takes them to be merely abstract postulates.

It is because of this experience-linkage that Heil argues that rejecting the identification of
powers with qualities veers toward idealism: “If minds have qualities but no material thing
has qualities, then minds are not material things” (2005, 351).
of a quality. Consequently, I think identity theorists do well to avoid the
term ‘qualitative.’ I’ve suggested that they say instead simply that there
are different vocabularies, some dispositional others nondispositional, for
describing the different theoretical roles that properties play.

The identity theory of powers has several noteworthy features. First,
it claims that powers are essentially directed toward their manifestations.
This directedness has led some philosophers to draw analogies between
dispositionality and intentionality (Martin and Pfeifer 1986; Place 1996a,b;
Molnar 2003). Intentional mental states are said to be directed at things.
My desire is essentially a desire for something; my fear is essentially a fear
of something. Something analogous is true of powers; they are essentially
powers for various exercises or manifestations. Likewise, just as my desire
can remain unfulfilled and my fear unrealistic, so too a power can remain
unmanifested. A quantity of table salt has the power to dissolve in water,
yet that power might never actually be exercised. It is possible that the salt
might remain forever undissolved. Martin (1996a) defends this idea with
an example: it seems possible that there might be fundamental physical
particles in the universe that have the power to interact in various ways with
particles around here, and yet that are so far away that they reside outside
the light cone of the particles around here. The two groups of particles
never actually interact, yet it seems obvious that the distant particles still
have the power to interact with the local ones.

Another feature of the identity theory is that powers are manifested or
exercised only in specific circumstances and typically only in conjunction
with individuals that have reciprocal powers—what Martin calls ‘reciprocal
disposition partners.’ I mentioned earlier that powers come in both active
and passive varieties: there are powers to affect things and also powers
to be affected by them. Powers are typically exercised only when individ-
uals with reciprocal active and passive powers are conjoined in the right
circumstances. Water, for instance, can exercise its power to dissolve things
only in conjunction with things that have the power to be dissolved by it. 
Harré and Madden’s (1975) examples of radioactive decay and ammonium
tri-iodide seem initially to provide counterexamples to the general rule that
powers are manifested or exercised in pairs, or triples, or . . . But even
here it might be possible to understand the cases in a way that conforms
to the general reciprocity model. At the very least the environment sur-
rounding the radioactive nuclei or the ammonium tri-iodide cannot include
any agents that inhibit the exercise of their powers to decay or explode,
respectively. Environments that are free of inhibitory factors might then be
viewed as reciprocal disposition partners for the decaying nuclei and the
explosive compound.

In addition, the exercise of some powers can inhibit or excite, impair
or enhance, or strengthen or weaken the exercise of others. An antidote
has the power to inhibit the power of a poison, and there might be other
things with the power to enhance or strengthen it. These observations
reflect a more general point: the same power can manifest itself differently in conjunction with different disposition partners. To use Heil’s example, a ball will roll on a hard surface on account of its roundness, and it will make a concave depression in a soft surface on account of that same roundness. The same property, the ball’s roundness, manifests itself in different ways in conjunction with different disposition partners.

3 Individual-making Structures

The ontology I have just described provides a basis for understanding the hylomorphic notion of structure. The kinds of structures on which I will focus are the ones that make individuals what they are—individual-making structures. According to hylomorphists, activities also have structures, but a discussion of activity-making structures would take us beyond the confines of this paper.

The theoretical roles that we expect activity-making structures to play, such as the role of conferring powers, are characteristic of properties in the ontology I have articulated. If structures are properties, then they have all the characteristics of properties described earlier. First, they must be powers—powers in particular to configure (organize, order, or arrange) materials. Each structured individual organizes or configures the materials that compose it. I configure the materials that compose me, and you configure the materials that compose you. Describing the way each of us configures our respective materials is something that hylomorphists say is an empirical undertaking—in our cases, an undertaking left largely to biology, biochemistry, neuroscience, and other biological subdisciplines. Collectively, these disciplines are likely to deliver long, complicated descriptions of cells, tissues, and organ systems, along with their characteristic activities, capacities, and interrelations. It will be convenient to have a term to stand in for these descriptions. Let us say that you and I configure materials humanwise, where ‘humanwise’ is a placeholder for the longer descriptions that it is the collective job of biologists, neuroscientists, and others to supply.

Second, structures are particulars. To say that you and I configure materials humanwise does not imply that there is a universal, configures humanwise, that you and I have in common. If properties are tropes, then my configuring and your configuring are numerically different properties, although they resemble each other rather closely—more closely than, say, either resembles Fido’s configuring the materials that compose him or the oak tree’s configuring the materials that compose it. My configuring and yours are also nontransferable: my configuring cannot belong to anything other than me, nor can your configuring belong to anything other than you.

Third, structures have the same directedness that all powers do. The structures of living things in particular appear to be directed toward developing and maintaining the organism’s mature state, as well as the powers
that characterize that state and their manifestations (Mayr 1997, 22). Like
many of the powers we have considered, an organism’s structure mani-
fests itself in many different ways—in, for instance, the organism’s various
developmental stages and in the variety of self-regulating processes that
maintain the cells, tissues, and organs that living things develop such as
photosynthesis, glycolysis, and protein synthesis.

Fourth, structures confer whatever powers they do necessarily. It is
metaphysically impossible for my structure not to confer on me the power
to grow lungs, skin, and bones. Critics might object that we can easily
conceive of situations in which I fail to develop normally, and end up
without lungs, skin, or bones. There are at least two ways hylomorphists
can respond to this kind of objection. Either they can deny that worlds
in which I lack the power to develop lungs, skin, and bones are genuinely
conceivable, or they can deny that the kind of conceivability we achieve
in these cases is a reliable guide to possibility. Consider an example of the
first strategy. Hylomorphists can claim that when we take ourselves to be
conceiving of me lacking the power to develop lungs, skin, or bones we are
really conceiving of me in circumstances in which something is inhibiting
my power to develop normally. Recall that powers can inhibit or enhance
the manifestation of other powers; that includes the powers of living things.
It is possible for outside influences to interfere with the ways my structure
is manifested—teratogenic agents that could prevent me from developing
lungs, skin, or bones. If critics insist that they are conceiving of me fail-
ing to develop lungs, skin, or bones in the absence of outside influences,
hylomorphists have the option of shifting to the second strategy; they can
accept that the critics are in some sense conceiving what they say, but deny
that conceiving in this sense is any guide to what is possible. Perhaps critics
are tacitly using an epistemic notion of conceivability (Shoemaker 1980,
231), and when they say that they are conceiving of me failing to meet
various developmental milestones in the absence of any noxious outside
influences, they are merely saying that such a circumstance is not inconsis-
tent with everything they know about human development. This kind of
conceivability is clearly not an infallible indicator of possibility, for among
other things, critics might not know much about human development. It is
possible that if they knew more, they might no longer be able to conceive
what they currently do.

With these points in mind, consider again the theoretical roles attributed
to structures in Section 1. It should be apparent how structure makes a
difference on the hylomorphic view. Structures are powers. Consequently,
if something has a structure, it has powers that it would not otherwise
have. Structure thus makes a difference. Structure also matters. Structured
individuals have their configuring properties essentially; each is essentially
an organizer of materials. For a structured individual to cease configuring
some materials or other is for that individual to cease to exist. Structures
are thus essential properties of structured individuals. In addition, unlike
many of the powers we have considered, structures cannot go unmanifested.
Crystals of table salt can sit idly; their power to dissolve in water can
remain forever unmanifested. But there is no sitting idle when it comes
to my power to configure the materials that compose me. If I am not
manifesting that power, if I am not configuring those materials, then I
do not exist, and if I do not exist, then there is no individual to do my
configuring. Structures, then, are not just essential powers of structured
individuals; they are powers of structured individuals that are essentially
manifested, that cannot exist unmanifested.

Structure also counts; it explains the unity and persistence of composite
individuals, and in the case of living things that means explaining their
unity and persistence through the dynamic influx and efflux of matter and
energy that characterizes their interactions with the surrounding world.
To understand how structure plays this role, it is helpful to consider the
hylomorphic view of composition.

4 Hylomorphic Composition

The hylomorphic view of composition is similar in its outlines to Peter
van Inwagen’s (1990). Van Inwagen presents his view as an answer to the
Special Composition Question (SCQ): Under what conditions do multiple
things compose one thing? Extreme answers to the SCQ are offered by
mereological universalists, on the one hand, who claim that composition
happens under any conditions, and mereological nihilists, on the other, who
claim that composition happens under no conditions. Moderate answers to
the SCQ claim that composition happens under some conditions but not
under all. Van Inwagen’s own moderate answer claims that composition
happens exactly if the activities of some fundamental physical particles
constitute a life. By ‘a life’ van Inwagen takes himself to mean what
biologists do: “the individual life of a concrete biological organism . . .
[the] sense according to which ‘Russell’s life’ denotes a purely biological
event” (van Inwagen 1990, 83). Van Inwagen’s descriptions of lives stay
largely at the level of metaphor and analogy. The reason is that providing
the literal details of what lives are and what characteristics they have is, he
thinks, an empirical undertaking (1990, 84).

Van Inwagen’s answer to the SCQ implies that x is a proper part of y if
and only if y is an organism and x is caught up in the life of y (1990, 94).
The expression “caught up in a life” is one that van Inwagen borrows from
the biologist J. Z. Young (1971). Van Inwagen explains with an example:

Alice drinks a cup of tea in which a lump of sugar has
been dissolved. A certain carbon atom . . . is carried along
with the rest of the sugar by Alice’s digestive system to
the intestine. It passes through the intestinal wall and into
the bloodstream, whence it is carried to the biceps muscle
of Alice’s left arm. There it is oxidized in several indirect
stages (yielding in the process energy . . . for muscular
contraction) and is finally carried by Alice’s circulatory
system to her lungs and there breathed out as a part of
a carbon dioxide molecule. . . . Here we have a case in
which a thing, the carbon atom, was . . . caught up in the
life of an organism, Alice. It is . . . a case in which a thing
became however briefly, a part of a larger thing when it
was a part of nothing before or after. . . . (1990, 94–95)

According to van Inwagen, then, composition does not happen apart
from lives; composite beings are all living things. So there are two kinds
of material beings on van Inwagen’s view: mereological simples (material
beings with no proper parts) and living things. Moreover, the only liv-
ing things, according to van Inwagen, are single cells and multicellular
organisms.

Van Inwagen’s view has several noteworthy implications. First, it implies
what he calls ‘the Denial,’ the claim that many objects belonging to a
commonsense ontology do not exist. Examples include artifacts such as
tables and chairs, and also natural bodies such as rocks, mountains, stars,
and planets. Since the only material beings on van Inwagen’s view are
living things and mereological simples, and tables, chairs, mountains, and
so on are neither simples nor living things, van Inwagen’s view implies that
these things do not exist (he calls them ‘virtual objects’). Although this
seems counterintuitive, van Inwagen argues that his view can accommodate
our pedestrian intuitions. The reason is that it is possible to paraphrase
statements that are apparently about artifacts and natural bodies in ways
that mention only mereological simples. When we say that there is a chair
in the corner, for instance, we are really saying that certain mereological
simples are arranged in the corner chairwise. This strategy allows van
Inwagen to countenance ordinary talk of artifacts, mountains, and stars
without compromising his answer to the SCQ.

The Denial also enables van Inwagen to solve philosophical puzzles
about composition. Consider two examples. The first is a biological
analogue of the Ship of Theseus. Organisms are constantly exchanging the
materials that compose them for new materials. Suppose, then, that I am
an organism composed by the xs at time $t_1$. Gradually the xs come to be
replaced entirely by the ys at time $t_2$. Suppose, moreover, that at that time
the xs themselves get reassembled into an exact replica of the organism
composed by the ys. Which organism, if either, am I: the one composed
of the ys, or the replica composed of the reassembled xs? Van Inwagen’s
answer is that I am the organism composed of the ys since organisms can
survive gradual part replacement. The reason is that they persist on account
of their lives (van Inwagen 1990, 148–149). So long as the life constituted
by the activity of the xs at $t_1$ persists, I persist. Since the life constituted by
the activity of the $x$s at $t_1$ is the same as the life constituted by the $y$s at $t_2$,
it follows that I am the organism composed of the $y$s at $t_2$.

The second problem is a biological analogue of the statue-lump puzzle.
I share all the same parts with the mass of matter that composes me at
exactly the same time. But two things cannot share all the same parts at
exactly the same time, so I must be identical to the mass of matter. But
the mass and I cannot be identical since we have different properties. The
mass of matter existed (scattered throughout the biosphere) before I did,
and unlike me it can survive being squashed. Since the mass and I have
different properties, it follows from Leibniz’s law that we must be distinct.
There is thus good reason to think both that the mass and I are identical
and that the mass and I are distinct. Van Inwagen’s (1990, 144) solution
is to deny that there are masses of matter (or lumps, chunks, or hunks of
matter). The particles that occupy my location compose nothing other than
me, and in that case, there is nothing—no mass of matter—located exactly
where I am in addition to I myself, so there can be no question whether I
am identical to a mass of matter.

Why does van Inwagen stop with organisms? Why not deny that all
composites exist? Van Inwagen’s most compelling answer is that organisms
have _nonredundant_ causal powers that other alleged composites lack. The
activities attributed to artifacts and natural bodies can be understood
as disguised cooperative activities performed by simples. The chair, the
mountain, and the planet don’t do anything that cannot be exhaustively
described and explained by appeal to the activities of mereological simples,
but according to van Inwagen, not all activities are like this. Organisms
are capable of doing things that cannot be done by simples alone but only
by composite individuals. We are thus forced to grant that they exist as
distinctive individuals since they engage in activities (such as thinking)
which, van Inwagen argues, cannot be performed by simples alone (1990,
118, 122). There are thus good reasons, van Inwagen thinks, for accepting
that organisms exist while yet denying that artifacts and natural bodies do.

Importantly, then, van Inwagen’s view implies a kind of property pluralism.
Living things have properties, such as thinking, which are different from
any of the properties had by simples. As a result, those properties cannot
be understood as cooperative activities performed by simples; they must be
understood as properties unique to living wholes.

Let the foregoing remarks suffice for an overview of van Inwagen’s
account of composition. Importantly, van Inwagen’s lives play precisely
the kinds of theoretical roles that hylomorphic structures are supposed to
play. _Lives matter_ on van Inwagen’s view; they are ontological principles:
whether the $x$s constitute a life makes a difference to whether or not some
composite individual exists. Likewise, _lives make a difference_; they are
explanatory principles: living things are capable of doing things that cannot
be exhaustively described and explained using the conceptual resources
used to describe and explain the materials that compose them (1990, 122,
Finally, *lives count*; they operate as principles of unity (121) and persistence (145, 148). What binds the simples that compose me into a single being is that their activity constitutes a life, and what enables me to persist through changes in those simples is the persistence of that life. Because van Inwagen's lives play these roles, it is easy to use his view of composition as a basis for developing the hylomorphic view.

Like van Inwagen's view, the hylomorphic view of composition provides a moderate answer to the SCQ. Configuring materials and being composed of materials are co-foundational concepts on the hylomorphic view, just as having a life and being composed of simples are co-foundational concepts on van Inwagen's. Likewise, just as van Inwagen restricts composition to living things, hylomorphists restrict it to structured individuals in general. According to hylomorphists, composition occurs when and only when an individual configures materials; there is a y such that the xs compose y if and only if y is an individual that configures the xs. I will call individuals that configure the materials composing them structured individuals.

Structured individuals are emergent individuals on the hylomorphic view. There are empirically describable conditions that are sufficient to bring into existence new structured individuals where previously no such individuals existed. Once a structured individual comes into existence it is essentially and continuously engaged in configuring materials. The materials it configures are precisely those that compose it. When it comes to characterizing the configuring activity of structured individuals, hylomorphists can adopt most of what van Inwagen says about lives, at least when it comes to the configuring activities of living things, the paradigmatic structured individuals. My life is identical to my configuring various fundamental physical materials at various times—an event that has the characteristics van Inwagen attributes to lives, and that has many other characteristics it is business of the biological sciences to describe. An individual living thing does not configure exactly the same materials for very long since those materials are in constant flux; despite this, the individual maintains itself one and the same through all the changes on account of its ongoing configuring activity. That activity is what unifies various materials into a single individual, both synchronically and diachronically, just as lives do on van Inwagen's account.

The hylomorphic view has many of the same implications as van Inwagen's. It rejects the existence of artifacts, and masses (or chunks, hunks, or lumps) of matter, and can therefore solve philosophical puzzles about composition in the same way van Inwagen does. It is also committed to property pluralism. It implies that structured individuals have properties of at least two sorts: properties due to their structures (or their integration into individuals with structures), and properties due to their materials alone independent of the ways they are structured. Subatomic particles, atoms, and molecules have physical properties, such as mass, irrespective of their surroundings. Under the right conditions, however, they can contribute to
the activities of living things. Nucleic acids, hormones, and neural transmitters are examples. They are genes, growth factors, and metabolic and behavioral regulators. Each admits of two types of descriptions. They can be described in terms of the contributions they make to a structured system, but they are also independently describable in noncontribution-oriented terms. Descriptions of the former sort express the properties that are characteristic of structured individuals such as organisms and their parts. Descriptions of the latter sort express the properties they possess independent of their integration into structured wholes. A strand of DNA might always have various atomic or fundamental physical properties regardless of its environment, but it acquires new properties when it is integrated into a cell and begins making contributions to the cell’s activities. It becomes a gene, a part of the cell that plays a role in, say, protein synthesis. Some philosophers and biologists call the “new” properties acquired by structured systems emergent properties.

There are nevertheless three noteworthy differences between the hylomorphic view and van Inwagen’s. First, van Inwagen is a committed atomist; he claims that fundamental physical materials are particulate. Hylomorphists are not committed to this. They assume that fundamental physical entities are capable of composing structured wholes, but they do not take a further stand on the natures of those entities. They instead leave it to the relevant empirical disciplines to tell us what their natures are. To express this neutrality about the nature of fundamental physical entities, I’ve used the term ‘materials’ to refer to them since the term ‘materials’ can be applied both to discrete individuals and to continuous stuffs (‘building materials,’ for instance, can be applied both to individual timbers and nails, and to stuffs such as glue, metal, and wood).

Second, van Inwagen limits composition to living things. According to hylomorphists, living things are the paradigmatic structured individuals, but hylomorphists do not rule out a priori the possibility that there might be structured individuals of other sorts. Consider atoms and molecules. Van Inwagen claims that they do not exist; they are virtual objects that are virtually composed of mereological simples. Hylomorphists are free to take the same stance as van Inwagen, but two more options are available to them. They can claim that atoms and molecules are structured wholes in their own right distinct from living things and their parts, or they can claim that atoms and molecules are parts of living things and the atom and molecule-wise arrangements of fundamental physical materials we find outside organisms are virtual objects in van Inwagen’s sense. Which stance they take depends on broadly empirical considerations. If atoms and molecules are discovered to have powers distinct from those that can be exhaustively described and explained by appeal to fundamental physical materials alone, then there are grounds for claiming that they are not mere aggregates of fundamental physical materials, but distinctive individuals in their own right. Hylomorphists thus countenance a larger
ontology than van Inwagen’s. His ontology includes mereological simples and organisms. Hylomorphism’s includes fundamental physical materials, structured individuals (which might include individuals other than living things), and their parts.

Third, the hylomorphic view of parts is less revisionary than van Inwagen’s. Van Inwagen (1981; 1990) denies that there are organic parts such as eyes, hearts, and kidneys; the only proper parts are fundamental physical particles and individual cells. Hylomorphists, by contrast, accept that there are parts such as eyes, hearts, and kidneys. Their reasons for doing so are again broadly empirical. Our best descriptions and explanations of human behavior postulate parts like these, and this gives us good reason to think that such parts exist. It is worth considering the argument for this claim in greater detail.

There are multiple ways of dividing things into parts. A hammer can be exhaustively decomposed into functional parts such as the head, the claw, and the handle—parts that contribute to the hammer’s overall operation. It can also be exhaustively decomposed into spatial parts such as the top third, the middle third, and the bottom third, or into the spatial parts obtained by dividing the hammer along the lines of a three-dimensional coordinate grid with metric units. Different principles of part identity and individuation yield different inventories of parts, all of which may be consistent with principles of formal mereology such as the transitivity and asymmetry of proper parthood. Because there are many different principles for part identity and individuation, whenever we want to consider the parts that a particular individual has we need to determine which principle is (or which principles are) best suited to our descriptive and explanatory interests. If we accept a broad naturalism in matters of ontology, then empirical adequacy is an important criterion for making that determination. A broad ontological naturalism implies that when it comes to determining what exists, empirical investigation—paradigmatically science—is our best guide. Consequently, when it comes to choosing principles of part identity and individuation for various individuals, we should choose principles that reflect our best empirical descriptions and explanations of their behavior. Roughly, if principle $P$ does a better job enabling us to describe and explain the behavior of $K$s than principle $P^*$, then we have good reason to accept that $K$s have parts that are identified and individuated by $P$ instead of $P^*$.

Consider now living things such as human organisms. Like the hammer, a human can be divided along purely spatial lines into thirds or fifths, or along the lines of a three-dimensional coordinate grid with metric units. However, biologists, neuroscientists, and psychologists are more interested in dividing humans and other organisms along functional rather than purely
spatial lines (Bechtel 2007, 2008; Craver 2007).\(^4\) Perhaps the best example of how the biological sciences divide organisms into hierarchically ordered functional parts is provided by the method functional analysis (other names include ‘mechanical decomposition’ or ‘functional decomposition’).\(^5\)

Functional analysis is a method that biologists, cognitive scientists, engineers, and others frequently employ to understand how complex systems operate. It involves analyzing the activities of those systems into simpler subactivities performed by simpler subsystems (Fodor 1968; Cummins 1975; Lycan 1987, Ch. 4; Bechtel and Richardson 1993; Glennan 2002; Bechtel 2007, 2008; Craver 2007).\(^6\) Consider a complex human activity such as running. Functional analysis reveals that running involves a circulatory subsystem that is responsible for supplying oxygenated blood to the muscles. Analysis of that subsystem reveals that it has a component responsible for pumping the blood—a heart. Analysis of the heart’s pumping activity shows that it is composed of muscle tissues that undergo frequent contraction and relaxation. These activities can be analyzed into the subactivities of various cells, and these in turn can be analyzed into the operations of various organelles. This analytic process continues until something is discovered to have a property or to engage in an activity not on account of the activities of some lower-level subsystems, but as an unanalyzable matter of fact. At that point, functional analysis comes to an end.

Functional analysis is important because it provides a basis for understanding the kinds of parts postulated by descriptions and explanations in the biological sciences. Those parts are subsystems or components, things that contribute in empirically specifiable ways to the activities of the wholes to which they belong. Saying that \(x\) is a part of \(y\) implies that \(y\) engages in some activity, that there is a functional analysis of that activity into subactivities, and that \(x\) performs one of those subactivities. Saying that my heart is part of me is saying that my activities can be given an analysis into subactivities (or those into further sub-subactivities, and so on), and that one of those subactivities (or sub-subactivities or sub-sub- . . . subactivities) is performed by the heart. What distinguish different parts of me from

\(^4\) Carl Craver (2007, Ch. 5) calls purely spatial parts ‘pieces’ and parts in the functional sense ‘components.’ John Heil (2003, 100) also suggests something like the distinction between merely spatial parts and parts of other sorts, which he calls ‘substantial parts.’

\(^5\) The term ‘functional analysis’ is due to Cummins (1975). Bechtel (2008) calls it ‘mechanistic decomposition’ or ‘functional decomposition.’ Craver (2007) subsumes it under the heading of ‘mechanistic explanation.’ He takes Cummins’s notion of functional analysis to be the exemplar of what he calls the ‘systems tradition,’ but argues that Cummins fails to provide an adequate account of mechanistic explanation. He thus distances himself from the term ‘functional analysis.’

\(^6\) Elsewhere I have discussed functional analysis in greater detail. I have argued among other things that it does not correspond to the notion of function that is operative in discussions of functionalism in the philosophy of mind (including teleological functionalism), and that it does not imply a commitment to reductionism (Jaworski 2011, 2012).
each other, moreover, are the different ways they contribute to my activities: different parts contribute in different ways.

Because hylomorphism endorses this account of parthood, its inventory of parts that exist is less revisionary than van Inwagen’s. It is able to countenance the functional parts postulated by the biological sciences, and in many cases these will include parts that are postulated by common sense, such as eyes and hearts.

5 Functional Parts and the Body-minus Problem

I want to close by considering an objection to the claim that there are functional parts. Van Inwagen (1981) argues that there is no principled reason for choosing to divide an organism into the kinds of functional parts we recognize in our pedestrian dealings as opposed to, say, parts on a metric grid. Functional divisions do not reflect anything deep in reality, only our peculiar descriptive interests. We can easily imagine a race of beings with descriptive interests different from ours who would divide humans into parts in a way that is different from the way we customarily do. Consequently, says van Inwagen, hands, eyes, hearts, and other functional parts are arbitrary; there is no principled reason for choosing to postulate them instead of parts of various other sorts. But arbitrary parts do not exist, for their existence would generate body-minus problems (Wiggins 1968; Burke 1994). Consider an example. It focuses on the brainstem. Why the brainstem? Eric Olson (1996) has argued that there is good empirical reason to suppose that the brainstem is the functional part with which at the barest minimum a human can survive: a human survives if and only if his or her brainstem does. Call this the ‘brainstem survival thesis,’ and suppose that Olson is right about it. We can now formulate a body-minus problem:

1. Descartes exists before \( t \), and (2) a proper part of him, namely his brainstem, \( B \), exists before \( t \). Due to some catastrophe, however, every proper part of Descartes except \( B \) and its proper parts is destroyed at time \( t \). (3) If \( B \) is the bare minimum functional part with which a human animal can survive, then Descartes survives the catastrophe. So Descartes exists after \( t \). But (4) \( B \) also survives the catastrophe, so it too exists after \( t \). Now, it seems that after \( t \) Descartes must be identical to \( B \) since (5) after \( t \) Descartes and \( B \) have the same size, shape, position, orientation, attitude, mass, velocity, and color, but (6) two objects cannot have the same size, shape, position, orientation, attitude, mass, velocity, and color. Hence, Descartes and \( B \) must be one, yet the identity of Descartes and \( B \) would violate Leibniz’s law since Descartes used to have arms and legs, but
B did not. There are thus good reasons to think both that Descartes and B are identical, and that they are distinct.

Van Inwagen’s solution to the problem is to deny claim (2). If there is no such thing as Descartes’s brainstem, then the body-minus problem never gets off the ground. Hylomorphists, however, endorse the existence of functional parts, so they cannot reject claim (2). They look instead to reject claim (4). According to them ‘B’ designates a proper part of Descartes that immediately prior to \( t \) was composed of objects \( f_1, f_2, \ldots, f_n \) (the cells, organelles, molecules, and so forth that would be revealed through functional analyses of B’s activities before \( t \)). After time \( t \), however, \( f_1, f_2, \ldots, f_n \) no longer compose a proper part of Descartes; they compose only Descartes himself. What had been a proper part of Descartes, his brainstem, no longer exists even though Descartes does.

This solution implies that the brainstem survival thesis is false, but since there are empirical reasons to think the thesis is true, hylomorphists should try to find a way of accommodating something very much like it. Here is one suggestion: Suppose that Descartes will continue to exist as long as \( f_1, f_2, \ldots, f_n \) continue to contribute to his overall operation as they have done hitherto, but that if any of them is damaged or destroyed, and is thus incapable of performing its contributing subactivity at a time, then Descartes will cease to exist at that time. Collectively, then, \( f_1, f_2, \ldots, f_n \) constitute a core of functional components that Descartes needs to exist, and that are sufficient to enable him to exist. They are in this sense the barest minimum functional parts with which Descartes can survive. Objects \( f_1, f_2, \ldots, f_n \) composed Descartes’s brainstem prior to \( t \), and as a result, someone might be tempted to say that Descartes’s brainstem is the bare minimum Descartes needs to survive, but strictly speaking this is false. What is true instead is that \( f_1, f_2, \ldots, f_n \) are the bare minimum that Descartes needs to survive, and \( f_1, f_2, \ldots, f_n \) needn’t compose a brainstem. Descartes thus survives the catastrophe along with the proper parts that used to compose his brainstem, but that now compose only him.

Critics might complain that it is implausible to suppose that Descartes’s brainstem would disappear even though all the parts that previously composed it remain where they are. There are at least two things hylomorphists can say in response. First, the objection appears to be tacitly committed to the idea that the intrinsic properties and the spatial arrangement of \( f_1, f_2, \ldots, f_n \) are sufficient for those things to compose a brainstem. But the functional account of composition suggests otherwise. For \( f_1, f_2, \ldots, f_n \) to compose something, they must contribute to the activities of the whole they compose. Suppose, then, that brainstems are essentially things that coordinate the activities of diverse organ systems.\(^7\) When Descartes is whittled down to \( f_1, f_2, \ldots, f_n \), he no longer has any diverse organ

\(^7\) Van Inwagen (1990, 177–178) himself appears to endorse a principle like this.
systems to coordinate. In that case, however, it is not implausible to claim that he does not have a brainstem among his proper parts.

Second, hylomorphists can argue that even if it is implausible to suppose that Descartes's brainstem ceases to exist when he is whittled down, it is nevertheless no more implausible than the alternatives. It is no more implausible, for instance, than claiming that Descartes's brainstem never existed at all. If this solution to the body-minus problem is no more implausible than the alternatives, then the charge of implausibility loses its force.

There is clearly a great deal more to be said about the hylomorphic notion of structure. I nevertheless hope that what I have said here provides a serviceable introduction to an account of hylomorphic structure different from those currently on offer.

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